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# **Validation and Optimization of the Oral Health-Related Section of the InterRAI Suite of Assessment Instruments**

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# Table of contents

Abbreviations.....	5
Introduction.....	9
Oral health in older adults: changes and challenges.....	11
Consequences of oral disease in older adults.....	13
Improving oral health in care-dependent older adults.....	15
Oral health assessment by non-dental caregivers.....	17
Minimum Data Set and interRAI suite of instruments.....	18
The oral health-related section of the interRAI suite of instruments.....	20
References.....	23
Objectives and research questions.....	35
Chapter 1: Reasons for the failure of the current ohr-interRAI section.....	39
1.1 Expert rating and caregiver opinion.....	41
1.2 Missing oral health-related data in the interRAI.....	57
Chapter 2: The optimized photograph-supported ohr-interRAI section.....	69
2.1 Assessment of oral health conditions presented in photographs.....	71
2.2 Development and validation of an optimized ohr-interRAI section.....	81
Chapter 3: Practice guidelines for daily oral hygiene care.....	105
Development of practice guidelines for daily oral hygiene care.....	107
General discussion.....	127
Interpretation and relevance of the study results.....	129
Methodological considerations.....	133
Future perspectives.....	136
Impact and relevance.....	138
Conclusion.....	140
References.....	141
Supplementary material.....	147
A Refined optimized ohr-interRAI section.....	149
B CAP assistance with hygiene.....	159
C CAP referral to dentist.....	165
D Summary.....	167
E Samenvatting.....	169
F Acknowledgments and conflict of interest.....	173
G List of publications.....	175
H About the author.....	179
Personal acknowledgments.....	180



# Abbreviations

## Abbreviations

ADA	American Dental Association
ADLH	Activities of Daily Life Hierarchy
BelRAI	Belgian interRAI version
BOHSE	Brief Oral Health Status Examination
CA	Consensus on Agreement
CAP	Clinical Assessment Protocol
CI	Confidence Interval
CPS	Cognition Performance Scale
CVI	Content Validity Index
DHR	Dental Hygiene Registration
DRS	Depression Rating Scale
IMA	Intermutualistisch Agentschap
InterRAI AC	InterRAI Acute Care
InterRAI HC	InterRAI Home Care
InterRAI LTCF	InterRAI Long-Term Care Facilities
InterRAI PC	InterRAI Palliative Care
IQR	Inter Quartile Range
MDS	Minimum Data Set
MICE	Multivariate Imputation by Chained Equations
MPS	Mucosal Plaque Score
OAS	Oral Assessment Sheet
OR	Odds Ratio
OHAT	Oral Health Assessment Tool
Ohr-interRAI	Oral health-related section of the interRAI
Ohr-MDS	Oral health-related section of the Minimum Data Set
OHSTNP	Oral Health Screening Tool for Nursing Personnel
RAI	Resident Assessment Instrument
ROAG	Revised Oral Assessment Guide
THROAT	The Holistic Reliable Oral Assessment Tool
VAS	Visual Analogue Scale
VIF	Variance Inflation Factors



# Introduction

## Introduction

## Oral health in older adults: changes and challenges

Moving towards an aging world, in 2018 for the first time in history the number of people older than 64 years old surpassed the number of children under 5 years old <sup>1</sup>. This demographic transition results from the combination of decreasing fertility rates with increasing life expectancy. Globally, the number of older people is growing and due to the further rise of maximum life expectancy, the older population is further aging <sup>2</sup>. Ideally, the added life years are spent in good health.

Good oral health is a key indicator of overall health and well-being. The World Health Organization defines good oral health as ‘... *a state of being free from mouth and facial pain, oral diseases and disorders that limit an individual’s capacity in biting, chewing, smiling, speaking and psychosocial well-being*’<sup>3</sup>.

When a person ages, this process triggers physiological, normal changes in oral morphology. The oral mucosa is increasingly thinning <sup>4</sup> with epithelial cells tending to become larger and flatter <sup>5</sup>. Teeth appear slightly shorter and more yellowy-colored due to enamel wear and dentine sclerosis <sup>6</sup>. The latter also reduces sensitivity of the teeth. These physiological changes need to be distinguished from oral pathology. Mucosal lesions such as candidiasis and malignancies are often found in older adults <sup>7,8</sup>, but the most prevalent oral diseases are caries and periodontitis <sup>9</sup>. Both caries and periodontitis are related to the oral biofilm and they represent the main reasons for oral discomfort and tooth loss. Their relationship with age is complex: as caries and periodontitis cumulate over lifetime, the experience of disease increases with age <sup>9</sup>. Due to gingival recession, the number of surfaces at risk for caries further increases <sup>10</sup>. When extracted teeth are replaced by partial removable dentures, a vicious circle is triggered causing more periodontal damage and caries in abutment teeth <sup>11</sup>. Only limited evidence is available indicating that older adults are inherently more vulnerable to caries and periodontitis <sup>9</sup>. Physiological and medication-related hyposalivation <sup>12</sup>, immune senescence <sup>13</sup> and reduced wound healing capacity <sup>10</sup> might facilitate oral pathology. The normal aging process, disease or medication use can also reduce the gustatory sense in older adults <sup>14</sup>, leading to altered dietary choices that contain more sugars. Eventually, age-related physical and

## Introduction

cognitive impairment affects the capability to perform adequate daily oral hygiene and impedes the access to professional dental care.

In the past, loss of teeth in older adults was common and has been considered an inevitable old-age phenomenon. However, over the last three decades, older adults keep their natural dentition longer and rates of edentulism are declining. This evolution is more prevalent in high-income countries and results from improvements in prevention and from the adoption of less invasive techniques in dentistry<sup>15,16</sup>. Another trend is the increased use of dental implants to replace extracted teeth<sup>17</sup>. However, when older adults become functionally dependent and thorough maintenance of natural teeth and dental restorations is failing, oral health deteriorates quickly<sup>15,18</sup>. Literature consistently shows that oral health is particularly poor in care-dependent older adults<sup>8,19–24</sup>.



*Illustration 1: Accumulation of dental plaque, tooth decay and gum inflammation are often found in care-dependent older persons*

For example, a survey on oral health in frail older people in Belgium reported non-adequate oral hygiene in more than 60% of the participants. Among dentate study subjects, severe periodontal disease was prevalent in 36% and 77% was in need of dental treatment. Mucosal lesions were observed in about 25% of the older adults<sup>25</sup>. A Canadian study in long-term care residents reported moderate or severe inflammation on at least one tooth in 80% of the dentate subjects. Denture hygiene was poor in 43% of the residents who wore a removable denture<sup>22</sup>. Clinical data from care-dependent older adults in Sweden showed that among 16,210 dentate individuals, 68% had manifest caries<sup>20</sup>. An article on geriatric oral health in Japan confirmed the increase of tooth retention. At the same time, treatment of caries and periodontitis also increased in the older population<sup>26</sup>.

**In current society, the older population is growing and further aging. Older adults keep their natural dentition longer, but when they become care-dependent, oral health deteriorates quickly.**

## Consequences of oral disease in older adults

### Oral biofilm formation

When daily oral hygiene is poor, bacteria associate together forming dense multicellular communities called biofilm. The oral biofilm is a complex entity that consists of microbes and is held together by a matrix of excreted polymeric compounds providing protection, adhesion, stabilization and nutrients. Within the biofilm, proteolytic enzymes are produced that can cause direct damage to soft and hard tissues, but also interfere with host defense mechanisms. Structure of the biofilm and changes in gene expression further protects the included microbes from disinfectant agents or antibiotics<sup>27</sup>. If not disrupted by daily oral hygiene, the oral biofilm matures, which is the main cause of dental decay, periodontitis, mucosal inflammation and subsequent effects on general health and well-being.

### Local consequences of oral disease

Mucosal oral lesions such as candidosis, denture stomatitis or large carcinomas can cause discomfort and hamper normal oral functioning<sup>28</sup>. When the size of a caries cavity increases, this can gradually cause painful inflammation of the pulp, necrosis, abscess formation and fracturing of the tooth. Periodontitis is usually painless, but causes discomfort when teeth become mobile in an advanced stage of the disease. When left untreated, caries and periodontitis finally result in the loss of teeth. Tooth removal is followed by progressive resorption of the alveolar bone. Combined with the loss of occluding contacts, this causes a reduction in the vertical dimension of the face. Further morphological changes include prognathism, narrowing lips and deepening of naso-labial grooves, causing the typical 'old age' appearance of edentulous adults<sup>29</sup>. Advanced bone atrophy in the mandible often impairs conventional denture stability<sup>30</sup>. With regard to oral functioning it has been indicated that extensive uncompensated tooth loss is associated with impaired chewing ability<sup>31</sup> and swallowing dysfunction<sup>32</sup>.

## Introduction

But even when treated with complete dentures, edentulous individuals have lost the sensory input from (perio-) dental neural receptors. The latter are involved in oral muscle-patterns and proprioceptive signals <sup>33</sup>.

## Oral disease and general health

As the mouth is a part of the human body, oral disease and loss of function are associated with other health aspects. It was even shown that oral health indicators can predict general health indicators in the future, and vice-versa <sup>34,35</sup>.

Convincing evidence is available on the relationship between oral plaque accumulation and aspiration pneumonia in older adults. Literature concludes unanimously that oral hygiene confines the incidence of pneumonia <sup>36-38</sup>. About one in ten cases of pneumonia-associated death might be prevented by oral care <sup>36</sup>, particularly when interventions are provided by dental care professionals <sup>38</sup>.

The relation of periodontitis with diabetes mellitus and with cardiovascular disease is also well-studied. The link seems to be based on pathogenic mechanisms that are triggered by chronic inflammation <sup>39</sup>. Literature shows a two-way-relationship between periodontitis and diabetes mellitus, with periodontitis affecting diabetes incidence, glycemic control and risk of complications <sup>40</sup>. Periodontitis patients further have a higher risk to experience cardiovascular events <sup>39,41</sup>, while treatment of the disease improves the atherosclerotic profile <sup>42</sup>.

A variety of literature is available on the impact of oral functioning. The interrelation between chewing problems and cognition is complex. On the one hand, cognitive decline impairs self-care ability, which in turn results in the deterioration of oral health. On the other hand, evidence is accumulating that poor chewing ability causes a decline in cognitive function, mediated by reduced cerebral blood flow <sup>43,44</sup>. It was further shown that chewing difficulty and other oral health problems are associated with functional status and frailty. This indicates that oral health problems can be a valuable predictor of general health decline <sup>45-47</sup>.

## Oral disease and well-being

Eventually, a clean mouth and painless oral functioning are fundamental for oral health-related quality of life<sup>48,49</sup>. Oral malodour is associated with dorsal tongue coating and periodontitis<sup>50</sup>. It reduces self-confidence and causes avoidance and burdening of social contacts<sup>51</sup>. An unpleasant breath in care-dependent older adults can adversely affect contact with family and professional caregivers. A prospective cohort study with older adults in Brazil further showed that tooth loss and chewing problems affected general well-being. Satisfaction with oral appearance also played a role<sup>52</sup>. Accordingly, a study with older adults in Germany reported that oral health-related quality of life at baseline was a substantial predictor of subjective well-being ten years later<sup>53</sup>. A systematic literature review also indicated a link between poor oral health and hygiene and reduced food perception<sup>54</sup>. This is relevant, as satisfaction with dietary life affects oral health-related quality of life and subjective well-being in older adults<sup>55</sup>. In addition, evidence is available that the deterioration of oral health and oral health-related quality of life is associated with a higher risk of depressive symptoms in older populations<sup>56,57</sup>.

**Oral disease in older adults is inversely associated with general health and well-being.**

## Improving oral health in care-dependent older adults

In institutional settings for care-dependent older adults the cornerstones of effective oral health programs consist of daily oral hygiene care, professional dental treatment and regular oral health assessment<sup>58</sup>.

Daily oral hygiene care aims to prevent dental decay and gum disease by disintegration of the bacterial biofilm and application of active ingredients<sup>59</sup>. To protect abutment teeth and oral mucosa covered, removable dentures need to be cleaned as well. In care-dependent older adults, the ability to perform adequate oral hygiene is often reduced due to impaired manual dexterity and cognitive functioning<sup>60</sup>. In professional care-settings, this task is usually assisted or performed by care aides. However, the provision of daily oral hygiene care is complex and particularly challenging in dentate individuals suffering from dementia. Systematic literature reviews on the

## Introduction

main barriers to provide oral hygiene care identified clients' non-cooperative behavior, time constraints, and care aides' lack of knowledge, education and training. Indistinct responsibility or lack of staff were shown to play a role as well <sup>61,62</sup>. Regular presence of a dental care professional was identified as a facilitator <sup>62</sup>. Accordingly, a multi-faceted approach is required to improve daily oral hygiene in professional care settings.

Professional dental treatment is usually provided by a dentist, but certain activities can be performed by an oral hygienist as well. A study from Wales showed that treatment in care homes mainly consisted of basic dentistry such as oral hygiene instruction, scaling, direct restorations, denture renewal and fluoride application <sup>63</sup>. However, the frequency of dental visits declines with age <sup>64</sup>. As a result, oral problems aggravate and more complex treatment is needed in patients who are already challenging due to polypharmacy and impaired cooperation, communication and maneuverability in the dental chair. Accordingly, it was confirmed that additional time is often needed when treating care-dependent older adults <sup>63</sup>. Systematic review on the main barriers for professional dental treatment identified lack of suitable facilities, difficulty with transportation, and non-cooperative behavior of care-dependent older adults <sup>62</sup>.

Regular oral health assessment is the basis, allowing to monitor and adapt the previous aspects. The physical and cognitive condition of older persons is dynamic, in general aggravating over time. This includes the capability to perform adequate daily oral hygiene. Only when the oral state is evaluated regularly, deterioration can be detected early and preventive countermeasures can be taken in time. In addition, less complex professional treatment procedures are required. Systematic literature review confirms that regular dental visits facilitate dental treatment in care dependent older persons <sup>62</sup>. However, it was shown that even among community-living older adults, a significant proportion loses contact with dental services despite enrollment in a recall system <sup>65</sup>. In addition, with increasing age, dental appointments shift from prevention to more complaint-oriented <sup>66</sup>. This is a problem as older adults often are not aware of their oral health or do not worry about it <sup>67,68</sup>. Impaired communication skills further reduce the probability that complaints are expressed actively which further emphasizes the need to regularly assess the mouth.

**Regular oral health assessment belongs to the cornerstones of effective oral health programs for care-dependent older adults.**

## **Oral health assessment by non-dental caregivers**

In an ideal situation, regular oral check-ups are performed by a dental professional. However, particularly in rural areas a dentist is not always located nearby and access to the dental practice can further be complicated by impaired mobility of care-dependent older persons. Dentists might not be able or not willing to provide home visits and finally, financial aspects can refrain older persons from using preventive dental health services. Acute oral discomfort also needs to be evaluated in persons who regularly visit a dentist, but who have impaired skills to clearly communicate the problem. In such cases, regular oral health assessments by professional non-dental caregivers can help to detect care needs <sup>58</sup>.

Based on a simple and non-expensive approach that only requires basic equipment, care clients are screened for oral hygiene deficiency and the need for referral to an oral health professional for further evaluation <sup>69</sup>. It was shown that routine oral health assessment by caregivers facilitates dental treatment in care-dependent older adults <sup>62</sup>. To guide the oral assessment and to register the findings of the caregivers, a variety of instruments is available:

- Brief Oral Health Status Examination (BOHSE)
- Oral Health Assessment Tool (OHAT)
- Revised Oral Assessment Guide (ROAG)
- The Holistic Reliable Oral Assessment Tool (THROAT)
- Oral Assessment Sheet (OAS)
- Dental Hygiene Registration (DHR)
- Mucosal Plaque Score (MPS)
- Oral health-related section of the Minimum Data Set (MDS) <sup>69</sup>.

All instruments were developed to be applied by professional non-dental caregivers, such as nurses. They assess the condition of the mouth in care-dependent older adults <sup>70-75</sup> and register between two (DHR) and ten (BOHSE) oral health aspects. Most frequently, lips, mucosa membrane, tongue, gums, teeth, denture, saliva, and oral hygiene are assessed. The

## Introduction

instruments register whether oral health aspects appear healthy or not, using scales that consist of two to four points <sup>69</sup>.

Everaars et al. (2020) systematically reviewed measurement properties of the oral health assessments above. The authors reported that the main part of the included studies had at least partial methodological shortcomings. Studies varied extensively with regard to the professional background of the caregivers, how they were trained, or to what benchmark their registrations were compared with. Everaars et al. (2020) cautiously concluded that the OHAT and the ROAG were most frequently assessed in studies with sufficient methodological quality. However, evidence on adequacy of measurement properties is scarce, impeding a well-grounded recommendation on the most useful assessment instrument <sup>69</sup>.

To tackle oral health problems in the target population, ideally all care-dependent older adults should be assessed periodically. However, most oral assessment instruments for non-dental professional caregivers were developed and applied in a limited, rather academic context. The oral health-related section of the MDS/interRAI stands out and deserves closer consideration as it is already implemented and applied internationally on a large scale <sup>76</sup>.

**Oral health assessment by non-dental professional caregivers can help to detect problems early and facilitate preventive and curative treatment.**

## Minimum Data Set and interRAI suite of instruments

In modern Western societies an extensive and complex care system has arisen to cover the needs of older adults suffering from chronic conditions. To ensure high quality of care, a comprehensive and holistic assessment of the persons' care needs and capacities is essential <sup>77</sup>.

During the 1980's in the United States a standardized Resident Assessment Instrument - Minimum Data Set (RAI-MDS) was developed to improve the identification of care needs in nursing home residents. The RAI-MDS consists of a multidimensional set of items that registers physical, cognitive, psychometric, emotional and sociographic strengths and needs of a person. In addition, relevant diagnoses, symptoms and treatments are recorded. From

1990, an early version of the RAI-MDS was implemented in the United States and mandated in Medicare and Medicaid funded nursing homes. In 1992 the interRAI consortium was established. This international research network promotes the development and application of comprehensive assessment instruments for vulnerable persons. The original version of the RAI-MDS was refined and led to the RAI-MDS 2.0 and later to the interRAI version for long-term care facilities (interRAI LTCF). In the following years, interRAI versions for other health care settings were released such as home care (interRAI HC), acute care (interRAI AC) or palliative care (interRAI PC). Although the different versions were designed based on the same principles, items measuring the same construct were not completely consistent. This impeded the comparability of outcomes and hindered the transfer of information and tracking of persons over multiple care settings. As a consequence, the integrated system of the InterRAI suite of instruments was released in 2005 aiming to harmonize the different versions. It consists of a set of core-items that are considered relevant for all care sectors, such as the cognitive state or the physical functioning in activities of daily living. This backbone is complemented by optional and sector-specific items. All versions share common data collection methods, language and terminology, with harmonized time frames and response codes. In addition, the different interRAI versions are consistent with regard to the theoretical basis for the triggering of care plans and with regard to care protocols themselves. This integrated and coordinated system allows efficient passing of information when care-dependent persons rely on multiple care services<sup>78</sup>.

The interRAI system is a web-based computer application and tablet versions are available too. This facilitates the process of data collection and transfer across different authorized care professionals.

The interRAI system is focused on a functional assessment of clients. Based on the assessment, multiple outcome measures are calculated automatically to support care planning. InterRAI scales allow an instant overview of the condition of a person. For example, the *Cognition Performance Scale* (CPS) quantifies the cognitive status on a 7-point scale. It is based on a variety of items related to everyday decision making, short-term memory, procedural memory, self-expression and eating<sup>79,80</sup>. Furthermore, the interRAI system uses algorithms to determine whether certain Clinical Assessment Protocols

(CAP) are triggered. The CAPs are designed to help caregivers with the systematical interpretation of the information collected. They indicate specific risks or resources and help to prioritize and specify individual care needs <sup>77,81</sup>. For example, triggering of the CAP *Physical Activity* indicates a potential for improvement in this domain which can be helpful in concrete care planning. Depending on the care setting, the assessment is performed periodically to detect changes and adapt care planning. Measurement properties of different versions and components of the interRAI were evaluated in numerous studies over different countries, resulting in regular review and update of the instruments. For example, in 2020 the 10th version of the interRAI LTCF instrument was released <sup>77</sup>.

Currently, components of the interRAI suite of instruments are applied in 35 countries for comprehensive assessment of care-dependent individuals <sup>77</sup>. In New Zealand, the interRAI LTCF, interRAI HC, and interRAI PC are mandated nationwide. In Canada, almost all provinces mandate the different interRAI instruments and millions of assessments are carried out each year. In other countries, the use is limited to provinces, such as Lombardia in Italy, or to a number of organizations, e.g., in Poland. In Belgium, research on different assessment instruments proved that interRAI provides the most useful system for holistic and interdisciplinary registration of care needs. The instruments were translated, adapted to the Belgian health care context and named BelRAI <sup>78</sup>. After a phase of testing and piloting, on March 26, 2018 the different governments in Belgium agreed on the national implementation of the interRAI suite <sup>82</sup>. Currently, implementation is most advanced in Flanders. In Flemish long-term care facilities, a complete BelRAI assessment will be mandatory by December 31 2022 for each client.

**The interRAI suite of instruments is used internationally for comprehensive and multidisciplinary assessment of care needs.**

## **The oral health-related section of the interRAI suite of instruments**

An oral health-related section (ohr-interRAI) is included in the interRAI versions for long-term care facilities and for home care. On admission to care and regularly thereafter it is completed by professional non-dental

caregivers such as nurses, nurse assistants or care-coordinators. Section K5 of the current interRAI LTCF consists of six oral health-related items. They dichotomously (yes/no) register presence of a removable dental prosthesis, broken teeth, chewing problems, dry mouth, gum inflammation and pain. The HC version (section K4) is identical but does not include the latter two items.

The RAI-MDS 2.0 is the predecessor of the interRAI and is still used in some countries. Compared to the RAI-MDS 2.0, less oral health-related items were included in the interRAI and wording of items was slightly modified. Table 1 provides an overview of the items and how these are worded in the different versions. The related RAI-MDS 3.0 version is only available in the United States and does not belong to the interRAI system <sup>83</sup>.

Utilization guidelines provide a short definition of each item. The assessors are instructed to collect the information by interview, observation during meals, or inspection of the mouth. Assessors receive three days of training on how to complete the whole assessment, but the oral health-related section does not receive particular attention during training sessions.

With regard to measurement properties of the oral health-related section, Hawes et al. (1995) determined inter-caregiver reliability based on 123 US nursing home residents. Correlation between caregivers was at the low range of acceptable and lower compared to other RAI-MDS items <sup>76,84</sup>. Morris et al. (1997) reported moderate inter-caregiver reliability for the RAI-MDS HC and the RAI-MDS 2.0 LTCF <sup>85</sup>. However, the publications did not provide detailed information on data collection procedures and prevalence of oral health problems, impeding an appraisal of the results. A recent study from Canada with 103 nursing home residents found low inter-caregiver reliability of the oral health-related section, even among trained research assistants <sup>86</sup>. Training of caregivers seems to improve reliability <sup>87</sup>, but the value of the information that is generated with completion of the oral health-related section is highly questionable. Previous research showed that - when compared to professional oral examinations and prevalence data - the oral health-related section failed to adequately detect oral conditions that require care. Folse (2001) compared RAI-MDS 2.0 LTCF data to dental examination forms and national prevalence data from the United States.

## Introduction

**Table 1: Oral health-related items in RAI-MDS 2.0 and interRAI, LTCF and HC**

Ohr-RAI-MDS 2.0		Ohr-interRAI	
Long-Term Care	Home Care	Long-Term Care	Home Care
Chewing problems	Problem chewing: e.g., poor mastication, immobile jaw, surgical resection, decreased sensation/motor control, pain while eating	Reports difficulty with chewing	Reports difficulty with chewing
Mouth pain	-	Reports mouth or facial pain/discomfort	-
Debris (easily removable substances) in mouth at bedtime	Problem brushing teeth or dentures	-	-
Daily oral health care by resident or staff	-	-	-
Has dentures/removable bridge	-	Wears a denture/removable prosthesis	Wears a denture/removable prosthesis
Some/all natural teeth lost, no dentures/partial plates available/used	-	-	-
Broken, loose, or carious teeth	-	Has broken, fragmented, loose, or otherwise non-intact natural teeth	Has broken, fragmented, loose, or otherwise non-intact natural teeth
Inflamed, swollen or bleeding gums, oral abscesses, ulcers, or rashes	-	Presents with gum (soft tissue) inflammation or bleeding adjacent to natural teeth or tooth fragments	-
-	Mouth is "dry" when eating a meal	Reports having dry mouth	Reports having dry mouth

While pain in the mouth was recorded in 1% of the RAI-MDS 2.0 data, 56% of the dental examination forms reported pain. The same tendency was seen for dental problems and gum inflammation with 4% and 1% prevalence in the RAI-MDS 2.0, but more than 30% in the other data sources <sup>88</sup>. The study from Cohen-Mansfield and Lipson (2002) had methodological limitations <sup>89</sup>, but confirmed the severe under-detection of oral health-related problems with the RAI-MDS 2.0 <sup>89</sup>. Nordenram and Ljunggren (2002) conducted a study with 192 nursing home residents in Sweden. Participants underwent a RAI-MDS 2.0 assessment by a nurse and an oral examination by a dentist. Comparison of data revealed that the RAI-MDS 2.0 identified treatment

need correctly in only 50% of the subjects<sup>90</sup>. Accordingly, among the 236 Directors of Nursing that participated in the study of Ettinger et al. (2000) only 9% stated that the ohr-RAI-MDS 2.0 section was often useful in identifying oral health-related problems<sup>91</sup>. A longitudinal study from Canada analyzed RAI-MDS 2.0 records from 2,711 nursing home residents. Compared to prevalence data, oral health-related problems were significantly under-detected. In addition, well-known associations between predictors and oral health-related problems could not be found in the sample<sup>76</sup>. The same research group conducted a study with 103 nursing home residents. RAI-MDS 2.0 data collected by care staff were compared with assessments registered by trained research assistants and dental hygienists. It was shown that care staff identified least oral health-related problems and that agreement with the other groups of assessors was poor<sup>86</sup>. In Belgian interRAI data from 804 nursing home residents, chewing problems were registered in 5% of the subjects. This is considerably lower compared to other studies with older institutionalized persons reporting prevalence rates between 26% and 49%<sup>92,93</sup>. Gum inflammation was registered in 3% of the subjects in the BelRAI data set, while De Visschere et al. (2016) found periodontal disease in 87% of the studied care-dependent older adults in Belgium<sup>25</sup>. Although the methods of data collection and reporting cannot be compared directly, under-detection of gum inflammation in the interRAI is obvious. In summary, the studies above indicate that concurrent validity of the oral health-related section is limited. In addition, content validity of the ohr-RAI-MDS 2.0 section was challenged by a representative of the American Dental Association<sup>94</sup>.

**The current ohr-interRAI section and related precursor versions do not adequately detect oral health-related care needs.**

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# Objectives and research questions

## Objectives and research questions

Based on the need for regular oral assessment in care-dependent older adults and the potential that is related to the interRAI, this PhD project had the following objectives:

In a first step, underlying reasons for the failure of the current ohr-interRAI section to correctly identify oral health-related problems were explored. In a second step, an optimized photograph-supported ohr-interRAI section and related training materials were developed and psychometric properties were tested. Finally, practice guidelines for daily oral hygiene care were developed to help to improve care when poor oral hygiene was registered with the optimized ohr-interRAI section.

These objectives led to the formulation of research questions (RQ) that are discussed in the following chapters of the PhD thesis.

## **1. Evaluation of the underlying reasons for the failure of the current ohr-interRAI section to correctly identify oral health-related problems**

- RQ 1.1.1 Do experts consider the items of the current ohr-interRAI section complete, relevant, clearly worded and feasible to be completed by non-dental caregivers?
- RQ 1.1.2 Are caregivers aware of the relevance of oral health? Do they seriously attempt to complete the ohr-interRAI section correctly, and what challenges do they perceive?
- RQ 1.2 Is the prevalence of missing ohr-interRAI data dependent on clients' general health status?

## **2. Development and validation of an optimized photograph-supported ohr-interRAI section and related training materials**

- RQ 2.1 Does the interpretation of oral health-related conditions shown on clinical photographs differ between dentists and non-dental caregivers?

## Objectives and research questions

- RQ 2.2.1 What is the agreement between caregivers and dentists as well as the agreement among caregivers using the optimized ohr-interRAI section?
- RQ 2.2.2 Does the video training affect measurement properties of the optimized photograph-supported ohr-interRAI?

### **3. Development of practice guidelines for daily oral hygiene care in care-dependent older adults**

- RQ 3.1 Which guidelines for daily oral hygiene care result from the combination of available evidence with practice-based expert feedback?

# Chapter 1: Reasons for the failure of the current ohr-interRAI section

## Chapter 1: Reasons for the failure of the current ohr-interRAI section

## 1.1 Expert rating and caregiver opinion

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### Abstract

**Background:** Poor oral health negatively affects quality of life and is associated with a number of systemic diseases in older individuals. The interRAI instruments, internationally used for geriatric assessment, should accurately detect oral conditions that require care. Previous research showed that the oral health-related section of the interRAI (ohr-interRAI) and related precursor versions do not achieve this goal. To explore the underlying reasons for this failure, this study investigated test content validity (A.) and reasons for inaccurate assessments (B.).

**Materials and methods:** (A.) A group of 12 experts rated completeness, relevance, clarity of wording and feasibility of the ohr-interRAI. Content validity indices were calculated per item (threshold 0.78). (B.) Focus group discussions with 23 caregivers were organized. A semi-structured question guide made sure that all topics of interest were covered. Qualitative content structuring analysis was applied after transcription.

**Results:** (A.) Experts agreed on the relevance of the items on chewing, pain, gingival inflammation and damaged teeth. They regarded none of the items as worded clearly and only prosthesis use and pain were considered to be assessable by untrained caregivers. All experts agreed that the ohr-interRAI was incomplete. (B.) Focus group discussions revealed that in the care environment oral health had low priority. Aspects related to the ohr-interRAI itself and aspects related to the assessment situation impeded the oral health assessment. The approach of the caregivers to complete the ohr-interRAI was inappropriate to accurately detect oral care needs.

Chapter 1: Reasons for the failure of the current ohr-interRAI section

Conclusions: Findings challenge test content validity of the ohr-interRAI and reveal reasons for inaccurate assessments.

# The oral health-related section of the interRAI: Evaluation of test content validity by expert rating and assessment of potential reasons for inaccurate assessments based on focus group discussions with caregivers

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## Abstract

**Objectives:** To explore the failure of the oral health-related section of the interRAI (ohr-interRAI), this study investigated test content validity (A.) and reasons for inaccurate assessments (B.).

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## KEYWORDS

caregivers, focus groups, geriatric assessment, inaccurate assessments, InterRAI, mouth diseases, oral health, test content, validity

## 1 | INTRODUCTION

The interRAI suite of instruments is used internationally for comprehensive assessment of care-dependent individuals.<sup>1,2</sup> A first version of the instrument, the Resident Assessment Instrument—Minimum Data Set (RAI-MDS 1.0), was developed and tested between 1987 and 1989 and implemented in 1990 in the United States. It assessed concerns, strengths and needs of care-dependent nursing home residents on multiple dimensions.<sup>3</sup> In the following years, versions for other healthcare settings (Home Care, Acute Care, et cetera) were released, psychometric properties of the constituting components were evaluated and the instruments were updated regularly. In 2005, the restructured interRAI suite of instruments was released by the international interRAI consortium to facilitate compatibility of the versions available for the different healthcare settings.<sup>1</sup>

Based on the assessment, scaled outcome measures are calculated that assist to determine the condition and needs of care-dependent individuals. Furthermore, algorithms are used to determine whether a certain Clinical Assessment Protocol (CAP) is triggered or not. These triggers indicate specific risks or resources and help to prioritise and specify individuals care needs.<sup>1,4</sup>

The present study focuses on the oral health-related section that is available in the interRAI version for Long-Term Care Facilities (LTCF) and for Home Care (HC), respectively. Care-dependent individuals often lack the cognitive and physical abilities to perform adequate oral hygiene and to access professional dental care.<sup>5,6</sup> As a result, oral health of care-dependent individuals is generally poor.<sup>7,8</sup> Compromised oral health causes pain and discomfort, which in turn is related to low oral health-related quality of life.<sup>9,10</sup> It is also associated with a number of systemic diseases,<sup>11-13</sup> deteriorated physical<sup>14-16</sup> and cognitive performance,<sup>17-19</sup> depression,<sup>20</sup> institutionalisation,<sup>21</sup> and even mortality<sup>22,23</sup> in frail individuals. This emphasises the need of a thorough and accurate assessment of oral health which in turn facilitates planning of daily oral care and the referral for professional treatment if needed.

To evaluate the quality of data based on the ohr-interRAI, psychometric properties need to be examined. Inferences are meaningful, appropriate and useful only if the instrument is valid. Validity is composed of different aspects that each require particular validation activities: test content, response process, internal structure, relations to other variables and consequences of testing. Accumulated results allow to indicate whether the ohr-interRAI is valid.<sup>24,25</sup>

A study based on home care data from 7590 individuals in Belgium revealed a substantial proportion of about 17% missing data for the ohr-interRAI. Prevalence of missing data was higher in clients with cognitive impairment or depression.<sup>26</sup> Missing data challenge test content validity of the ohr-interRAI as they might be caused by unobtainable information, misinterpretation or low relevance of oral health on part of the assessors.<sup>25</sup>

Other studies on validity were based on the oral health-related section of the Resident Assessment Instrument—Minimum Data

Set 2.0 (ohr-RAI-MDS 2.0) which is the predecessor of the ohr-interRAI. Folse<sup>27</sup> compared ohr-RAI-MDS 2.0 data of about 3.6 million subjects to data retrieved from dental examination forms in the United States. Pain in the mouth was recorded in 0.8% of the ohr-RAI-MDS 2.0 data, although 56.1% of the dental examinations revealed pain. The same trend was seen for other oral health-related variables.<sup>27</sup> Based on ohr-RAI-MDS 2.0 measurements from about 2700 institutionalised individuals in Canada, Hoben et al<sup>28</sup> as well found a substantial under-detection of oro-dental problems when compared to prevalence data that were based on oral examinations. Well-known associations between predictors and oro-dental problems were not found in the RAI-MDS 2.0 data.<sup>28</sup> In a study with about 200 institutionalised subjects from Sweden, treatment need was not identified correctly by the ohr-RAI-MDS 2.0 when compared to professional oral examinations for 50% of the participants.<sup>29</sup> Accordingly, of the 236 Directors of Nursing that participated in the study of Ettinger et al<sup>30</sup>, only 9% stated that the ohr-RAI-MDS 2.0 was often useful in identifying dental problems. Although Arvidson-Bufano et al<sup>31</sup> showed that a short training session can improve the ability of caregivers to assess oral health, study results above indicate that validity based on correlation with external variables is poor for the ohr-RAI-MDS 2.0. Guay<sup>32</sup> had challenged content validity and Hawes et al<sup>33</sup> reported a low average inter-rater reliability of 0.46 for the oral health-related items.

The ohr-interRAI is a shorter, slightly modified version of the ohr-RAI-MDS 2.0 (see Table A1 for an overview of the different versions and where they are used) and the findings mentioned above raise the question whether the instrument is adequate to detect care-requiring oral health-related conditions.

The overall objective of our research project is the development and validation of an optimised ohr-interRAI. As a preparatory step, limitations of the current instrument need to be investigated more comprehensively. The current study consisted of two equivalent parts that each included a distinct group of participants. In the first part, test content validity was evaluated based on expert rating. It was determined whether the current items were considered complete, relevant, clearly worded and feasible to detect oral health-related treatment need. The second part of the study focused on potential reasons for inaccurate oral health-related assessments with the ohr-interRAI. Based on focus group discussions with caregivers who were acquainted with the use of the ohr-interRAI, it was evaluated whether their attitude and approach of data collection was suitable to detect oral health-related treatment need.

## 2 | METHODS

### 2.1 | Ohr-interRAI

The interRAI Long-Term Care Facility (LTCF) instrument dichotomously (0 = no, 1 = yes) registers oral health-related problems occurring in the 3 days prior to the assessment. The following items are included:

- Wears a denture/removable prosthesis (prosthesis use)
- Has broken, fragmented, loose or otherwise non-intact natural teeth (damaged teeth)
- Reports having dry mouth (dry mouth)
- Reports difficulty with chewing (chewing difficulty)
- Reports mouth or facial pain/discomfort (pain)
- Presents with gum (soft tissue) inflammation or bleeding adjacent to natural teeth or tooth fragments (gingival inflammation)

Pain and gingival inflammation are not included in the Home Care (HC) version. The interRAI utilisation guidelines give a short definition of each item. The instructions advise the assessors to collect the information by interview, observation during meals or inspection of the mouth.

## 2.2 | InterRAI in Belgium

In 2016, the Belgian government decided to incrementally mandate the use of the instruments that in Belgium are named BelRAI.<sup>34</sup> Currently, they are in the state of implementation and applied in multiple pilot projects in different healthcare settings.<sup>35</sup> Depending on the individual care facility, the instruments are either completed multidisciplinary or by a single caregiver.<sup>36</sup> Assessors receive three days of training on how to complete the interRAI instrument.<sup>37</sup> Based on reports from instructors and training participants, the ohr-interRAI does not receive special attention during training sessions.

### 2.2.1 | Expert rating to evaluate test content validity

The ideal ohr-interRAI should identify clients who need to be referred to a dentist or who need help with their daily oral hygiene.<sup>8</sup> By investigating test content validity this part of the study examines, to what extent items are relevant, clearly worded, feasible and complete to be considered adequate for this goal. Expert rating is a procedure that is widely accepted and used to analyse test content validity.<sup>25,38-40</sup>

In October 2015, an expert meeting was organised in Flanders, Belgium. The 12 experts that were invited agreed to take part. Experts were chosen based on their academic and clinical professional background relevant for oral health of frail individuals. The group comprised three university professors in gerodontology, two experienced dentists working in long-term care facilities, one periodontologist, three geriatricians and one college lecturer in geriatric nursing care. Two experts—one university professor and one experienced dentist—were specialised in prosthetic dentistry.

Using the method outlined by Lynn,<sup>38</sup> relevance of each item of the ohr-interRAI was quantified in a standardised way. A questionnaire was provided to the experts who rated each item on a 4-point Likert scale (1 = not relevant, 2 = somewhat relevant, 3 = quite relevant, 4 = highly relevant). The original method was extended to evaluate further limitations of the items, even if basically the experts considered them relevant. Clarity of wording was assessed per item and the associated utilisation guidelines (1 = not clearly formulated,

2 = somewhat clearly formulated, 3 = quite clearly formulated, 4 = very clearly formulated). Additionally, expert opinion on feasibility was evaluated, rating whether the items can be completed by caregivers who were not specifically trained for the ohr-interRAI (1 = not feasible, 2 = somewhat feasible, 3 = quite feasible, 4 = very feasible). For each item, relevance, clarity of wording and feasibility were quantified using the content validity index (CVI-I) that defines the proportion of favourable rankings (3 or 4) over the total rankings on item-level.<sup>38</sup> As recommended by Polit et al,<sup>40</sup> 0.78 was used as a threshold.

Experts also dichotomously (yes/no) assessed the completeness of the list of items.

### 2.2.2 | Focus group discussions with caregivers to evaluate potential reasons for inaccurate assessments

Accurate assessments are threatened when caregivers are not aware of the relevance of oral health and do not seriously attempt to complete the items correctly. Problems caused by the ohr-interRAI instrument itself or challenges related to the assessment situation might also impede accurate assessments. A qualitative approach was chosen to make sure that the whole range of opinions and experiences could be explored. The social interaction of the focus group discussions encourages participants to think about the topic deeply and to clarify individual and shared perspectives.<sup>41,42</sup>

## 2.3 | Development of the question guide

A semi-structured question guide was designed to direct the discussions in a way that all topics of interest would be covered. The guide was designed by one researcher based on the recommendations of Krueger & Casey.<sup>41</sup> It was revised during two meetings of the research group. It was agreed that the first focus group would also be regarded as a pilot test for the question guide.

To initiate the discussion, participants were asked to reflect about oral health-related activities provided by the employing care organisations. They were also invited to share their opinion on the relevance of oral health compared to other care needs of the clients. Furthermore, the question guide covered the following points of interest:

- Attitudes and knowledge related to oral health and hygiene.
- Attitudes and problems related to the ohr-interRAI.
- Approach to complete the ohr-interRAI.
- Reasons to not complete the ohr-interRAI (missingness).
- Perceived competency to complete the ohr-interRAI.
- Suggestions for an optimised version of the ohr-interRAI.

The moderator was also open for additional topics that were brought up by the participants.

To gain insight in their personal oral health-related behaviour, participants were asked to fill in a short questionnaire that included the history of dental extractions (excluding wisdom teeth), dental

emergency consults during the previous year, frequency of annual dental check-ups and frequency of daily tooth brushing.

## 2.4 | Recruitment of participants

Recruitment of focus group participants was based on a complete list of 102 care projects/organisations in Flanders, Belgium, that used or had used the interRAI-LTCF or -HC. The 76 responsible management executives were contacted by e-mail and by phone and the objectives of the study were explained. They were invited to send one caregiver who actually completed or had completed the ohr-interRAI on a daily basis. No further inclusion or exclusion criteria were applied. Six contacts could not be reached and participation was refused for 65 projects (Table 1).

Non-participation was predominantly motivated by other priorities and low relevance of the topic. Cessation of interRAI related care projects was also mentioned as explanation for refusal. From the initial 31 participants, eight dropped out due to illness or other reasons on the day of the discussion.

## 2.5 | Practical organisation

In March 2016, four focus group discussions were organised at different locations in Flanders. The discussions took place in the meeting room of a care facility and took approximately two hours. Participants completed the questionnaire on their personal oral health-related behaviour before starting the discussions. The background and goals of the research project and of the involved researchers were introduced to the participants. A trained researcher (SKH) moderated the groups, guided by the semi-structured question guide. The discussions were conducted in the Flemish Dutch language. A co-moderator (JD) took field notes and assisted with the practical organisation. Only participants and researchers were present during the focus groups. All discussions were audio recorded.

## 2.6 | Analysis

Discussions were transcribed verbatim. For readability, dialect was translated to standard language and filling words were removed. Para- and non-verbal communication was excluded from the analysis. Coding was done by one researcher (SKH) and validated by another member of the group (JDAM). Code differences were resolved by discussion between the two researchers. The software program NVivo 11 was used to manage data and to support the coding process.

Qualitative analysis was based on structuring content analysis—also called theme analysis—that combines deductive and inductive coding activities. Main categories were pre-determined by the topics of interest that were also translated to the question guide. First, the material was coded based on these categories. In a second step, further differentiation of the codes was based on the material itself.<sup>43</sup>

## 3 | RESULTS

### 3.1 | Expert rating to evaluate test content validity

Table 2 shows the content validity indices (CVI) that quantify the proportion of favourable expert rankings over total rankings for relevance, clarity of wording and feasibility for each item of the ohr-interRAI. Experts unanimously agreed on the relevance of chewing difficulty, pain and gingival inflammation. Based on the 0.78 threshold, damaged teeth was also considered relevant. This was not the case for prosthesis use and dry mouth. None of the items—and the corresponding utilisation guidelines—was considered clearly worded by the experts. Pain was assessed nearly satisfactorily. Out of the six items, only prosthesis use and pain were considered feasible to be completed by care givers not particularly trained for the ohr-interRAI. All experts agreed that the list of items was incomplete.

### 3.2 | Focus group discussions with caregivers to evaluate potential reasons for inaccurate assessments

The average age of the 23 participants (20 female) was 39.8 years (range 25-53 years). While 15 participants had worked with the interRAI-HC, five were acquainted with the interRAI-LTCF and three participants had worked with both versions. The participants had varying professional backgrounds, for example, nurses, quality-of-care coordinators, occupational therapists and social assistants. With regard to their personal oral health behaviour, all participants reported annual dental check-ups and daily tooth brushing. More than half of the participants had no history of tooth extractions (except wisdom teeth) and only three had a dental emergency consult in the previous year (Table A2).

For the four focus group discussions, the same question guide was applied. Table 3 presents discussion contributions of caregivers after structuring content analysis. Selected contributions relevant to discuss potential reasons for inaccurate assessments of the ohr-interRAI are summarised below.

**TABLE 1** Recruitment of focus group discussion participants

	Total	Confirmed	Refused	No contact	Late drop out	Level of participation in %
Care projects/organisations	102	31	65	6	8	23.5
Responsible management executives	76	28	42	6		21.3

	Relevance CVI	Clarity of wording CVI	Feasibility CVI
Prosthesis use	0.67	0.42	0.83*
Damaged teeth	0.91*	0.33	0.50
Dry mouth	0.67	0.25	0.58
Chewing difficulty	1.00*	0.58	0.75
Pain	1.00*	0.75	0.83*
Gingival inflammation	1.00*	0.58	0.41

\*CVI  $\geq$  0.78, content validity indices (CVI) define the proportion of favourable rankings (3 or 4) over the total rankings assigned by 12 experts who applied a 4-point ordinal scale.

**TABLE 2** Content validity indices (CVI) for relevance, clarity of wording and feasibility per item of the oral health-related section of the interRAI

### 3.2.1 | Attitudes and knowledge concerning oral health and hygiene

In general and on a personal level, oral health and hygiene were considered to be important. Participants were aware of the impact on general health and on social relationships. However, in the daily care environment and for clients themselves, priority of oral health was low compared to other problems.

Citation: When time is short, oral care is the first task that is omitted.

This was attributed to low visibility of the results of oral care and aversion towards the oral area of clients.

### 3.2.2 | Complaints and criticism concerning the ohr-interRAI

Participants considered oral health and hygiene uncommon and sensitive topics of discussion. They mentioned that the assessment might evoke feelings of embarrassment and fear.

Citation: Oral health is not a normal topic of conversation, especially not during a first meeting.

It was further criticised that the ohr-interRAI fails to register oral health-related information that was considered important by the participants. For example, oral hygiene, soft tissue lesions, and functionality and fitting of dental prostheses.

Citation: Are they able to brush their teeth and are teeth clean after brushing? Are clients aware that they have to take out their dental prosthesis for cleaning? Do they accept if caregivers do it for them?

Participants also missed an outcome measure based on the ohr-interRAI that would allow interpretation of registrations and emphasise the importance of the oral health assessment. It was further mentioned that the item on gingival inflammation should be removed, as detection by caregivers was not considered feasible.

### 3.2.3 | Situational factors that challenge the assessment of oral health

Participants mentioned that a short contact time with clients impaired the establishment of a trustful relationship that was needed to assess oral health. Client characteristics and needs also played a role, for example, poor communication skills. Completion of the ohr-interRAI was considered inappropriate during a first assessment or during a crisis assessment, when clients performed oral hygiene independently and when oral health was not relevant for clients.

Citation: It is the same with shoes. When I ask, is it important for you that your shoes are clean and you say no, I will not inquire, when for the last time you have cleaned them. I will just think, OK, never mind.

The background of the assessors and the healthcare setting played a role as well. Completion of the ohr-interRAI was considered inappropriate when the organisation the caregiver was employed by did not provide daily oral care and when clients with oral care needs were not referred to professional treatment. Some professions were considered to be less common to work with the mouth. Based on their education, competencies and anticipated client expectations, assessment of oral health seemed inappropriate.

Citation: I am a social assistant—I cannot ask them if there is a problem with their teeth.

### 3.2.4 | Approach to complete the ohr-interRAI

In general, the ohr-interRAI was completed hastily and superficially. Clients were observed during conversation, mealtime or care-giving. Completion was also based on conversation. Participants preferred to talk to primary caregivers and oral health-related questions were softened by harmless chatting. Inspection of the mouth was regarded disrespectful, inappropriate, and devaluating and the mouth was considered an intimate area of the body.

**TABLE 3** Focus group discussion contributions of caregivers

<b>Attitudes and knowledge concerning oral health and hygiene</b>	
Personal attitudes and knowledge of participants	<ul style="list-style-type: none"> <li>• Oral health is important on a general and on a personal level.</li> <li>• Participants feel responsible for oral health of clients based on their role as professional caregiver.</li> <li>• Participants are aware that oral health affects general health (particularly eating ability) and social interactions.</li> </ul>
Attitudes in the general care environment	<ul style="list-style-type: none"> <li>• Oral hygiene belongs to the daily care tasks.</li> <li>• Oral health has low priority compared to other problems of clients.</li> <li>• Oral hygiene is one of the first care tasks neglected.</li> <li>• The results of oral hygiene are less visible compared to other care tasks.</li> <li>• Caregivers feel aversion towards the oral area of clients.</li> </ul>
Attitudes of clients and families	<ul style="list-style-type: none"> <li>• Oral health is less important than other problems.</li> <li>• Oral care evokes care-resistant behaviour.</li> <li>• The generation of the current care-dependent population was not raised with regular oral hygiene and dental care.</li> <li>• Clients/families are not inclined to spend money on oral health care.</li> <li>• Clients/families do not always follow the advice concerning recommended dental treatments.</li> </ul>
<b>Complaints and criticism concerning the ohr-interRAI</b>	
Related to the topic	<ul style="list-style-type: none"> <li>• Oral health and hygiene are uncommon and sensitive topics of discussion.</li> <li>• Clients might be embarrassed as oral health is associated with self-care.</li> <li>• Home care clients might fear institutionalisation as oral health is associated with food intake.</li> </ul>
Related to the instrument itself	<ul style="list-style-type: none"> <li>• The ohr-interRAI fails to register the following relevant oral health-related information:               <ul style="list-style-type: none"> <li>◦ performance, capacity and applied technique of oral hygiene,</li> <li>◦ history of dental visits,</li> <li>◦ soft tissue lesions,</li> <li>◦ functionality and fitting of dental prostheses.</li> </ul> </li> <li>• Dichotomous yes/no categories do not allow a differentiated assessment of oral health.</li> <li>• An outcome measure based on the ohr-interRAI is missing. This would be helpful to interpret registrations and emphasise the importance of oral health.</li> <li>• The item on gingival inflammation should be removed as detection by caregivers is not feasible.</li> </ul>
<b>Situational factors that challenge the assessment of oral health</b>	
Contact time	<ul style="list-style-type: none"> <li>• Short contact time with the client impairs the establishment of a trustful relationship which is needed to assess oral health.</li> </ul>
Client characteristics and needs	<ul style="list-style-type: none"> <li>• Assessment of oral health is more challenging when               <ul style="list-style-type: none"> <li>◦ clients have poor cognition and communication abilities,</li> <li>◦ primary caregivers are not available to mediate communication.</li> </ul> </li> <li>• Assessment of oral health is considered inappropriate               <ul style="list-style-type: none"> <li>◦ during the first interRAI assessment,</li> <li>◦ during an urgent crisis assessment,</li> <li>◦ when clients perform oral care independently,</li> <li>◦ when clients consider oral health not important.</li> </ul> </li> </ul>
Background caregiver and healthcare setting	<ul style="list-style-type: none"> <li>• Assessment of oral health is considered inappropriate when the organisation the caregiver is employed by               <ul style="list-style-type: none"> <li>◦ does not provide daily oral care,</li> <li>◦ does not refer clients to professional oral treatment.</li> </ul> </li> <li>• Some professions are considered to be less common to work with the mouth, for example social assistants. This is based on their education, competencies, and anticipated client expectations.</li> <li>• Assessment of oral health is less feasible in the home care setting.</li> </ul>
<b>Approach to complete the ohr-interRAI</b>	
General approach	<ul style="list-style-type: none"> <li>• Hasty and superficially,</li> <li>• Oral health is not assessed accurately by caregivers.</li> <li>• Scores of the last assessment sometimes are copied.</li> <li>• The mouth is inspected only when clients complain about oral problems.</li> <li>• Oral inspection is considered disrespectful, inappropriate and devaluating.</li> <li>• Oral inspection is not considered feasible due to poor lighting and a lack of time.</li> <li>• Oral health-related questions are answered vaguely by clients.</li> </ul>
Aspects of observation	<ul style="list-style-type: none"> <li>• The ohr-interRAI is completed based on observation during conversation, meals or care-giving.</li> </ul>
Aspects of conversation	<ul style="list-style-type: none"> <li>• The ohr-interRAI is completed based on conversation with clients, family or professional care-givers.</li> <li>• Participants prefer to ask primary caregivers instead of clients.</li> <li>• Oral health-related questions are softened by harmless chatting.</li> </ul>

(Continues)

**TABLE 3** (Continued)

Aspects of oral inspection	<ul style="list-style-type: none"> <li>The mouth is an intimate area of the body.</li> </ul>
Aspects of active client reporting	<ul style="list-style-type: none"> <li>Wording "Client reports ..." implies that problems should be actively reported by clients.</li> </ul>
<b>Missing values due to non-completion of the ohr-interRAI</b>	
Attitude towards non-completion	<ul style="list-style-type: none"> <li>Complete assessment are requested by most care organisations.</li> <li>Participants generally attempt to complete the ohr-interRAI.</li> </ul>
Reasons for non-completion	<ul style="list-style-type: none"> <li>The ohr-interRAI remains uncompleted when               <ul style="list-style-type: none"> <li>items are not applicable, for example, client does not chew due to a feeding-tube, comatose client.</li> <li>assessment of oral health is considered unfeasible, for example detection of damaged teeth.</li> </ul> </li> </ul>
<b>Perceived competency to complete the ohr-interRAI</b>	
Generally competent	<ul style="list-style-type: none"> <li>In general the ohr-interRAI is considered clear and participants feel competent to complete the items.</li> <li>More training is not considered necessary.</li> </ul>
Challenging items	<ul style="list-style-type: none"> <li>Damaged teeth, dry mouth and gingival inflammation are considered challenging.</li> </ul>

Citation: Ask somebody to open the mouth—that is a question you never ask another person. One does not do that, you have to respect other people's dignity.

It was also mentioned that item wording implied active reporting of oral health-related problems by clients.

### 3.2.5 | Missing values due to non-completion of the ohr-interRAI

In general, participants attempted to complete the whole interRAI as this was requested by the employing care organisations. However, non-completion of the ohr-interRAI was considered inevitable when items were not applicable. For example, the item on chewing problems was left open when nutrition was exclusively provided via a feeding-tube or when clients were comatose. Participants also mentioned that items were not completed when the assessment was considered unfeasible, for example, detection of damaged teeth.

### 3.2.6 | Perceived competency to complete the ohr-interRAI

In general, items were considered clear and participants felt no need for training. However, it was mentioned that the assessment of damaged teeth, dry mouth and gingival inflammation was challenging.

## 4 | DISCUSSION

The ideal ohr-interRAI should detect clients with oral health-related treatment needs. Previous research indicated that the current instrument and related precursor versions do not achieve this goal.<sup>27-30</sup> The present study investigated the underlying problems of this failure by examining test content validity and potential reasons for inaccurate assessments with the ohr-interRAI.

### 4.1 | Expert rating to evaluate test content validity

An oral assessment instrument that is used by caregivers should identify clients who need help with their daily oral hygiene or who need to be referred to a dentist for further diagnosis and treatment.<sup>8</sup> Experts agreed unanimously that items of the ohr-interRAI were not complete to achieve this goal. For example, registration of oral hygiene is essential as plaque accumulation is the basis for dental decline and correlated to respiratory disease.<sup>11,44-46</sup> It also needs to be clarified why gingival infection and pain are registered in the interRAI-LTCF, but not in the -HC version.

Rating of individual items showed that experts considered damaged teeth, chewing difficulty, pain and gingival inflammation relevant for the ohr-interRAI. The American Dental Association (ADA) had recommended these items to be included in the ohr-RAI-MDS 2.0 as well.<sup>32</sup> Their relevance was also confirmed by numerous publications that found associations with either general health or oral health-related quality of life in older individuals.<sup>9,12,13,19,47-60</sup> Registration of prosthesis use was not considered relevant by the experts. Non-adequate functionality and fitting of prosthesis might instead be more important for the decision whether clients need to be referred to a dentist.<sup>61-63</sup> Recommendations of the ADA also suggested to register problems related to the prosthesis.<sup>32</sup> Dry mouth was not considered relevant by the experts, although literature showed that both hyposalivation (insufficient production of saliva) and xerostomia (perception of dry mouth) affected oral health and quality of life.<sup>64-66</sup> However, dry mouth does not have to be a problem if oral hygiene is adequate and if oral perception of the client is not negatively affected. ADA recommendations also did not suggest dry mouth to be included in the ohr-RAI-MDS 2.0.<sup>32</sup>

Experts challenged clarity of wording for all items of the ohr-interRAI. This might be attributed to the unspecified method of data collection. While a number of items are worded as "Client reports"—implying a verbal assessment—guidelines invite assessors to complete the section based on observation, interview or inspection. Suitability of data for research was doubted due to this vague description of the assessment procedure.<sup>67,68</sup> Dry mouth received the lowest rating for

clarity of wording. This might be caused by the ambiguity whether hyposalivation or xerostomia should be detected. Literature showed that the relationship between both phenomena is complex.<sup>69</sup>

Registration of prosthesis use was considered feasible by the experts, probably as the presence of a removable prosthesis can be assessed easily. Pain was rated feasible as well and chewing difficulty was rated nearly feasible to be assessed by untrained caregivers. Clients can be asked about the presence of these symptoms; however, clear instructions are lacking for the assessment of clients who are unable to communicate. Feasibility of the current *ohr-interRAI* to detect damaged teeth, dry mouth and gingival inflammation was doubted by the experts. These findings on feasibility are in line with the results of Chalmers et al<sup>70</sup> who had invited caregivers to share their experiences concerning the completion of the Oral Health Assessment Tool—a validated oral screening instrument. The ADA had already questioned test content of the *ohr-RAI-MDS 2.0* and suggested a revised version of the instrument.<sup>32</sup> However, it was unclear how test content validity was assessed and how the modified version was developed. In the present study, a structured method was applied to evaluate test content validity. The assessment of item relevance was further complemented by the evaluation of clarity of wording, feasibility and completeness to allow for a more detailed view.

#### 4.2 | Focus group discussions with caregivers to evaluate potential reasons for inaccurate assessments

The second part of the study explored whether attitudes and approach of caregivers who complete the instrument were suitable to detect oral health-related treatment need. Personal oral health-related behaviour of participants showed that the majority had only their wisdom teeth extracted, had annual dental check-ups and practiced dental hygiene on a regular basis. Participants were also aware of the relevance of oral health on a general and on a personal level. These findings support a thorough completion of the *ohr-interRAI*. It has been reported that health promotion and provision of care was influenced by caregivers' own behaviours, attitudes, priority and awareness towards health.<sup>71,72</sup> In the routine of the care environment, however, oral health had low priority compared to other problems. This was confirmed by other studies that evaluated attitudes of caregivers towards oral health of clients.<sup>71,73,74</sup> Low relevance of oral health on part of the clients might be a major cause of this divergence of priority. This is also reflected by the perception of inappropriateness when the *ohr-interRAI* had to be completed for clients for whom oral health was not important. It was reported in the literature as well that respect for the self-determination of clients was an impediment for caregivers to provide daily oral care.<sup>71</sup> Oral health was further considered a sensitive and uncommon topic which is an additional threat for a thorough completion of the *ohr-interRAI*.

Participants also expressed their complaints with regard to the instrument itself, for example, lack of an item that registers oral hygiene. Findings related to missingness caused by non-completion revealed further deficits such as the absence of a

non-applicable response option. But if caregivers perceive the *ohr-interRAI* as not valuable to detect oral health-related care needs, their motivation to make effort to complete the instrument could be compromised. Psychological research confirmed that low task significance was negatively associated with work motivation and performance.<sup>75</sup> Participants further criticised that it was not feasible for caregivers to detect gingival inflammation and damaged teeth. This position also challenges a thorough completion of the *ohr-interRAI* as it was shown that poor self-efficacy reduces the effort individuals exert on a given task.<sup>76</sup> The study further revealed a number of situational factors that challenged the oral health assessment. This indicates a lack of training that conveys the skills how oral health has to be assessed accurately and how challenges can be dealt with. Instead, the general approach to complete the *ohr-interRAI* was hasty and superficially. A further threat to an accurate oral health assessment is that the approach to complete the instrument did not include an oral inspection. Previous research revealed an extensive discrepancy between normative and self-perceived oral health-related needs in older individuals<sup>6</sup> and the value of a superficial observation during meals or care-giving is highly questionable. However, participants considered an oral inspection of the client inappropriate and the mouth was perceived an intimate area. It was reported previously that for caregivers the mouth was an intimate region of the body.<sup>77</sup>

In summary, findings of the second part of the study indicate potential reasons for inaccurate assessments. The adequate detection of oral health-related treatment needs is impeded by shortcomings of the instrument and a lack of clear guidelines and training. It has been reported in the literature that even a short training enhanced the ability of caregivers to assess the oral health of clients.<sup>31</sup> The training should not be limited to the acquisition of skills, but also raise awareness of the interrelation between oral health, other health aspects and quality of life.

It is a strength of the present study that two distinct aspects of the *ohr-interRAI* were investigated. Findings of the two parts complement each other and provide a detailed view of the limitations related to the current instrument and how this is used. These results are valuable for the development of an optimised *ohr-interRAI*, which is the follow-up project of this research. As an integrated part of the *interRAI* assessment, the optimised *ohr-interRAI* should briefly register relevant oral health aspects. It should include questions to evaluate subjective oral health complaints, but also mandate an oral examination.

It is a limitation of the present study that among the experts, groups who complete the items were under-represented, for example, nursing scientists. Their expertise would be valuable to more validly assess feasibility of the items. It further needs to be mentioned that the second part of the study did not include the perspective of other parties, for example, clients or management executives. However, caregivers are the most relevant group, as they actually complete the *ohr-interRAI*. In an early phase of the current study, it was planned to conduct focus group discussions

with management executives, but these were not aware of the details related to the completion of the ohr-interRAI. The authors also consider to investigate the perspective of the clients in a later stage of the project when the optimised ohr-interRAI will be validated. Another limitation that needs to be discussed is that only a small proportion of the contacted care organisations sent a participant to the focus group discussions. This reflects and confirms the finding that oral health has only low priority in the care environment. Recruitment of participants required approval of their management executives who had to consider oral health a topic relevant enough worth the expenditure of time and effort. Data saturation is the gold standard for qualitative research<sup>76</sup> and we can only speculate whether further respondents would have added additional insights. Future research—preferably on a larger and international scale—could clarify if results of the current study are exhaustive and generalisable.

## 5 | CONCLUSIONS

The presented study contributes to the understanding why the existing ohr-interRAI and related precursor versions fail to adequately assess oral health-related treatment need.<sup>26-30</sup> Findings challenge test content validity and reveal potential reasons for inaccurate assessments. In a follow-up project, the present results will be integrated to develop an optimised and validated ohr-interRAI and an associated training tool.

## ACKNOWLEDGEMENTS

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## CONFLICT OF INTERESTS

The authors declare that they have no conflict of interests.

## ETHICS APPROVAL AND CONSENT TO PARTICIPATE

In July 2015, the protocol of the present study was sent to the Social and Societal Ethics Committee of the KU Leuven. We received the response that—as participants were not subjected to tests or experiments—approval of the committee was not required. The study adhered to standard ethical guidelines as detailed study information for participants, voluntariness of participation and guaranteed privacy. Participants were aware and consented that results of the study will be published.

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APPENDIX

**TABLE A1** Long-Term Care and Home Care versions of the oral health-related section of the MDS 2.0 and of the interRAI

Version	MDS 2.0		interRAI	
	Long-Term Care	Home Care	Long-Term Care	Home Care
Countries where the instruments are used or tested (status 03/2019)	North America (Canada), Europe (Finland)	North America (Canada), Europe (Finland)	North America (Canada), Europe (Austria, Belgium, Czech Republic, Denmark, Estonia, France, Germany, Iceland, Italy, Lithuania, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom), Asia and Pacific Rim (Australia, China, Hong Kong, Japan, New Zealand, Singapore, South Korea)	North America (Canada), Europe (Austria, Belgium, Czech Republic, Denmark, Estonia, France, Germany, Iceland, Italy, Lithuania, Netherlands, Norway, Poland, Portugal, Spain, Sweden, Switzerland, United Kingdom), Asia and Pacific Rim (China, Hong Kong, Japan, New Zealand, Singapore, South Korea)
Items				
Chewing	Chewing problems	Problem chewing: for example, poor mastication, immobile jaw, surgical resection, decreased sensation/motor control, pain while eating	Reports difficulty with chewing	Reports difficulty with chewing
Swallowing	Swallowing problems		Detailed evaluation in section K3	
Pain	Mouth pain		Reports mouth or facial pain/discomfort	
Status oral hygiene	Debris (easily removable substances) in mouth at bedtime	Problem brushing teeth or dentures		
Performance daily oral hygiene	Daily oral health care by resident or staff			
Removable dental prosthesis use	Has dentures/removable bridge		Wears a denture/removable prosthesis	Wears a denture/removable prosthesis
Tooth loss and absence removable dental prosthesis	Some/all natural teeth lost, no dentures/partial plates available/used			
Condition teeth	Broken, loose or carious teeth		Has broken, fragmented, loose, or otherwise non-intact natural teeth	Has broken, fragmented, loose, or otherwise non-intact natural teeth
Condition gums	Inflamed, swollen or bleeding gums, oral abscesses, ulcers, or rashes		Presents with gum (soft tissue) inflammation or bleeding adjacent to natural teeth or tooth fragments	
Dry mouth		Mouth is "dry" when eating a meal	Reports having dry mouth	Reports having dry mouth

**TABLE A2** Personal oral health-related behaviour of participants

Dental extractions		Dental emergency consult in previous year		Annual dental check-up's (average)		Daily tooth brushing (average)	
0 (only wisdom teeth)	13	No	20	2	7	2	15
1-6	9	Yes	3	1	16	1	8
>6	1			<1	0	<1	0



## 1.2 Missing oral health-related data in the interRAI

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### Abstract

**Background:** Missing data within the comprehensive geriatric assessment of the interRAI suite of assessment instruments potentially imply the under-detection of conditions that require care as well as the risk of biased statistical results. Impaired oral health in older individuals has to be registered accurately as it causes pain and discomfort and is related to the general health status.

**Objective:** This study was based on interRAI-Home Care (HC) baseline data from 7590 subjects (mean age 81.2 years, SD 6.9) in Belgium. It was investigated if missingness of the oral health-related items was associated with selected variables of general health. It was also determined if multiple imputation of missing data affected the associations between oral and general health.

**Materials and methods:** Multivariable logistic regression was used to determine if the prevalence of missingness in the oral health-related variables was associated with activities of daily life (ADLH), cognitive performance (CPS2) and depression (DRS). Associations between oral health and ADLH, CPS2 and DRS were determined, with missing data treated by 1. the complete-case technique and 2. by multiple imputation, and results were compared.

**Results:** The individual oral health-related variables had a similar proportion of missing values, ranging from 16.3% to 17.2%. The prevalence of missing data in all oral health-related variables was significantly associated with symptoms of depression (dental prosthesis use OR 1.66, CI 1.41–1.95; damaged teeth OR 1.74, CI 1.48–2.04; chewing problems OR 1.74, CI 1.47–

2.05; dry mouth OR 1.65, CI 1.40–1.94). Missingness in damaged teeth (OR 1.27, CI 1.08–1.48), chewing problems (OR 1.22, CI 1.04–1.44) and dry mouth (OR 1.23, CI 1.05–1.44) occurred more frequently in cognitively impaired subjects. ADLH was not associated with the prevalence of missing data. When comparing the complete-case technique with the multiple imputation approach, nearly identical odds ratios characterized the associations between oral and general health.

Conclusion: Cognitively impaired and depressive individuals had a higher risk of missing oral health-related information. Associations between oral health and ADLH, CPS2 and DRS were not influenced by multiple imputation of missing data. Further research should concentrate on the mechanisms that mediate the occurrence of missingness to develop preventative strategies.

RESEARCH ARTICLE

# Missing Oral Health-Related Data in the interRAI-HC - Associations with Selected Variables of General Health and the Effect of Multiple Imputation on the Relationship between Oral and General Health

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**Data Availability Statement:** The BeIRAI contains sensitive information like admission-, assessment- and mortality dates that might enable re-identification. Baseline- as well as follow-up measures are included in the original dataset. Therefore unrestricted dissemination and public use of the data is not possible. However, by following the standard requirements for the demanding process we obtained permission from the Belgian Privacy Commission. Any other research can make the same request and should get the same permission. We could and would

## Abstract

### Background

Missing data within the comprehensive geriatric assessment of the interRAI suite of assessment instruments potentially imply the under-detection of conditions that require care as well as the risk of biased statistical results. Impaired oral health in older individuals has to be registered accurately as it causes pain and discomfort and is related to the general health status.

### Objective

This study was based on interRAI-Home Care (HC) baseline data from 7590 subjects (mean age 81.2 years, SD 6.9) in Belgium. It was investigated if missingness of the oral health-related items was associated with selected variables of general health. It was also determined if multiple imputation of missing data affected the associations between oral and general health.

### Materials and Methods

Multivariable logistic regression was used to determine if the prevalence of missingness in the oral health-related variables was associated with activities of daily life (ADLH), cognitive performance (CPS2) and depression (DRS). Associations between oral health and ADLH, CPS2 and DRS were determined, with missing data treated by 1. the complete-case technique and 2. by multiple imputation, and results were compared.

assist anyone who asks with this request. For access to the dataset, the Belgian Privacy Commission should be contacted at [commission@privacycommission.be](mailto:commission@privacycommission.be) ([www.privacycommission.be](http://www.privacycommission.be)).

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**Competing Interests:** The authors have declared that no competing interests exist.

## Results

The individual oral health-related variables had a similar proportion of missing values, ranging from 16.3% to 17.2%. The prevalence of missing data in all oral health-related variables was significantly associated with symptoms of depression (dental prosthesis use OR 1.66, CI 1.41–1.95; damaged teeth OR 1.74, CI 1.48–2.04; chewing problems OR 1.74, CI 1.47–2.05; dry mouth OR 1.65, CI 1.40–1.94). Missingness in damaged teeth (OR 1.27, CI 1.08–1.48), chewing problems (OR 1.22, CI 1.04–1.44) and dry mouth (OR 1.23, CI 1.05–1.44) occurred more frequently in cognitively impaired subjects. ADLH was not associated with the prevalence of missing data. When comparing the complete-case technique with the multiple imputation approach, nearly identical odds ratios characterized the associations between oral and general health.

## Conclusion

Cognitively impaired and depressive individuals had a higher risk of missing oral health-related information. Associations between oral health and ADLH, CPS2 and DRS were not influenced by multiple imputation of missing data. Further research should concentrate on the mechanisms that mediate the occurrence of missingness to develop preventative strategies.

## Introduction

The interRAI suite of instruments consists of third-generation comprehensive geriatric assessment tools, designed to define what kind of care is required for an individual care-dependent person [1]. Based on the multidimensional and multi-domain computer-assisted assessment, possible prevention and treatment options as well as referral for further evaluation is considered. In addition, interRAI data can be a source for quality-of-care evaluations, informed health policy decisions and research. In the context of this broad scope of utilizations, quality of interRAI data needs to be examined.

Missing values—defined as incompleteness of the registered data—can occur due to technical disturbances, if subjects refuse or are unable to respond, or if assessors do not fill in the instrument thoroughly. If the distribution of missingness is not completely at random, results based on this data might be biased if not appropriately analyzed [2]. Missing data within the interRAI also implies the potential under-detection of medical, psychological or social conditions that require care.

In a multi-center study based on the interRAI—Acute Care in Belgium, Wellens et al. (2011) found a substantial number of missing data [3]. Vanneste et al. (2015) described missing data rates equal or more than 15% for the Belgian interRAI-Home Care (HC) and concluded that further evaluation is necessary [4].

This research article focuses on missingness in the oral health-related variables of the interRAI-HC. A thorough and accurate registration of oral health is essential as oral infections are related to pain and discomfort. They are also the main cause for tooth loss [5], which may in turn affect chewing function and nutrition [6]. Additionally, oral health in older individuals is related to a number of systemic diseases, physical and cognitive status, depression, institutionalization and mortality [7–13].

In the present study, an interRAI-HC dataset of older Belgian home-care patients was used to investigate the relationship between missing values of the oral health-related variables and

selected variables of general health. It was hypothesized that missing data of the oral health-related variables do occur more frequently in subjects with a compromised general health status. Furthermore, associations between oral health and selected variables of general health were analyzed before and after multiple imputation of the missing data. Assuming that missingness is related to poor general health, it was hypothesized that associations between oral and general health were more pronounced after replacing missing data by estimated values using the multiple imputation method.

## Materials and Methods

### Dataset and ethical considerations

The present study used 01/2010-08/2013 baseline data from the Protocol 3 project that included frail older people (65+ years) receiving home care in Belgium. The original project intended to identify interventions that delay institutionalization. The Belgian version of the interRAI-HC was applied by professional care givers who received three days of training. Detailed information of the study design was described elsewhere [14].

The protocol 3 project was approved by the Belgian Privacy Commission and by the Ethics committee of the Belgian Universities—Université Catholique de Louvain and Katholieke Universiteit Leuven with dossier number B40320108337. Approval included the retrospective study that is presented here. Older persons were asked to sign an informed consent agreement. In case they were not capable of signing this document, a family member or another legal representative signed it on their behalf, as stipulated by Belgian law. Clients had the right not to participate in the research and they could withdraw their consent at any time. In that case, all data for this person was removed. All data were anonymized and de-identified before the dataset was sent to the researchers for analysis.

### Oral health and selected variables of general health

Section K of the BelRAI-HC contains 4 dichotomous (yes/no) oral health-related questions. It registers *dental prosthesis use* and the following oral health-related problems: *cracked, broken, not intact teeth (damaged teeth), chewing difficulty* and *dry mouth*—occurred in the three days prior to the assessment. The data were collected by interview and observation of the subject, as well as inspection of the mouth.

General health was operationalized by three scales that represent a quantified summary of the subject's functional, cognitive and mental condition. Each scale is calculated automatically by the interRAI algorithms, based on a number of individual items.

The validated Activities of Daily Life Hierarchy Scale (ADLH) represents the functional ability of the subject to perform the following self-care tasks: personal hygiene, toilet use, locomotion, and eating. The resulting 7-point ADLH scale ranges from 0 (completely independent) to 6 (completely dependent) [15]. The second version of the internationally validated Cognitive Performance Scale (CPS2) was used to operationalize the cognitive status of the subject. It is based on a variety of items concerning cognitive skills for everyday decision making, short-term memory, procedural memory, self-expression and eating. The 7-point scale ranges from 0 (intact) to 6 (severely cognitively impaired) [16–17]. The Depression Rating Scale (DRS) was used to represent the mental condition of the subject with reference to symptoms of depression during the last three days. The DRS is based on a number of items as negative statements, expression of unrealistic fears, repetitive complaints or crying for no reason. The scores range from 0 to 14 with higher scores representing more pronounced symptoms of depression [18].

### Statistical analyses

ADLH, CPS2 and DRS were recoded into dichotomous variables using validated cut-off points. Subjects with a ADLH score  $\geq 3$  were considered as functionally impaired [19] and cognitive impairment was denoted for scores  $\geq 2$  on the CPS2 Scale [17, 20]. For the Depression Rating Scale, scores  $\geq 3$  were used to characterize an older person as being depressed [18]. Dichotomization of the scales was necessary due to the distribution characteristics of these variables and the requirements of the statistical procedures used.

For each oral health-related item, a missing-value indicator was created and associations with ADLH, CPS2, and DRS were evaluated. Subsequently, associations between the observed values of the oral health-related variables and ADLH, CPS2, and DRS were analyzed for subjects with completely registered observations (complete-case technique). After multiple imputation of missing values, associations between oral health and ADLH, CPS2, and DRS were re-evaluated and results were compared. Age and gender were examined as potential confounding variables.

For all analyses, multivariable logistic regression included those predictors and covariates that were significantly associated with the outcome variable on a  $p < 0.05$  level of significance in univariable logistic regression.

Multiple imputations were created using the fully conditional specification method [21], also referred to as MICE (Multivariate Imputation by Chained Equations). All outcome variables, predictors, and covariates were used in the imputation model. With the exception of age for which a linear regression model was applied, variables were imputed by a logistic regression model. Ten imputations were performed and results were summarized over the 10 imputed data sets using PROC MIANALYZE.

Multicollinearity of the predictors was examined by Spearman correlations and Variance Inflation Factors (VIF). The correlation matrix revealed low Spearman correlation coefficients ( $< 0.3$ ). Using the 2.5 criterion for VIF, it was concluded that multicollinearity had not to be considered a problem for the multivariable analysis.

Analyses were performed by using the statistical software SAS, version 9.3 (SAS Institute, Inc., Cary, NC).

### Results

#### Description of the dataset

InterRAI-HC baseline assessments were available for 8123 individuals. As the original project intended to include individuals aged 65 or older, subjects with a chronological age less than 65 years were removed. Cases with undefined dates of measurement or birth were also excluded. After cleaning of the dataset, 7590 subjects were available for analysis. The mean age was 81.2 years (SD 6.9, range 65–102) and 69% (5203) were female.

Table 1 presents the descriptive statistics and illustrates that the individual oral health-related variables had a similar proportion of missing values, ranging from 16.31% to 17.18%.

**Table 1. Descriptive statistics of oral health-related variables and corresponding missingness.**

	N	% Missingness	% Yes, Complete-case technique	% Yes, Multiple imputation
Number of patients	7590			
Dental prosthesis	6306	16.92	74.15	73.96
Damaged teeth	6286	17.18	13.95	14.23
Chewing problems	6352	16.31	12.52	12.72
Dry mouth	6326	16.65	17.47	17.57

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Using the completely registered observations, about 74.15% of the subjects wore a *dental prosthesis*. *Damaged teeth*, *chewing problems* and *dry mouth* were registered for 13.95%, 12.52% and 17.47% of the subjects, respectively. After multiple imputation of the incomplete observations, the percentage of subjects with a *dental prosthesis* decreased to 73.96%. The prevalence of *damaged teeth*, *chewing problems* and *dry mouth* increased to 14.23%, 12.72% and 17.57%, respectively.

General health variables were distributed as follows: Assessed by the ADLH scale, 50.1% of the participants were functionally dependent with 8.1% missing values. Cognitive impairment (CPS2) was detected for 43.9% with a missing value proportion of 8.3%. The DRS classified 29.6% of the participants as *depressed* with 7.5% missing values.

### Associations between oral health-related variables, their corresponding missingness and ADLH, CPS2, DRS

Table 2 shows odd's ratios (OR) and their 95% confidence intervals (CI) to illustrate associations between oral health-related items, their corresponding missingness, ADLH, CPS2, DRS and covariates. In the following, results are described for the multivariable analyses.

Missing values for *dental prosthesis use* occurred significantly more frequent if subjects scored higher on the DRS scale (OR 1.66, CI 1.41–1.95) after correction for CPS2. Missingness

**Table 2. Oral health-related variables and corresponding missing values: associations with ADLH, CPS2 and DRS.**

	Oral health-related variables, Odds ratio [95% Confidence interval]					
	Missing values		Complete Case Technique		With Multiple Imputation	
	Univariable	Multivariable	Univariable	Multivariable	Univariable	Multivariable
	Dental prosthesis					
ADLH (≥3 vs <3)	0.98 [0.84–1.13]		** 0.83 [0.74–0.93]	** 0.82 [0.73–0.92]	** 0.82 [0.73–0.92]	*** 0.80 [0.70–0.90]
CPS2 (≥2 vs <2)	*** 1.31 [1.13–1.52]	1.15 [0.98–1.34]	* 0.89 [0.79–1.00]	0.93 [0.82–1.05]	0.90 [0.81–1.01]	
DRS (≥3 vs <3)	*** 1.93 [1.67–2.23]	*** 1.66 [1.41–1.95]	0.90 [0.80–1.02]		0.92 [0.81–1.04]	
Gender (m vs f)	1.13 [1.00–1.29]		*** 0.68 [0.61–0.77]	*** 0.73 [0.64–0.83]	*** 0.67 [0.59–0.76]	*** 0.71 [0.62–0.81]
Age (years)	1.00 [0.99–1.01]		*** 1.05 [1.04–1.06]	*** 1.05 [1.04–1.06]	*** 1.05 [1.04–1.06]	*** 1.05 [1.04–1.06]
	Damaged teeth					
ADLH (≥3 vs <3)	0.97 [0.84–1.12]		1.13 [0.98–1.31]		1.14 [0.98–1.31]	
CPS2 (≥2 vs <2)	*** 1.44 [1.25–1.67]	** 1.27 [1.08–1.48]	*** 1.37 [1.19–1.59]	*** 1.33 [1.14–1.54]	*** 1.37 [1.19–1.57]	*** 1.31 [1.13–1.52]
DRS (≥3 vs <3)	*** 2.05 [1.78–2.36]	*** 1.74 [1.48–2.04]	** 1.26 [1.08–1.48]	* 1.18 [1.00–1.39]	** 1.23 [1.05–1.44]	1.16 [0.99–1.36]
Gender (m vs f)	1.09 [0.96–1.24]		*** 1.35 [1.16–1.56]	*** 1.32 [1.13–1.54]	*** 1.37 [1.19–1.58]	*** 1.32 [1.14–1.53]
Age (years)	1.00 [0.99–1.01]		** 0.99 [0.98–1.00]	** 0.98 [0.97–1.00]	* 0.99 [0.98–1.00]	* 0.99 [0.98–1.00]
	Chewing problems					
ADLH (≥3 vs <3)	1.00 [0.86–1.16]		*** 1.91 [1.63–2.23]	*** 1.68 [1.43–1.98]	*** 1.91 [1.64–2.22]	*** 1.67 [1.43–1.96]
CPS2 (≥2 vs <2)	*** 1.42 [1.22–1.66]	* 1.22 [1.04–1.44]	*** 2.09 [1.80–2.44]	*** 1.65 [1.41–1.95]	*** 2.08 [1.79–2.41]	*** 1.66 [1.43–1.94]
DRS (≥3 vs <3)	*** 2.04 [1.76–2.36]	*** 1.74 [1.47–2.05]	*** 2.09 [1.79–2.44]	*** 1.88 [1.60–2.21]	*** 2.08 [1.78–2.43]	*** 1.87 [1.59–2.19]
Gender (m vs f)	1.08 [0.95–1.23]		1.11 [0.95–1.30]		1.12 [0.96–1.30]	
Age (years)	1.00 [0.99–1.01]		* 1.01 [1.00–1.02]	1.01 [1.00–1.02]	* 1.01 [1.00–1.02]	* 1.01 [1.00–1.02]
	Dry mouth					
ADLH (≥3 vs <3)	1.01 [0.87–1.17]		** 1.23 [1.08–1.40]	** 1.21 [1.06–1.39]	** 1.22 [1.07–1.40]	** 1.20 [1.05–1.38]
CPS2 (≥2 vs <2)	*** 1.42 [1.22–1.65]	* 1.23 [1.05–1.44]	1.00 [0.88–1.14]		1.00 [0.87–1.16]	
DRS (≥3 vs <3)	*** 1.95 [1.69–2.25]	*** 1.65 [1.40–1.94]	*** 1.89 [1.65–2.17]	*** 1.88 [1.63–2.16]	*** 1.89 [1.65–2.16]	*** 1.87 [1.62–2.14]
Gender (m vs f)	1.10 [0.97–1.25]		* 0.87 [0.75–1.00]	* 0.86 [0.74–1.00]	* 0.86 [0.75–0.99]	* 0.87 [0.75–1.00]
Age (years)	1.00 [0.99–1.01]		1.00 [0.99–1.01]		1.00 [0.99–1.01]	

\* p<0.05  
 \*\* p<0.01  
 \*\*\* p<0.001

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was associated with cognitive impairment and depression for *damaged teeth* (CPS2 OR 1.27, CI 1.08–1.48; DRS OR 1.74, CI 1.48–2.04), *chewing problems* (CPS2 OR 1.22, CI 1.04–1.44; DRS OR 1.74, CI 1.47–2.05) and *dry mouth* (CPS2 OR 1.23, CI 1.05–1.44; DRS OR 1.65, CI 1.40–1.94).

Using the complete-case technique, *dental prosthesis use* was significantly associated with better ADLH (OR 0.82, CI 0.73–0.92), female gender (OR 0.73, CI 0.64–0.83) and higher age (OR 1.05, CI 1.04–1.06) after correction for CPS2. *Damaged teeth* were significantly more often registered in subjects with impaired cognition (CPS2 OR 1.33, CI 1.14–1.54) and symptoms of depression (DRS OR 1.18, CI 1.00–1.39). Male gender (OR 1.32, CI 1.13–1.54) and younger age (OR 0.98, CI 0.97–1.00) were also significantly associated to this outcome. *Chewing problems* were significantly associated to poor ADLH (OR 1.68, CI 1.43–1.98), CPS2 (OR 1.65, CI 1.41–1.95), DRS (OR 1.88, CI 1.60–2.21) after correction for age when missing values were treated by the complete-case approach. *Dry mouth* was significantly more often registered in subjects with poor ADLH (OR 1.21, CI 1.06–1.39), DRS (OR 1.88, CI 1.63–2.16) and female gender (OR 0.86, CI 0.74–1.00).

For the four oral health-related variables, after multiple imputation of missing data almost identical odd's ratios—including their 95% confidence intervals—were obtained for the analyzed associations. However, the association between *damaged teeth* and DRS was not significant in the multivariable model after multiple imputation.

## Discussion

In general, three types of missing values are discussed in the literature [22]. If values are *missing completely at random*, the probability of missingness is not related to any observed or unobserved characteristics of the subject. Ignoring this type of missing values does not result in biased statistical results but causes imprecision due to a reduction of statistical power. The *missing not at random* type can be found if the probability of missingness depends on information that is related to unobserved subject characteristics. Universal methods for handling this kind of missing data adequately do not exist and as a result, statistical results are biased. Most frequently, missing values are of the *missing at random* type which means that the probability of missingness may depend on observed characteristics but may not depend on unobserved characteristics of the subject. Statistical methods like multiple imputation provide unbiased statistical results given a correctly specified imputation model [22]. However, missing values are frequently treated by ad-hoc methods like the complete-case technique that is commonly applied by most statistical software packages [2]. Of the 262 epidemiological studies reviewed by Eekhout et al. (2012), 5% provided information on item missingness. The reported levels ranged from 1% to 44% [2], which corresponds to the findings of the present study with missing values ranging from 16.3% to 17.2% for the individual oral health-related variables. According to the analytic guidelines of the National Health and Nutrition Examination Survey in the United States, further examination of non-respondents with respect to the outcome is necessary if more than 10% of the data for a variable are missing [23].

In our study, as hypothesized, missingness in all oral health-related variables was significantly associated with the occurrence of symptoms of depression. The odds for missingness were about 1.7 times higher in depressed individuals. Except for *dental prosthesis use*, missingness was also related to cognitive impairment with approximately 1.2 times higher odds of missing oral health-related information. Opposing our hypothesis, ADLH was not associated with missingness. The presented results indicate that the prevalence of missing data in the oral health-related variables is not completely at random and needs further investigation.

Literature on the causes of item-missingness in epidemiological research is scarce. A study with community-residing older individuals revealed that missing values of the items

*employment and finances* in a personal interview were associated with self-rated physical health, mental health, and cognitive functioning [24]. In accordance with the results of our study, missingness was significantly more pronounced in subjects with poor mental health and cognitive functioning. For self-rated physical health no significant group differences were found [24]. Based on the interRAI-HC, Vanneste et al. (2015) found the highest amounts of missing data in the predominantly medically-oriented items, including disease diagnoses and drug allergies. The authors suggest that this might be caused by the fact that the nurses who performed the assessment had only limited access to this information in the home-care environment. Items that required a careful and thorough inspection of the client were also completed less thoroughly [4].

During the interRAI-HC assessment, oral health-related data are collected by observation, interview and/or inspection of the mouth. Hence, we can only speculate about the mechanisms responsible for the associations found in our study. A poor cognitive status of the subject might have an impact on cooperation and the ability to process and answer questions of the interRAI-HC. Attitudes of general indifference and disinterest, inherently connected to a depressive disorder, might also affect cooperation during the interRAI-HC. Moreover, assessing oral health in cognitively impaired and depressed individuals may be more challenging for the assessors, who are usually not trained as oral health professionals. The finding that ADLH was not associated with missingness might be attributed to the fact that a poor functional condition does not imply a reduction in cooperative behavior. Furthermore, a frail functional status might evoke more empathy, leading to a more precise assessment.

In our study, multiple imputation was applied to evaluate the impact of item missingness on statistical results concerning the associations between oral health and selected variables of general health. The well-founded multiple imputation technique estimates missing data by using available information of the subjects. Multiple data sets are created with different imputations, based on a random sample from different estimated underlying distributions. After imputation, analysis is performed with each imputed dataset and the resulting estimates and their corresponding standard errors are pooled. As this approach accounts for the various aspects of uncertainty of the imputations, it results in statistically valid estimates [22]. A review based on 262 studies, published in one of the three leading epidemiology journals, revealed that only 8% had applied multiple imputation. In contrast, 81% of the studies had used the complete-case procedure, completely ignoring the potential bias introduced by missing data [2].

In our study, *dental prosthesis use* was significantly associated with a better ADLH status. The relationship between denture wearing and activities of daily life was confirmed by Furuta et al. (2013) [25]. In line with international literature [7–10, 12], the current study found oral health-related problems associated with an inferior status in other health areas. Contradicting our second hypothesis, all associations between oral health-related variables and predictors were characterized by nearly identical odd's ratios before and after multiple imputation. Almost complete overlap of the corresponding 95% confidence intervals confirmed that statistical results did not differ between the two approaches. This finding might be explained by the fact that associations between missing data and predictors were too small to largely bias statistical results based on the whole dataset. To examine the impact of the statistical procedure used, we also investigated risk ratios by using a log-link. This approach led to similar results.

However, on a subject level, missing data in the interRAI-HC implies the potential under-detection of a condition that requires care. Comparing the frequencies of oral health-related problems before and after multiple imputation, 0.28%, 0.20% and 0.10% of all subjects with *damaged teeth, chewing problems and dry mouth* were not registered as having these problems (Table 1). Given the extensive literature on the interaction between oral and general health [7–10, 12],

further research should concentrate on the mechanisms that mediate the occurrence of missing data to develop preventative strategies.

It is a limitation of the present study that the sample is not representative for all older individuals receiving home care in Belgium. Furthermore, validity of the oral health-related variables of the interRAI needs to be considered. Folse (2001) reported a profound under-detection of oral health-related problems after comparing interRAI data with dental examination forms [26]. A similar tendency was described by Nordenram et al. (2002) based on oral examination data and interRAI assessments from the same subjects [9]. An international study on inter-rater reliability also revealed that, compared to other items of the interRAI, the oral health-related items had relatively low mean kappa values (between 0.6 and 0.7) [1].

However, the above mentioned papers concerned an earlier version of the interRAI than the one that was used in this study. Further research is necessary in order to clarify, if processes that mediate the occurrence of missing data are linked to problems of validity and reliability.

International extrapolation of our results has to consider the context of the Belgian health care system, where a complete interRAI assessment was not required for coverage of care. If this is the case, arbitrary responses or automatic response patterns might replace missing data problems.

## Conclusion

Data revealed that cognitively impaired and depressive individuals had a higher risk of oral health-related problems and missing oral health-related data. Associations between oral health and ADLH, CPS2 and DRS were not influenced by multiple imputation of missing data.

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## Author Contributions

Conceived and designed the experiments: SKH DD JD. Analyzed the data: SKH KB MH EL. Contributed reagents/materials/analysis tools: JDAM AD. Wrote the paper: SKH MH KB NCFM DD AD JD.

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## **Chapter 2: The optimized photograph-supported ohr- interRAI section**

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## 2.1 Assessment of oral health conditions presented in photographs

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### Abstract

**Background:** Photographs can help non-dental professional caregivers to identify problems when inspecting the mouth of care-dependent older individuals. This study evaluated whether the assessment of oral health-related conditions presented in photographs differed between dentists and non-dental professional caregivers.

**Materials and methods:** One-hundred-and-seventy-nine photographs were taken from long-term care facility residents and from patients at the Department of Dentistry of a University Hospital. The following oral health aspects were depicted: denture hygiene, oral hygiene, teeth, gums, tongue and palate/lips/cheeks. Collection continued until for each oral health aspect a pool of photographs was available that showed conditions from perfect health and hygiene to severe problems. A segmented Visual Analogue Scale was applied to assess the conditions presented in the photographs. Each photograph was assessed by each participant of this study. The benchmark was established by three dentists with academic-clinical expertise in gerodontology, special needs dentistry and periodontology. For each photograph, they provided a collective score after reaching consensus. Photographs were assessed individually by 32 general dentists and by 164 non-dental professional caregivers. Linear mixed effects models and generalized linear mixed effects models were fitted and mean squared errors were computed to quantify differences between both groups.

**Results:** For the different oral health aspects, absolute distances from the benchmark scores were 1.13 (95% CI: 1.03-1.23) to 1.51 (95% CI: 1.39-1.65) times higher for the caregivers than for the dentists. The odds to overestimate the condition were higher for the caregivers than the dentists

## Chapter 2: The optimized photograph-supported ohr-interRAI section

for oral hygiene (OR=0.72, 95% CI: 0.62-0.84) and teeth (OR=0.74; 95% CI: 0.61-0.88). The odds to underestimate the condition were higher for the caregivers than the dentists for gums (OR=1.39; 95% CI: 1.22-1.59) and palate/lips/cheeks (OR=1.22; 95% CI: 1.07-1.40). Over all assessments, the variance in caregiver scores was 1.9 (95% CI: 1.62-2.23) times higher than that for the dentists.

Conclusion: Small but significant differences were found between dentists and non-dental professional caregivers assessing oral health-related conditions presented in photographs. When photographs are used to aid non-dental professional caregivers with the oral health assessment, these visualizations should be complemented with comments to facilitate accurate interpretation.

RESEARCH ARTICLE

Open Access



# Assessment of oral health conditions presented in photographs - is there a difference between dentists and non-dental professional caregivers?

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## Abstract

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**Conclusion:** Small but significant differences were found between dentists and non-dental professional caregivers assessing oral health-related conditions presented in photographs. When photographs are used to aid non-dental professional caregivers with the oral health assessment, these visualizations should be complemented with comments to facilitate accurate interpretation.

**Keywords:** Oral health assessment, Oral photographs, Caregivers, Dentists

## Background

International research shows that oral health in care-dependent individuals is poor [1–3]. This is confirmed by the ‘World Report on Ageing and Health’, which states that “Oral health is a crucial but often neglected area of healthy ageing” [4]. The challenges of oral disease are considerable due to associations with impaired oral functioning [5], aspects of general health [6–8], a number of systemic diseases [9–11] and quality of life [12–15]. Daily oral care and regular professional check-ups are the cornerstones of good oral health. They both are impeded in care-dependent individuals due to physical and cognitive restraints and insufficient availability or accessibility of care [5]. An oral health assessment by non-dental professional caregivers is suggested as a supplementary procedure to detect oral-health related care- and treatment needs [16]. A variety of assessment instruments for caregivers are available such as the Oral Health Assessment Tool (OHAT), the Revised Oral Assessment Guide (ROAG) or the oral health-related section of the Minimum Data Set/interRAI suite of instruments (MDS/interRAI). The instruments above expect caregivers to assess different oral health aspects on a nominal scale, in order to determine whether assistance with daily oral care and/or referral to an oral health professional is required. However, studies on concurrent validity that compare professional oral examination data with non-dental caregiver registrations show shortcomings in the latter in correctly identifying oral care needs [16–19].

As pictures do support, reinforce and illustrate written text [20], oral photographs could be used to visualize item categories and illustrate training materials. A review on the role of pictures in improving health communication concluded that visualizations can support comprehension by providing a context for organizing text information. Pictures are particularly helpful when content is complex and when prior knowledge of individuals is low [21]. Hence, clinical photographs may help non-dental professional caregivers to correctly identify oral care needs. However, expertise differences with regard to the interpretation of medical visualizations have been described in literature [22]. This raises the question of whether non-dental professional caregivers see what dentists see. Or, in other words, whether the

interpretation of clinical photographs significantly differs between both groups.

To our knowledge the present study is the first to explore the presence of differences between dentists and non-dental professional caregivers assessing oral health-related conditions presented in photographs. A pool of clinical photographs showing different oral health aspects was used to test the following hypotheses:

1. Distance from a benchmark assessment is higher for professional non-dental caregivers than for dentists.
2. Direction of the distance from the benchmark depends on the oral health aspect that is shown.
3. Variance around the benchmark assessment is higher for professional non-dental caregivers than for dentists.

## Materials and methods

### Background of the research project

The present study is part of a larger research project that aims to develop an optimized photograph-supported oral health-related section for the interRAI suite of instruments (ohr-interRAI). The interRAI suite is used internationally and consists of tools for comprehensive assessment of conditions and needs of care-dependent individuals. Different versions are available for various sectors, such as home care, nursing homes, hospitals or mental health care settings [23].

### Collection of a pool of clinical photographs

Photographs were taken from consenting long-term care facility residents and from patients at the Department of Dentistry of the University Hospitals KU Leuven, Belgium. Equipment for professional digital dental photography was used: Canon EOS5500 camera, EF-S60mmF2.8USM Macro Objective Lens and a Macro Ring Lite MR-14EX. Lip and cheek retractors as well as oral mirrors were used.

High-definition close-up photographs were taken of the following oral health aspects: denture hygiene, oral hygiene, teeth, gums, tongue and palate/lips/cheeks. The dentist (SKH) who took the photographs used the criteria provided in Table 1 to ensure that for each oral

**Table 1** Verbal description of the segments of the Visual Analogue Scale

Oral health aspects	Segments of the VAS		
	1 Acceptable	2 Not acceptable, moderate	3 Not acceptable, marked
Denture hygiene: Part of the inner surface covered with dental plaque or tartar	< 1/3	1/3–2/3	> 2/3
Oral hygiene: Part of the surface of teeth or denture retainers covered with dental plaque or tartar	< 1/3	1/3–2/3	> 2/3
Teeth	All teeth sound, adequately filled, maybe tooth wear	≥ 1 tooth broken, with decay, defect fillings, root remnants	a
Gums	Pink and firm, maybe minor aberration in color or texture	Moderate redness, swelling, glassy	Marked redness, swelling, bleeding, sores, wounds, fistulas
Tongue	Small bumps on upper and lateral surface, moist, pink	General redness, patches, extensive coating, deep grooves, dry	Red and/or white lesions, swelling, sores, wounds
Palate, oral surface of lips and cheeks	Smooth, moist, pink	General redness, rough, dry	Red and/or white lesions, swelling, sores, wounds

The criteria provided in this table were developed based on a review of the literature and several discussion rounds among the members of the research group  
 \*For teeth, definition of the appearance of ‘not acceptable marked’ conditions was not considered meaningful  
 Verbal description of the appearance of dentures and oral tissues for each segment of the Visual Analogue Scale that was applied for assessment of the photographs

health aspect a balanced number of photographs was included showing ‘acceptable’, ‘not acceptable moderate’ and ‘not acceptable marked’ conditions. In addition, each condition of the different oral health aspects included multiple variations such as full and partial dentures, anterior and posterior teeth as well as buccal and palatal/lingual views. Implant-supported structures were depicted and dorsal, lateral and ventral tongue photographs were taken.

The final pool consisted of 179 clinical photographs: denture hygiene (30), oral hygiene (30), teeth (20), gums (35), tongue (30) and palate/lips/cheeks (34) including a variety of conditions from perfect health and hygiene to severe problems.

**Assessment of the photographs**

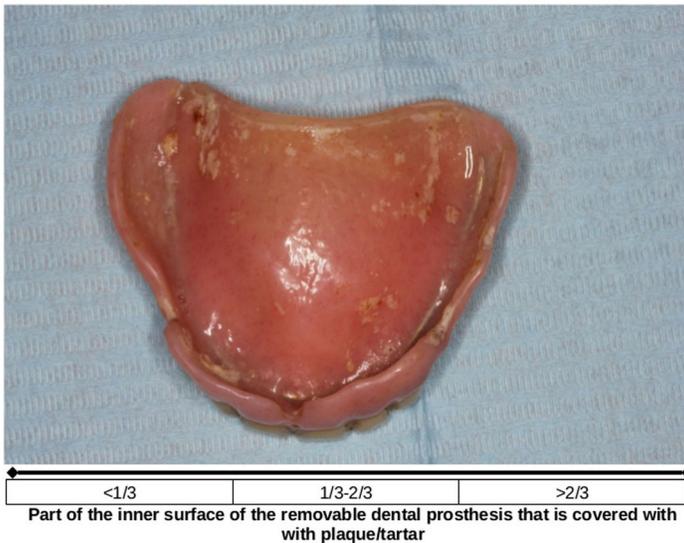
Each of the 179 photographs was assessed by each participant of this study. Photographs were presented per oral-health aspect in six blocks in randomized order on an individual PC screen that was placed in front of each participant. A three-segmented 150 mm Visual Analogue Scale (VAS), (100 mm two-segmented for teeth) was used for the assessment. Participants were instructed to apply the VAS as follows: 1. First select a segment of the scale. The definition of the segment should most suitably describe the appearance of denture or tissue shown on the photograph (Table 1). 2. Then indicate a position on the VAS that is located within the range of the chosen segment. Zero on the VAS represents a perfectly healthy or clean condition, while the right end of the scale indicates severe problems. An example of a photograph on denture hygiene and the scale that was applied is shown in Fig. 1.

The benchmark was established by three dentists with expertise in gerodontology, special needs dentistry and periodontology, affiliated with the Dentistry Department of the University Hospitals, KU Leuven. For each photograph they provided a collective VAS score after reaching consensus. The photographs were assessed individually by dentists and by non-dental professional caregivers in separate sessions. The sessions were organized during certified continuous education activities that were in no way linked to the assessment of the photographs. Participants did not receive any training related to appearance, diagnosis or interpretation of oral health-related pathology.

**Sample and recruitment of dentists and non-dental professional caregivers**

Previous studies with a similar aim and design were not available to estimate the minimum sample size. The current research focused on large effects as literature reports substantial problems of professional non-dental caregivers to correctly identify oral treatment need in care clients [18, 19, 24]. Defining a standard  $\alpha$ -level of 0.05 and a recommended power of 0.8 to compare mean differences, a minimum of 26 participants per group were required to detect a large effect (0.8) [25].

To recruit dentists, an invitation was sent to all attendees of previous permanent education activities organized by the Department of Oral Health Sciences of the University. To recruit the caregivers, care facilities, high-schools for nursing education, umbrella organizations and professional associations for caregivers in Flanders, Belgium were contacted to circulate the invitation among employees or members. Professional non-



**Fig. 1** Example of a photograph on denture hygiene and the scale that was applied

dental caregivers having direct contact with clients in home- or long-term care were invited to participate (e.g., nurses, auxiliary nurses, speech therapists, occupational therapists, dietitians or physicians). Participation was allowed to all dentists and non-dental professional caregivers who responded to the invitation.

**Statistical analysis**

The absolute value of the distance from the benchmark score was calculated for dentists and for non-dental caregivers for each photograph. Due to skewness of the distribution, logarithm of the values was used. The direction of distance from the benchmark indicated whether the score assigned to a photograph was lower, equal or higher than the benchmark score.

To quantify differences between caregivers and dentists with regard to the distance from the benchmark as well as the direction of this difference, a linear mixed effects model and a generalized linear mixed effects model were fitted, respectively. Type of assessor (caregiver, dentist) and oral health aspect (denture hygiene, oral hygiene, teeth, gums, tongue, palate/lips/cheeks) were added to the models as random effects.

Mean squared errors were computed to compare the scores provided by non-dental caregivers and dentists with regard to the variance around the benchmark for each oral health aspect. Statistical programs R (version 3.6) and SAS (version 9.4) were used.

**Results**

**Characteristics of dentists and caregivers**

Thirty-two dentists and 164 non-dental professional caregivers participated in this study. All participants were Caucasian. Table 2 shows that most participants were female. In the caregiver group the gender imbalance was more pronounced with 94.5% female participants. The caregiver group was also relatively younger than the dentist group. Most frequent occupations among caregivers were nurses and nurse aids with 57.9 and 23.8%, respectively. All dentists were primary dental care providers with 46.9% having an additional training in endodontology or prosthetic dentistry.

**Distance from the benchmark**

Figure 2 illustrates the distance from the benchmark for dentists and caregivers, for each oral health aspect, respectively. In both groups, the majority of the assessments peak around the value zero, indicating no or little distance from the benchmark. However, in each of the six graphs, the curve of the dentists exceeds the curve of the caregivers around the zero value. This implies that the distance from the benchmark tends to be lower for dentists. Accordingly, over all photographs the mean absolute distance from the benchmark score on the VAS is 20.1 for the dentists and 27.7 for the caregivers

**Table 2** Characteristics of dentists and non-dental caregivers

		Dentists, N = 32	Caregivers, N = 164
Gender in %	Female	68.8	94.5
	Male	31.2	5.5
Age groups in %	< 30 years	9.4	29.3
	30–40 years	12.5	22.6
	41–50 years	31.3	37.8
	> 50 years	46.9	10.4
Occupation	Nurse		57.9
	Nurse aid		23.8
	Nurse lecturer		7.3
	Speech therapist		3.7
	Others (e.g., physician, psychologist, dietitian)		7.3

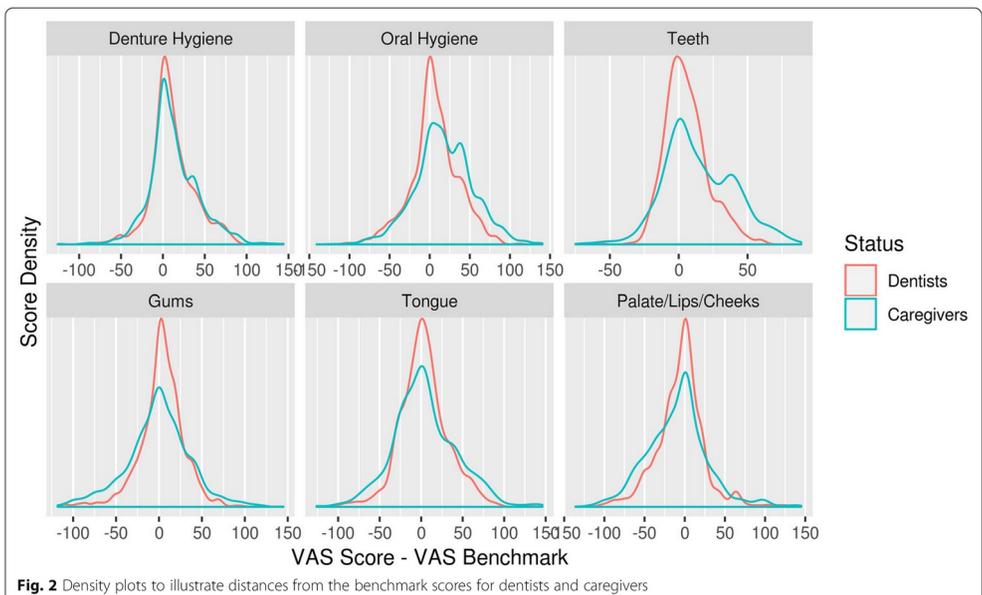
Table 3 presents the results of the linear mixed effects model. It confirms that for all oral health aspects the distances from the benchmark scores are 1.13–1.51 times higher for the caregivers than for the dentists.

**Direction of the distance from the benchmark**

With regard to the direction of the distance, a lower VAS score than the benchmark implies that the condition was underestimated by the participant. A higher score than the benchmark implies that the condition

was overestimated. Table 4 provides an overview over all photographs for caregivers and dentists.

The results of the generalized linear mixed effects model allow a more detailed view. Table 5 illustrates the odds ratios for caregivers versus dentists to assign a lower score than the benchmark. Odds ratios are < 1 for aspects of hygiene and teeth, but > 1 for aspects of the oral soft tissues. This implies that compared to the dentists, caregivers tended to overestimate aspects of hygiene and condition of the teeth, but underestimated aspects of the soft tissues.



**Fig. 2** Density plots to illustrate distances from the benchmark scores for dentists and caregivers

**Table 3** Distance from the benchmark

Oral health aspect	Distance from the benchmark: difference between dentists and caregivers on log scale (increase for caregivers)	95% confidence interval	P-value
Denture hygiene	0.118 (1.13)	0.028–0.208	0.010
Oral hygiene	0.326 (1.39)	0.236–0.416	<.0001
Teeth	0.411 (1.51)	0.308–0.513	<.0001
Gums	0.414 (1.51)	0.328–0.499	<.0001
Tongue	0.368 (1.44)	0.278–0.458	<.0001
Palate, lips, cheeks	0.347 (1.41)	0.260–0.435	<.0001

For all oral health aspects the distances from the benchmark scores were significantly higher for the caregivers than for the dentists

**Variance around the benchmark**

Considering all oral health aspects, the variance around the benchmark scores was significantly higher for the caregivers than for the dentists. The mean squared error was 1.9 times higher for the caregivers than for the dentists (95% confidence interval: 1.62–2.23). When mean squared errors were computed for each oral health aspect separately, no differences were found between the two groups.

**Discussion**

**Interpretation and relevance of the study results**

To our knowledge this is the first study that evaluated whether the assessment of oral health-related conditions presented in clinical photographs differed between dentists and non-dental professional caregivers. Results indicate small but significant differences. A first graphical analysis illustrated that in both groups the majority of the assessments peaked around the benchmark scores. Graphs of dentists and caregivers appeared approximately congruent. This is in line with two studies from the field of dermatology showing high accuracy of nurses to classify skin damage shown in photographs when compared to dermatologists [26, 27].

A more detailed evaluation of the data revealed small but significant differences between both groups, with caregivers having a higher distance from the benchmark than dentists. In addition, the variance in scores

**Table 4** Direction of the distance from the benchmark – overview over all photographs

Direction of the distance from the benchmark	Dentists in %	Caregivers in %
Lower score than benchmark (= underestimation)	40.62	41.87
Same score as benchmark	3.37	0.78
Higher score than benchmark (= overestimation)	56.02	57.35

**Table 5** Direction of the distance from the benchmark

	Underestimation of the condition (lower score than benchmark, odds ratio caregivers/dentists)	95% confidence interval	P-value
Denture hygiene	0.95	0.81–1.11	0.522
Oral hygiene	0.72	0.62–0.84	<.0001
Teeth	0.74	0.61–0.88	0.001
Gums	1.39	1.22–1.59	<.0001
Tongue	1.12	0.97–1.30	0.118
Palate/lips/cheeks	1.22	1.07–1.40	0.004

For oral hygiene and teeth the odds to assign a lower score than the benchmark were significantly higher for the dentists. For gums and palate/lips/cheeks the odds to assign a lower score than the benchmark were significantly higher for the caregivers

provided by the caregivers was higher than the variance in scores provided by the dentists. This confirms the findings published by Yazdanyar et al. (2013) who compared general practitioners and dermatologists with regard to their congruence with a benchmark in identifying acne morphology using photographs and a short description. In all cases, responses of the dermatologists were more congruent with the benchmark and variation was lower compared to the general practitioners [28]. A meta-analysis on differences in the comprehension of visualizations found higher performance accuracy and shorter reaction times for experts than for non-experts [29].

With regard to the direction of the distance from the benchmark, differences between dentists and caregivers depended on the type of oral health aspect. For photographs showing aspects of oral hygiene and teeth, the non-dental professional caregivers tended to overestimate the condition compared to the dentists. In contrast, for photographs showing gums and palate/lips/cheeks the odds to underestimate the condition were higher for the caregivers than for the dentists. To suggest a possible explanation, age-related physiological changes such as discoloration or tooth wear might be misinterpreted by non-dental professional caregivers. Furthermore, dental plaque and tooth decay may look impressive to non-dental caregivers, while dentists know that these conditions often can be treated easily. On the other hand, caregivers are maybe less aware than dentists that oral soft tissue lesions can involve harmful malignities.

Considering the supporting role of pictures in health communication, our findings confirm that complex visualizations require instruction and guidance to ensure a correct interpretation [21]. Hence, when photographs are used to aid non-dental caregivers with the oral health assessment, these

visualizations should be complemented with comments to facilitate accurate interpretation. Results of the current study indicate that for aspects of hygiene and teeth, instructions are needed to differentiate between pathology and normal, age-related phenomena. It should further be emphasized that soft tissue lesions require close attention.

With regard to the development of the optimized interRAI oral health-related section, the benefits of including visualizations might reach beyond the correct identification of care needs. Focus group discussions with caregivers revealed that oral health has low priority in the care environment and that the oral health-related section of the interRAI is completed only superficially without inspection of the mouth [30]. As human beings are attracted to visual stimuli [20], photographs have the potential to enhance attention and raise awareness for the oral health assessment. Inclusion of various views of the different oral health aspects - such as dorsal, lateral and ventral tongue photographs - might motivate a more thorough assessment of the mouth. In this context it needs to be mentioned that oral health is often neglected in current training programs for non-dental professional caregivers. A study showed that among high schools in Norway providing basic education for auxiliary nurses, solely 49% offered three or more hours of teaching on oral health [31]. In a French study with professional caregivers only 21% reported previous theoretical training on oral disorders [32]. More emphasis on the topic of oral health during professional training of non-dental caregivers may raise the awareness and improve the ability to correctly recognize pathology.

#### Study limitations and further research

Correct understanding of the terminology used to describe the different segments the VAS was questioned for certain participants such as care aides who often receive only limited professional training. Accordingly, involvement of non-dental professional caregivers in development and pilot-testing of the scale should have been considered. Although the minimum sample size was exceeded for both groups, the number of participants was markedly unbalanced. The sample reflected actual differences between dentists and non-dental professional caregivers with regard to gender and age, but was not representative for the population of both groups. Further research - preferably on an international scale - needs to clarify whether findings are generalizable. In addition, the impact of participant demographics and oral health-related training, knowledge and awareness should be evaluated.

#### Conclusion

Small but significant differences were found between dentists and non-dental caregivers regarding the assessment of oral health-related conditions presented in clinical photographs. When photographs are used to aid non-dental professional caregivers with the oral health assessment, these visualizations should be complemented with comments to facilitate accurate interpretation.

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#### Authors' contributions

All authors meet the criteria for authorship and all those entitled to authorship are listed as authors. SKH, DD, JdAM, AD and JD designed the study and ensured approval of the Ethical Committee. SKH and JdAM collected the clinical photographs and recruited participants for the assessment sessions. The assessment sessions were organized by SKH, TDT and EL analyzed the data and the results were discussed and interpreted in a meeting with all authors. SKH, TDT and JDL were major contributors in writing the manuscript. The authors read and approved the final manuscript.

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#### Availability of data and materials

All data analyzed during this study are included in this published article [and its supplementary information files].

#### Ethics approval and consent to participate

The study was approved by the ethics committee research UZ/KU Leuven with study number s59152. Participants were informed comprehensively and provided written consent. To ensure anonymity, the identity of the participants was not registered during data collection.

#### Consent for publication

Not applicable.

#### Competing interests

The authors declare that they have no competing interests.

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## 2.2 Development and validation of an optimized ohr-interRAI section

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### Abstract

**Objectives:** An optimized oral health-related section and a video training were developed and validated for the interRAI suite of instruments. The latter is completed by professional non-dental caregivers and used in more than 40 countries to assess care needs of older adults.

**Methods:** The optimized oral health-related section (ohr-interRAI) consists of nine items and a video training that were developed in consecutive phases. To evaluate psychometric properties, a study was conducted in 260 long-term care residents. Each resident was assessed by a dentist and by four caregivers (two who received the video training, two who did not).

**Results:** Mean kappa values and percent agreement between caregivers and dentist ranged between  $\kappa=0.60$  (80.2%) for *dry mouth* and  $\kappa=0.13$  (54.0%) for *oral hygiene*. The highest inter-caregiver agreement was found for *dry mouth* with  $\kappa=0.63$  [95% CI 0.56-0.70] (81.6%), while for the item *palate/lips/cheeks* only  $\kappa=0.27$  [95% CI 0.18-0.36] (76.7%) was achieved. Intra-caregiver agreement ranged between  $\kappa=0.93$  [95% CI 0.79-1.00] (96.4%) for *dry mouth* and  $\kappa=0.45$  [95% CI 0.06-0.84] (82.8%) for *gums*. Logistic regression analysis showed only small differences between caregivers who watched the video training and those who did not.

**Conclusions:** Psychometric properties of the optimized ohr-interRAI section were improved compared to previous versions. Nevertheless, particularly the items based on inspection of the mouth require further refinement and caregiver training needs to be improved.

## Chapter 2: The optimized photograph-supported ohr-interRAI section

Clinical Relevance: Valid assessment of oral health by professional caregivers is essential due to the impaired accessibility of regular dental care for care-dependent older adults.



# Assessment of oral health in older adults by non-dental professional caregivers—development and validation of a photograph-supported oral health-related section for the interRAI suite of instruments

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**Clinical Relevance** Valid assessment of oral health by professional caregivers is essential due to the impaired accessibility of regular dental care for care-dependent older adults.

**Keywords** Oral health assessment · Oral screening · Older care-dependent adults · Non-dental caregivers · InterRAI suite of instruments

## Introduction

International research consistently reports poor oral health in care-dependent older individuals [1–4]. This causes oral infection and tooth loss and finally results in compromised oral functioning [5] and reduced quality of life [6, 7]. Oral health is further associated with the general cognitive and physical condition [8–10], and with systemic diseases such as diabetes mellitus or cardiovascular disease [11–13]. To maintain good oral health, daily oral care and regular professional check-ups and cleanings are essential. In care-dependent older adults, realization of these measures is challenged by cognitive and physical impairment and by accessibility and availability of care [14].

Non-dental professional caregivers can play a role in oral health screening to facilitate improvement of daily oral hygiene and timely referral to dental care [15, 16]. A variety of screening instruments is available such as the Oral Health Assessment Tool (OHAT) [16], the Revised Oral Assessment Guide (ROAG) [17], the Oral Health Screening Tool for Nursing Personnel (OHSTNP) [18], or the oral health-related section of the Minimum Data Set 2.0/interRAI suite of instruments (ohr-MDS 2.0/ohr-interRAI) [19]. Studies on psychometric properties of the above instruments vary with regard to the professional background of the caregivers, how they were trained, or to what benchmark their registrations were compared [16, 17, 20–24]. This variability and methodological shortcomings of the studies impair a reliable comparison between the oral screening tools [25].

A practical challenge for the effectiveness of any oral screening tool is its broad implementation in everyday care. Only if oral health of all clients is assessed regularly, care needs can be detected and tackled. While most screening instruments were developed and applied within a rather academic context, the ohr-interRAI and related precursor versions are widely used in more than 30 countries in North America, Europe, Asia, and the Pacific Rim [26]. The ohr-interRAI section belongs to the interRAI suite of instruments that consists of tools for comprehensive assessment of care needs. Various aspects of health and well-being are evaluated and used for holistic care planning. It is completed by caregivers upon admission to residential care or home care services and repeated periodically. A valid oral health section holds the potential to integrate oral care into general care planning. The current interRAI version for long-term care consists of six dichotomous (yes/no) oral health items that register

removable dental prosthesis use, non-intact teeth, dry mouth, chewing problems, gum inflammation and pain. Caregivers can choose to examine, interview, or observe clients, but clear definitions or guidelines on how to assess oral health are not provided in the utilization manual [19]. Compared to its precursor version included in the Minimum Data Set 2.0, the ohr-interRAI was slightly shortened and modified. [The different versions are shown in the [supplementary material](#) of this article].

Although widely used, it was consistently shown that the current ohr-interRAI section and related precursor versions do not adequately detect oral health-related care needs [24, 27–32]. In a study on the underlying reasons for this failure, experts challenged completeness, relevance, clarity of wording, and feasibility of the items [33]. Focus group discussions with caregivers revealed further shortcomings of the ohr-interRAI section, situational factors that impeded the assessment, and low awareness for oral health in the care environment. It was also found that the approach of the caregivers to complete the ohr-interRAI section was not suited to accurately detect care needs [33].

The present study aimed to develop and validate an optimized, photograph-supported ohr-interRAI section that effectively detects clients who need assistance with daily oral hygiene and/or referral to a dentist.

## Materials and methods

### Phase I: Development of an optimized ohr-interRAI section and a video training

**Step 1:** After literature review, test content, and requirements of an optimized ohr-interRAI section were discussed by a group of 12 experts. Participants had an academic-clinical background in gerodontology ( $n = 5$ ), prosthetic dentistry ( $n = 2$ ), periodontology ( $n = 1$ ), geriatric medicine ( $n = 3$ ), and geriatric nursing care ( $n = 1$ ). There was a consensus that, as an integrated part of the comprehensive interRAI assessment, the number of items should not exceed 10. An optimized ohr-interRAI section should not only include client self-reports (chewing problems, pain/discomfort, dry mouth) but also mandate an inspection of the mouth (oral/denture hygiene and condition of teeth, gums,

tongue, palate, lips, and cheeks). It was decided that the optimized ohr-interRAI section should differentiate between acceptable and non-acceptable conditions to indicate the need of a care intervention. The terminology acceptable/non-acceptable was chosen as the assessed persons are in the last phase of their life. It was considered that a meaningful and realistic oral health assessment should allow for the fact that in this population, aberrations from perfect oral health are tolerable. As a minimum standard, oral health should be acceptable. There was also a consensus that exemplary photographs—clearly and consistently interpreted by oral health professionals—were needed as visualizations for oral screening.

- 1 Preliminary items were formulated. To define acceptable and non-acceptable conditions for each item, literature was reviewed and several discussion rounds among the members of the research group were organized. Related to *chewing problems*, *pain/discomfort*, and *dry mouth*, definition of acceptable and non-acceptable conditions proved difficult. For these items, the response category non-acceptable was preliminarily divided into moderate and marked, anticipating that a refined dichotomous version will be formulated later based on the results and the experience of the presented research. Moreover, general utilization guidelines, definitions, and item-wise instructions on how to do the oral health assessment were added.

- Step 3: Photographs to visualize the 6 items that require inspection of the mouth were taken from older long-term care residents and from patients at the Department of Oral Health Sciences, University Hospitals Leuven. For each item, about 30 photographs were collected, including a variety of conditions that ranged from healthy to severely unhealthy. The photographs further depicted different views, such as the dorsal, lateral, and ventral surface of the tongue. The condition shown on each of the 179 photographs was then assessed by oral health professionals to exclude the most unclear visualizations. Three university-associated dentists, specialized in gerodontology, special needs dentistry, and periodontology, provided a collective score that constituted the benchmark. Photographs were further individually assessed by 32 general dentists. Only those photographs were considered to be used as visualizations if at least 80% of the dentists agreed with the benchmark on whether acceptable or non-acceptable conditions were shown. According to Huhg (2012), 80% is widely accepted and

recommended in the literature as minimum standard for agreement among raters [34].

- 1 In-depth interviews with 7 non-dental caregivers—acquainted with the current ohr-interRAI section—were conducted to refine the preliminary photograph-supported items and guidelines.

(The items and utilization guidelines of the optimized ohr-interRAI section are shown in the [supplementary material](#) of this article.)

- Step 5: A video training was produced that consisted of 9 clips with a total duration of about 30 minutes. It included comprehensive information on the oral health assessment and a variety of photographs. The first video illustrated the relevance of oral health and introduced known associations between oral health and general health. In the second video, general utilization guidelines of the optimized ohr-interRAI section were clarified and video 3 was about the registration of *chewing problems*, *pain/discomfort* and *dry mouth*. The remaining videos covered each an individual item: 4 *denture hygiene*, 5 *oral hygiene*, 6 *teeth*, 7 *gums*, 8 *tongue*, and 9 *palate/lips/cheeks*. (The videos are available in the [supplementary material](#) of this article.)

## Phase II: Study to evaluate psychometric properties of the optimized ohr-interRAI

Management executives of all 137 long-term care facilities in the province of Flemish-Brabant, Belgium, were invited by e-mail to participate. From each of the 9 facilities that agreed to take part, 4 non-dental caregivers were recruited. Before commencing the study, caregivers completed a questionnaire with 30 statements to evaluate oral health-related knowledge. The statements included oral health—general health associations and the appearance of oral health diseases. During a 1-hour session, all caregivers received instructions on completion of the optimized ohr-interRAI section and the study procedure. Two caregivers from each facility watched the video training in addition. After finishing data collection which took 2 or 3 days per care facility, caregivers again completed the questionnaire on oral health-related knowledge. Two dentist researchers examined the residents. To calibrate dentists, 20 residents were examined twice and differences were discussed per item. For the first 10 of these residents, a third dentist was present for calibration.

A convenience sample of non-palliative residents was taken. Sample size calculation was based on a binomial distribution of item responses, a worst-case theoretical detection ability of 50% and an acceptable estimation error of about 7%. It was determined that at least 200 residents had to be included.

An extra 30% of residents were added to account for potential dropouts during data collection.

For each resident, all oral health registrations were performed on the same day, spread over a period of about 3 hours. It was estimated that the total duration of the assessments summed up to approximately 35 minutes, depending on her or his dental status. Residents were individually assessed in their private room by each of the 4 caregivers using flashlights for illumination. The sequence of residents was scheduled for each caregiver to prevent order bias and to ensure efficiency of the data collection procedure. In addition, about 10% of the residents were assessed a second time by one of the caregivers. Finally, residents were examined by a dentist. First, the dentist inspected the mouth visually without additional aids, only using a headlamp for illumination. This corresponded to the conditions that applied to the caregivers. In a second step, dentists repeated the assessment using a standard dental mirror and a dental explorer. These registrations were considered the benchmark. After the oral health registration, the dentist rated the assessment ease to provide an estimate of how well the participant could be assessed. Considering communication fluency and physical cooperation, the dentist indicated a single value on a 5-point Likert scale that ranged from very easy to very difficult.

## Statistical analysis

Items with three response categories were dichotomized as follows: 1 = acceptable, 2 = non-acceptable moderate, and 3 = non-acceptable marked. Psychometric properties were determined for the individual items. They were further quantified for the resulting interventions *assistance with hygiene* and *referral to dentist* that were established by the individual items as follows:

- *Assistance with hygiene: denture hygiene, oral hygiene*
- *Referral to dentist: chewing problems, pain/discomfort, dry mouth, teeth, gums, tongue, palate/lips/cheeks.*

Interventions were recommended if one or more of the constituting items were rated as non-acceptable.

Agreement of caregivers with the dentist (using dental mirror and explorer), inter-caregiver, and intra-caregiver were quantified using percent agreement and kappa statistics (Cohen's kappa and Krippendorff's alpha). For kappa statistics, the following interpretation was used: 0–0.20 no, 0.21–0.39 minimal, 0.40–0.59 weak, 0.60–0.79 moderate, 0.80–0.90 strong, and >0.90 almost perfect agreement [34]. Observations were excluded from the analysis if assessment of the condition was not possible due to non-cooperation of the resident or if dentures, retainers, or teeth were not present (outcome absent).

Logistic regression was used to model the effect of the video training on dentist-caregiver agreement and on inter-caregiver agreement. Fixed and random effects were included for residents and care facilities. Models were corrected for the following covariates: gender, age, and assessment ease of residents as well as gender, age, previous attendance of continuing education activities on oral health, responsibility for daily oral care, and work experience of caregivers.

Statistical programs SPSS (version 23), SAS (version 9.4), and R (version 3.6) were used.

## Results

### Descriptive results

The optimized ohr-interRAI section that was developed in the context of this study consists of 9 photograph-supported items, utilization guidelines, and a video training. Originally developed and tested in the Flemish-Dutch language, the instrument was translated to English for the readers of this journal (see [supplementary material](#) of this article).

The study that evaluated the psychometric properties of the developed instrument was conducted in 9 long-term care facilities in Flanders, Belgium. They had a capacity between 43 and 131 beds; 5 were public and 4 were privately organized.

Thirty-six caregivers—4 from each care facility—participated in the study. A proportion of 83.3% were female and they belonged to the following age groups: <30 years = 27.8%, 30–40 years = 38.9%, 41–50 years = 8.3%, and >50 years = 25.0%. With regard to professional function, 52.8% were nurses, 25.0% nurse aids, 16.7% occupational therapists, and 5.6% speech therapists. Previous continuous education activities on oral health were attended by 25.0% and 75.0% provided daily oral care for clients.

Between 24 and 30 residents from each care facility participated in the study—260 in total. The mean age was 86.3 ( $\pm$  7.3) years and 76.9% was female. While 57.4% could be assessed very easy or easy, 28.3% were classified as neutral and 14.3% were difficult or very difficult to examine.

Tables 1 and 2 present oral health and hygiene and the resulting interventions for dentists and caregivers, respectively. For the shown registrations, dentists had used a dental mirror and an explorer. Without these aids, about 6% less non-acceptable conditions were detected by dentists for *oral hygiene, teeth, and gums*. For *tongue and palate/lips/cheeks*, the difference was about 1%.

As only isolated and small effects of the video-training were found (Table 5), arithmetic means over all caregivers are reported in Tables 1, 2, 3, and 4.

**Table 1** Oral health and hygiene of residents registered by dentists and caregivers using the optimized ohr-interRAI section

	Dentist						Caregivers <sup>2</sup>					
	Acceptable		Non-acceptable		Outcome absent <sup>3</sup>		Acceptable		Non-acceptable		Outcome absent <sup>3</sup>	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Chewing problems*	103	39.6	145	55.8	12	4.6	108	42.0	138	53.4	12	4.6
Pain/discomfort*	214	82.3	29	11.2	17	6.5	213	82.9	37	14.3	7	2.7
Dry mouth*	136	52.3	106	40.8	18	6.9	126	48.9	123	47.9	9	3.2
Denture hygiene+	80	30.8	100	38.5	80	30.8	136	53.8	42	16.4	76	29.9
Oral hygiene+	24	9.2	130	50.0	106	40.8	90	35.6	63	24.9	100	39.5
Teeth+	35	13.5	117	45.0	108	41.5	57	22.2	97	37.6	103	40.3
Gums+ <sup>1</sup>	116	44.6	137	52.7	7	2.7	197	76.9	56	21.6	4	1.5
Tongue+	221	85.0	26	10.0	13	5.0	195	76.0	59	22.8	3	1.2
Palate/lips/cheeks+	193	74.2	59	22.7	8	3.1	205	79.8	49	18.8	8	1.4

<sup>1</sup> In patients without teeth or implant-based retainers, gum tissue of the edentulous ridges was assessed.

<sup>2</sup> Arithmetic mean over all caregivers

<sup>3</sup> Assessment was not possible due to the condition of the resident or dentures/retainers/teeth were not present

\*Registered based on client self-reports. Assessors turned to family/other caregivers when clients were not able to communicate

+ Registered based on inspection of the mouth. To collect the presented data, dentists used a standard dental mirror and a dental explorer. Caregivers did not apply any diagnostic instruments

**Dentist-caregiver agreement**

Over all caregivers, overall agreement with the benchmark was the highest for those items that were based on client self-reports (Table 3). Kappa values ( $\kappa$ ) and percent agreement are provided to quantify agreement. For *dry mouth*, *chewing problems*, and *pain/discomfort*, the mean dentist-caregiver agreement was  $\kappa = 0.60$  (80.2%),  $\kappa = 0.56$  (78.6%), and  $\kappa = 0.41$  (86.6%), respectively. For the remaining items, mean agreement ranged between  $\kappa = 0.29$  (69.9%) for *teeth* and  $\kappa = 0.13$  (54.0%) for *oral hygiene*. With regard to the resulting interventions, mean agreement was  $\kappa = 0.39$  (87.7%) for *referral to dentist* and  $\kappa = 0.23$  (56.1%) for *assistance with hygiene*.

**Table 2** Recommended interventions based on the optimized ohr-interRAI

	Dentist				Caregivers <sup>1</sup>			
	No		Yes <sup>2</sup>		No		Yes <sup>2</sup>	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Assistance with hygiene	72	27.7	188	72.3	160	64.0	91	36.0
Referral to dentist	22	8.5	238	91.5	31	12.0	226	88.0

<sup>1</sup> Arithmetic mean over all caregivers

<sup>2</sup> If  $\geq 1$  of the constituting items was non-acceptable

**Inter- and intra-caregiver agreement**

As shown in Table 4, the highest inter- and intra-caregiver agreement was reached for the items based on client self-reports.

*Dry mouth* scored best with  $\kappa = 0.63$  [95% CI 0.56–0.70] (81.6%), indicating a moderate inter-caregiver agreement, whereas for the item on *palate/lips/cheeks* only  $\kappa = 0.27$  [95% CI 0.18–0.36] (76.7%) was found.

Intra-caregiver agreement was highest for *dry mouth* with  $\kappa = 0.93$  [95% CI 0.79–1.00] (96.4%), and lowest for *gums* with  $\kappa = 0.45$  [95% CI 0.06–0.84] (82.8%).

**Effect of the video training**

With regard to caregivers’ oral health-related knowledge, the mean increase of the number of correct answers was 4.17 ( $\pm 3.37$ ) for those without the video training, and 10.44 ( $\pm 6.43$ ) for those who had watched the videos.

Table 5 illustrates agreement differences between both groups of caregivers. If caregivers had watched the video training, agreement with the dentist was significantly higher for non-acceptable *oral hygiene* (OR = 1.95 [95% CI 1.16–3.27]) and *gums* (OR = 1.69 [95% CI 1.01–2.85]). However, lower agreement with the dentist was found for acceptable *gums* (OR = 0.47 [95% CI 0.23–0.95]) and *tongue* (OR = 0.65 [95% CI 0.76–1.19]).

**Table 3** Dentist-caregiver agreement

	Dentist-caregiver agreement <sup>2,3</sup>							
	Overall			Non-acceptable/intervention recommended <sup>4</sup>			Acceptable/no intervention recommended <sup>5</sup>	
	<i>n</i>	%	$\kappa$	<i>n</i>	%	<i>n</i>	%	
Chewing problems*	189	78.6	0.56	111	79.2	79	77.6	
Pain/discomfort*	206	86.6	0.41	16	53.6	191	91.1	
Dry mouth*	190	80.2	0.60	89	84.7	102	76.7	
Denture hygiene+	106	61.8	0.28	35	36.7	71	92.9	
Oral hygiene+	71	54.0	0.13	55	49.7	16	77.1	
Teeth+	102	69.9	0.29	82	72.2	21	62.1	
Gums <sup>1</sup>	138	55.8	0.15	40	29.4	99	86.7	
Tongue+	187	76.5	0.18	13	47.6	174	79.9	
Palate/lips/cheeks+	184	74.0	0.23	21	35.3	164	85.9	
Assistance with hygiene	141	56.1	0.23	81	44.8	60	86.7	
Referral to dentist	228	87.7	0.39	216	92.0	12	54.5	

<sup>1</sup> In patients without teeth or implant-based retainers, gum tissue of the edentulous ridges was assessed.

<sup>2</sup> Arithmetic mean over all caregivers

<sup>3</sup> Registrations were not considered in the analysis if the outcome was absent.

<sup>4</sup> Calculation according to sensitivity

<sup>5</sup> Calculation according to specificity

\*Registered based on client self-reports. Assessors turned to family/other caregivers when clients were not able to communicate

+ Registered based on inspection of the mouth. To collect the presented data, dentists used a standard dental mirror and a dental explorer. Caregivers did not apply any diagnostic instruments

Inter-caregiver agreement was significantly higher for *tongue* (OR = 1.54 [95% CI 1.01–2.34]) for caregivers with video training.

## Discussion

An optimized oral health-related section was developed for the interRAI suite of instruments. It consists of 9 items that

include client self-reports but also require inspection of the mouth. As chewing problems, pain, and dry mouth impair oral health-related quality of life [35], registration of these aspects is crucial. However, an inspection of the mouth is inevitable since older individuals are often not aware or do not complain about oral problems [36, 37]. Photographs were used as visualizations to help caregivers to recognize non-acceptable oral conditions and to raise the awareness for oral health.

**Table 4** Inter-caregiver and intra-caregiver agreement

	Inter-caregiver agreement <sup>2</sup>		Intra-caregiver agreement <sup>2</sup>	
	% <sup>3</sup>	$\kappa$ [95% CI]	%	$\kappa$ [95% CI]
Chewing problems	76.6	0.53 [0.45–0.60]	96.4	0.92 [0.78–1.00]
Pain/discomfort	87.8	0.51 [0.39–0.61]	85.7	0.63 [0.32–0.94]
Dry mouth	81.6	0.63 [0.56–0.70]	96.4	0.93 [0.79–1.00]
Denture hygiene	77.3	0.38 [0.27–0.48]	90.0	0.62 [0.15–1.00]
Oral hygiene	69.8	0.36 [0.26–0.46]	81.3	0.63 [0.24–1.00]
Teeth	74.4	0.45 [0.35–0.55]	80.0	0.60 [0.20–1.00]
Gums <sup>1</sup>	74.7	0.28 [0.19–0.36]	82.8	0.45 [0.06–0.84]
Tongue	73.2	0.27 [0.19–0.35]	86.2	0.66 [0.35–0.96]
Palate/lips/cheeks	76.7	0.27 [0.18–0.36]	96.4	0.90 [0.71–1.00]
Assistance with hygiene	72.1	0.39 [0.32–0.46]	82.8	0.59 [0.26–0.91]
Referral to dentist	87.6	0.42 [0.29–0.52]	93.1	0.63 [0.15–1.00]

<sup>1</sup> In patients without teeth or implant-based retainers, gum tissue of the edentulous ridges was assessed

<sup>2</sup> Registrations were not considered in the analysis if the outcome was absent

<sup>3</sup> Arithmetic mean over all caregivers

**Table 5** Differences between caregivers with/without video training

Item/combination	Differences between caregivers with/without video training					
	Dentist-caregiver agreement			Inter-caregiver agreement		
	Non-acceptable/intervention recommended		Acceptable/no intervention recommended			
	Odds ratio [95% CI]	P value	Odds ratio [95% CI]	P-value	Odds ratio [95% CI]	P value
Chewing problems	0.89 [0.49–1.62]	0.708	1.86 [0.97–3.55]	0.062	1.52 [0.98–2.37]	0.065
Pain/discomfort	0.90 [0.24–3.36]	0.873	1.69 [0.87–3.30]	0.125	0.98 [0.57–1.66]	0.927
Dry mouth	0.95 [0.49–1.84]	0.869	1.83 [0.97–3.47]	0.064	1.07 [0.67–1.70]	0.775
Denture hygiene	0.93 [0.51–1.69]	0.815	1.80 [0.60–5.40]	0.295	0.65 [0.41–1.02]	0.065
Oral hygiene	1.95 [1.16–3.27]	0.012	0.56 [0.10–3.18]	0.514	1.06 [0.71–1.56]	0.788
Teeth	0.60 [0.33–1.09]	0.095	0.91 [0.37–2.29]	0.857	0.96 [0.60–1.54]	0.862
Gums <sup>1</sup>	1.69 [1.01–2.85]	0.047	0.47 [0.23–0.95]	0.037	0.91 [0.60–1.38]	0.672
Tongue	0.63 [0.23–1.77]	0.388	0.65 [0.76–1.19]	0.035	1.54 [1.01–2.34]	0.045
Palate/lips/cheeks	1.40 [0.65–3.01]	0.385	0.57 [0.32–1.03]	0.063	0.80 [0.51–1.23]	0.302
Assistance with hygiene	1.49 [0.92–2.12]	0.112	0.93 [0.37–2.32]	0.869	1.22 [0.78–1.89]	0.381
Referral to dentist	0.94 [0.53–1.69]	0.840	1.88 [0.46–7.59]	0.382	1.10 [0.63–1.92]	0.738

<sup>1</sup> In patients without teeth or implant-based retainers, gum tissue of the edentulous ridges was assessed

### Prevalence of oral health-related problems

Residents who participated in this study were not selected randomly, results do not refer to palliative residents, and over-representation of cooperative individuals is highly probable. However, the prevalence of problems identified by dentists confirms the findings of earlier research reporting poor oral health in care-dependent older adults in Belgium [38, 39]. In the present study, hygiene was non-acceptable for 55% of the dentures. Among residents with teeth or implant-based retainers in the mouth, 84% had non-acceptable oral hygiene. Accordingly, De Visschere et al. (2016) reported for the oldest age group that in 43% of the dentures, at least 25% of the surface was covered with plaque. The mean dental plaque score also demonstrated poor oral hygiene [38]. Seventy-seven percent of the dentate residents had a non-acceptable tooth condition in the present study, which is in line with the dental treatment needs reported by De Visschere et al. (2016) and Janssens et al. (2017) [38, 39]. In our study, a non-acceptable *gum* condition was registered in 54.1% of the residents whose gums could be assessed. De Visschere et al. (2016) found periodontal disease in 87% [38]. This considerable difference is likely to arise from the different methodologies that were applied. In contrast to De Visschere et al., in the present study, periodontal tissues were not manipulated and the mucosa on the alveolar bone was assessed in edentulous residents. With regard to mucosal tissues, non-acceptable conditions for *tongue* and *palate/lips/cheeks* were registered in 10.5% and 23.4% of the residents, respectively. Accordingly, De Visschere et al. (2016) observed mucosal lesions in about 25% of their participants [38].

Subjective oral health in care-dependent older individuals has not been evaluated in recent studies in Belgium. The present research identified 55.8% of residents with *chewing problems*. This proportion is higher compared to international studies reporting prevalence rates between 25.6 and 48.7% [40, 41]. Participating dentists in the current study remarked after data collection that *chewing problems* might be defined too strictly and suggested revision of this item. *Pain or discomfort* was registered in 11.2% of the residents which is comparable to Delwel et al. (2018) reporting oro-facial pain in 0–10% [37]. In our study, dentists registered a *dry mouth* sensation in 40.8% of the residents which is in line with other studies reporting prevalence rates between 28.6 and 63% [40, 42–45].

With regard to consistency within the current study, it might have been beneficial to have all participants examined by the same dentist. However, the calibration process revealed differences among dentists that could be mitigated by discussion. Hence, it can be assumed that using more than one dentist enhanced reproducibility of the study results.

### Dentist-caregiver agreement

Dentists and caregivers used the optimized ohr-interRAI section to assess oral health. The agreement of their registrations provides information on concurrent validity of the items. Dentists had specific experience with frail older adults, were calibrated, and used dental mirrors and explorers for the oral examination. The prevalence of oral health problems was comparable to other studies with older adults in Belgium

[38, 39], confirming that dentist registrations were a valuable benchmark to compare caregiver assessments with.

In accordance with comparable research, kappa values are reported to quantify agreement after the correction for chance agreement. As kappa values cannot be interpreted straightforwardly and as they are affected by the prevalence of the registered conditions [46], percent agreement is also reported.

In the current study, the highest kappa values were found for *chewing problems* ( $\kappa = 0.56$ ; 78.6%) and *dry mouth* ( $\kappa = 0.60$ ; 80.2%), indicating slightly moderate dentist-caregiver agreement. Among residents with a non-acceptable *dry mouth*, 84.7% were correctly identified by caregivers, which was the case for 79.2% of the residents who had *chewing problems*.

Agreement with the dentist on *pain/discomfort* was weak with  $\kappa = 0.41$  (86.6%) in the current study. However, this finding represents an improvement compared to previous versions of the oral health section. Hoben et al. (2019) reported  $\kappa = 0.13$  for the agreement between dental hygienists and trained research assistants using the MDS 2.0. Untrained care staff did not identify any residents with oral pain [47]. Under-detection of oral pain in MDS data was also confirmed by Folse (2001) [27].

For *teeth*, the current study found minimal agreement with  $\kappa = 0.29$  (69.9%) and 72.2% correct identification of non-acceptable conditions. Hoben et al. (2019) reported  $\kappa = 0.49$  for the agreement between dental hygienists and trained research assistants with 69.6% correct identification of tooth problems. For untrained regular care staff,  $\kappa = 0.02$  and 4.4% correct identification was found [47]. However, direct comparison with our results is impeded as Hoben et al. (2019) included an *outcome absent* category in their analysis. Folse (2001) also found serious under-detection of dental problems when MDS data were compared to dental examination forms [27].

The present study found very low dentist-caregiver agreement for *tongue* and for *palate/lips/cheeks*. Comparison with other studies is not possible, as previous versions of the oral health-related section did not assess these aspects.

The second-lowest kappa in this study was found for *gums* ( $\kappa = 0.15$ ; 55.8%). Dentists detected 137 residents with a non-acceptable condition, but only 29.4% were identified correctly by caregivers. Hoben et al. (2019) reported comparable results for the MDS 2.0 with trained research assistants who correctly identified 24.6% of residents with gum problems ( $\kappa = 0.14$ ). Untrained care staff in the same study did not identify any residents with gum problems [47].

In the current study, the lowest kappa was found for *oral hygiene* ( $\kappa = 0.13$ ; 54.0%). From the 130 residents with a non-acceptable condition, only 49.7% were correctly identified by the caregivers. However, dentist-caregiver agreement on oral hygiene was improved compared to previous versions. Hoben et al. (2019) reported  $\kappa = 0.05$  for trained research assistants

and  $\kappa = -0.02$  for nursing home staff [47]. Nordenram and Ljunggren (2002) found that from the 179 residents with non-acceptable oral hygiene detected by a dentist, only 12% was correctly identified by the MDS 2.0 [28].

A previous study on the shortcomings of the current ohr-interRAI section revealed that caregivers demanded an outcome that is derived from the oral health assessment to improve care [33]. To meet this request, two interventions were linked to the optimized ohr-interRAI section. If *denture* and/or *oral hygiene* was rated as non-acceptable, *assistance with hygiene* was recommended. *Referral to the dentist* was advised if one or more of the other items was considered non-acceptable. For both interventions, the current study found a low dentist-caregiver agreement with  $\kappa = 0.23$  (56.1%) for *assistance with hygiene* and  $\kappa = 0.39$  (87.7%) for *referral to dentist*. However, of the residents who were recommended to be referred to the dentist, 92.0% were correctly identified by caregivers. In contrast, Nordenram and Ljunggren (2002) reported that only 50% of residents with treatment need were correctly identified by caregivers [28].

### Inter-caregiver agreement

Kappa values in the current study ranged between  $\kappa = 0.27$  (73.2%) and  $\kappa = 0.63$  (81.6%), indicating minimal to slightly moderate agreement between caregivers. The highest kappas were found for the items based on subjective reports, with  $\kappa = 0.51$  (87.8%) for *pain/discomfort* and  $\kappa = 0.63$  for *dry mouth* (81.6%). Kappa values reported by Hoben et al. (2019) were lower with  $\kappa = 0.29$  for chewing and  $\kappa = 0.20$  for mouth pain [47].

For the items on *hygiene* and condition of the *teeth*, the current study found minimal to weak agreement ( $\kappa = 0.36$ – $0.45$ ; 69.8–74.4%). Hoben et al. (2019) reported a negative kappa for tooth problems and  $\kappa = 0.780$  for debris in the mouth [47]. However, a direct comparison of results is difficult as the authors included agreement on the absence of an outcome in their analysis.

The lowest kappas were found for *gums* and the soft tissue-related items, which is in line with Hoben et al. (2019) who found  $\kappa = 0.27$  for gum problems for trained research assistants [47].

With regard to the recommended interventions, inter-caregiver agreement was weak in the current study. Morris et al. (1997) reported moderate agreement for the MDS 2.0 with an average kappa of  $\kappa = 0.7$  for oral-dental items [48]. However, detailed information on data collection and prevalence of oral health problems were not reported, impeding interpretation and comparison of results.

### Intra-caregiver agreement

To the best of our knowledge, intra-caregiver reliability has not been assessed previously for the oral health-related

section of the MDS/interRAI. For most items, kappa values were  $\geq 0.6$  or only slightly lower, which represents adequate agreement [34]. The lowest kappa was found for gums ( $\kappa = 0.45$ ; 82.8%). This indicates substantial problems with this item which also achieved very low dentist-caregiver- and inter-caregiver agreement.

### Effect of the video training

Caregivers who watched the video training had a higher increase in oral health-related knowledge, but only isolated and small positive effects on psychometric properties were found. Agreement with the dentist on acceptable conditions of *gums* and *tongue* was even lower for caregivers who watched the video training. In contrast, Arvidson-Bufano et al. (1996) reported higher accuracy of nurses using the MDS after a 30-minute training with hands-on practice [23]. Hoben et al. (2019) confirmed that research assistants who had attended a half-day training session identified more oral health problems and achieved a higher agreement with a dental hygienist than untrained care staff [47].

An in-person training allows to ask questions, provide feedback, and practice hands-on. However, for feasibility reasons, we opted to develop a video training. Videos can be provided online and caregivers can individually choose place, time, speed, and frequency of watching. Studies that compared in-person- to video lectures in the medical field have shown that both can be equally effective in transferring knowledge to students [49]. However, it was found that students who attended a lecture in person performed somewhat better with regard to clinical practical skills [50].

The limited differences found in our study might result from the fact that all caregivers attended a 1-hour session on the optimized ohr-interRAI section and the study procedure. It can be expected that compared to a completely uninformed group, the video training may cause larger differences. Furthermore, caregivers watched the videos only once without the option to repeat sequences.

### Interpretation of the results and future prospects

Compared to previous versions, psychometric properties of the ohr-interRAI were improved, but substantial difficulties to detect oral care needs still remain. Comments from participating dentists and caregivers indicated that the items need further refinement. However, it can be supposed that the main problem is related to a lack of training and experience of the caregivers. The differences between caregivers and dentists were substantial, even when the latter did not use any diagnostic instruments. This indicates that further training can help to raise caregivers' abilities to detect oral care needs. The video training developed in this study might be more effective if caregivers are allowed to watch the videos on their own

pace. It also needs to be considered to provide hands-on training with feedback from oral health professionals which was shown to enhance the accuracy of oral health assessments [23]. To ensure a long-lasting effect, these training sessions need to be repeated regularly [51]. However, the interRAI assessment is very comprehensive and intricate training for each individual section is not feasible. An approach to solve this problem could be intense training of a few caregivers who complete the ohr-interRAI section for the clients of several care institutions. It was shown that coaching programs with practical support from oral health professionals for individual nursing home personnel are feasible [52]. A pilot study found that after 12 hours of training, nurses were able to formulate oral care plans that were highly congruent with those of an oral health professional [53]. In addition to specific ohr-interRAI training programs, the attention for oral health in the training of healthcare students needs to be increased as well. Current curricula of nursing students often cover the topic insufficiently, but it was repeatedly shown that particularly inter-professional education is suited to improve oral health-related knowledge, competence, and confidence among nursing students [54–57].

Further refinement of the optimized ohr-interRAI should include the general condition of the client. Particularly for persons in a palliative state, the main aim of the assessment shifts towards oral comfort and analgesia, while other aspects such as painless cavities become less relevant. InterRAI registers whether a person is in a terminal state of life. In the further refined version of the optimized ohr-interRAI, this information is included in the algorithm that determines the need of necessary care interventions.

### Conclusion

An optimized ohr-interRAI section was developed with test content pre-determined by a group of experts, resulting in recommended interventions derived from the assessment. Although psychometric properties were improved compared to previous versions, the optimized ohr-interRAI section and the video training need further refinement. Subsequently, the optimized ohr-interRAI section needs to be tested within the complete interRAI assessment in an everyday care context. The current research confirmed a high prevalence of oral health problems in care-dependent older adults, stressing that alongside the refinement of the optimized ohr-interRAI section, access to regular professional dental services should be pursued as much as possible.

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### Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

Ethical approval The study was approved by the *Ethics Committee Research UZ/KU Leuven* (study number s60612) and was conducted in accordance with ethical principles included in the *Declaration of Helsinki* (2008).

**Ethics** Informed consent was obtained from all individual study participants or from a legal representative.

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## Supplementary material: oral health-related section included in the MDS 2.0 LTCF and in the interRAI LTCF

	MDS 2.0	InterRAI
Countries where the instruments are used or tested (status 03/2019)		
	North America (Canada), Europe (Finland)	North America (Canada), Europe (Austria, Belgium, Czech Republic, Denmark, Estonia, France, Germany, Iceland, Italy, Lithuania, Netherlands, Norway, Poland, Spain, Sweden, Switzerland, United Kingdom), Asia and Pacific Rim (Australia, China, Hong Kong, Japan, New Zealand, Singapore, South Korea)
Items		
Chewing	Chewing problems	Reports difficulty with chewing
Swallowing	Swallowing problems	Detailed evaluation in section K3
Pain	Mouth pain	Reports mouth or facial pain/discomfort
Status oral hygiene	Debris (easily removable substances) in mouth at bedtime	
Performance daily oral hygiene	Daily oral health care by resident or staff	
Removable dental prosthesis use	Has dentures/removable bridge	Wears a denture/removable prosthesis
Tooth loss and absence removable dental prosthesis	Some/all natural teeth lost, no dentures/partial plates available/used	
Condition teeth	Broken, loose, or carious teeth	Has broken, fragmented, loose, or otherwise non-intact natural teeth
Condition gums	Inflamed, swollen or bleeding gums, oral abscesses, ulcers, or rashes	Presents with gum (soft tissue) inflammation or bleeding adjacent to natural teeth or tooth fragments
Dry mouth		Reports having dry mouth

## **Supplementary material: optimized photograph-supported ohr-interRAI section**

### General utilization guidelines

#### Relevance

- Good oral health contributes to general health and well-being.

#### Aim

- Detect clients who need assistance with daily oral hygiene and/or referral to a dentist

#### Communication

- Inform clients that you will ask questions about the mouth and that you will look into the mouth as well.
- Talk to clients themselves. Turn to family or caregivers only if clients are not able to communicate.

#### Inspection of the mouth

- Ask clients to take out dentures. Help, if necessary.
- Make sure that the head of clients is supported during the inspection.
- Wear examination gloves and use flashlights for illumination.
- Ask clients to open the mouth. For better view, pull cheeks and lips away with your finger or with the handle of a toothbrush.

If you are not certain, register presence of oral health problems.

## Items, guidelines and definitions

### **Chewing problems**

How well could you chew in the last 3 days?

- I could chew all kinds of food.
- I only had problems with hard or chewy food (e.g. nuts, raw apples, steak).
- I also had problems with soft food (e.g. cooked potatoes, banana, cake).
- Cannot be assessed/mixed food due to swallowing issues

Guidelines and definitions

- If clients don't have or don't wear dentures during meals, ask how chewing goes without dentures. If clients wear dentures during meals, assess chewing with the dentures.
- If food is blended/pureed due to chewing problems, register accordingly. If food is blended/pureed due to other reasons such as dysphagia, register that chewing cannot be assessed.
- If clients are not able to communicate, turn to primary caregivers and family or observe clients during meals and look out for nonverbal signs.

### **Discomfort or pain**

How often did you had discomfort or pain in the last 3 days?

- Not in last 3 days
- Not every day
- Every day
- Cannot be assessed

Guidelines and definitions

- Register discomfort or pain regardless of the underlying cause and whether appearing in rest, during meals or during oral care. Dentures might also cause discomfort or pain.
- If clients are not able to communicate, turn to primary caregivers and family or observe clients and look out for nonverbal signs.

## Dry mouth

How often did you had discomfort or pain in the last 3 days?

- Not in last 3 days
- Not every day
- Every day
- Cannot be assessed

Guidelines and definitions

- The mouth can feel dry in rest or during meals. Clients might also mention dry lips.
- If clients are not able to communicate, turn to primary caregivers and family or observe and look out for nonverbal signs.

## Denture hygiene

- $<1/3$  of the inner surface is covered by plaque or tartar



- $\geq 1/3$  of the inner surface is covered by plaque or tartar



- Cannot be assessed/does not have or does not wear denture

Guidelines and definitions

- Inner surface: surface that covers and rests on the gums.
- Plaque: sticky deposit that is white or pale yellow, can be removed with toothbrushing.
- Tartar: hard deposit that is yellow or brown, cannot be removed with toothbrushing.
- Take out dentures and rinse under water to remove food remnants.
- If clients wear dentures in upper and lower jaw, assess the denture with the poorest hygiene.

## 2.2 Development and validation of an optimized ohr-interRAI section

### Oral hygiene

- $<1/3$  of the surface of teeth or denture retainers is covered by plaque or tartar



- $\geq 1/3$  of the surface of teeth or denture retainers is covered by plaque or tartar



- Cannot be assessed/does not have teeth or denture retainers

### Guidelines and definitions

- Denture retainers: attachments that are fixed in the mouth to anchor the denture.
- Inspect all surfaces of teeth, spaces between teeth and denture retainers.
- Assess the area of the mouth with the poorest hygiene.

## Teeth

- All teeth sound, adequately filled, maybe with tooth wear



- One or more teeth broken, decayed or with defect fillings; root remnants



- Cannot be assessed/does not have teeth

## Guidelines and definitions

- Wear: teeth evenly flat and shortened.
- Tooth decay: cavities that are stained orange or brown; large cavities can cause breakage of teeth.
- Defect filling: filling fell out or is broken; space or tooth decay at interface between tooth and filling.
- Root remnant: crown of tooth is missing; upper part of the remaining root is visible.
- Inspect the different surfaces of all teeth.

## Gums

- Pink and firm, maybe minor aberration in color or texture



- One or more sites with redness, swelling, glassy, with sores or spontaneous bleeding



- Cannot be assessed

## Guidelines and definitions

- Gums: pink tissue surrounding teeth or denture retainers.
- If clients don't have teeth or denture retainers, inspect the areas of the jaws where usually the teeth are located.
- Look out for general and localized gum problems.

## Tongue

- Pink, moist, healthy



- One or more sites red, dry, swollen, with sores or patches



- Cannot be assessed

### Guidelines and definitions

- Ask the client to extend the tongue out of the mouth. Inspect the upper and the lateral surfaces of the tongue.
- Then ask the client to curl the tongue upward to inspect the lower surface and the area under the tongue.

**Palate and inner surfaces of cheeks and lips**

- Smooth, moist, pink



- One or more sites red, dry, swollen, with sores or patches



- Cannot be assessed

**Guidelines and definitions**

- Inspect the palate and the inner surfaces of cheeks and lips.

## Screenshots from the video training



*Video 1: Relevance of oral health and general utilization guidelines*



*Video 6: Condition of the teeth*



*Video 8: Condition of the tongue*

# Chapter 3: Practice guidelines for daily oral hygiene care

## Chapter 3: Practice guidelines for daily oral hygiene care

## **Development of practice guidelines for daily oral hygiene care**

**Published as:** Krausch-Hofmann S, Palmers E, Declerck D, Duyck J. Development of Practice Guidelines for Daily Oral Care in Care-Dependent Older Adults to Complement the InterRAI Suite of Instruments Using a Modified Delphi Approach. *International Journal of Older People Nursing*. 2020; 00:e12351. doi.org/10.1111/opn.12351.

### **Abstract**

**Aim:** To develop practice guidelines for nursing assistants who provide daily oral care to older adults.

**Background:** The interRAI suite of instruments is internationally used in professional health care to assess the needs of care-dependent older persons. An optimized oral health section was developed recently to identify care clients with poor oral health and hygiene. Internationally shared guidelines for daily oral care are needed to complement the optimized oral health section of the interRAI suite of instruments.

**Materials and methods:** The modified Delphi approach started with the preparation of an initial draft. Subsequently, an on-line survey and a face-to-face discussion were conducted with international experts. Their feedback was used to revise the draft. Two additional on-line surveys were conducted with the experts to reach consensus agreement for each item of the revised version. The same group of experts was invited to the different study phases.

**Results:** The three surveys were completed by 26, 27 and 23 international experts, respectively. A group of 18 experts completed each survey, whereof a sub-group of 11 experts also took part in the face-to-face discussion. Experts were dental hygienists, dentists, nursing scientists, physicians and psychologists from 14 different countries. After the final survey, consensus agreement was reached for 54 of the 57 (94.7%) items, representing the final version of the guidelines.

**Conclusion:** Available evidence was combined with practical feedback from international experts to develop clear and concise practice guidelines for daily oral care in older adults.

### Chapter 3: Practice guidelines for daily oral hygiene care

Implications for practice: The guidelines will help to improve knowledge and reduce barriers of nursing assistants to provide daily oral care.

## ORIGINAL ARTICLE

# Development of practice guidelines for daily oral care in care-dependent older adults to complement the InterRAI suite of instruments using a modified Delphi approach

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## Abstract

**Aim:** To develop practice guidelines for nursing assistants who provide daily oral care to older adults.

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**Material and methods:** The modified Delphi approach started with the preparation of an initial draft. Subsequently, an online survey and a face-to-face discussion were conducted with international experts. Their feedback was used to revise the draft. Two additional online surveys were conducted with the experts to reach consensus agreement for each item of the revised version. The same group of experts was invited to the different study phases.

**Results:** The three surveys were completed by 26, 27 and 23 international experts, respectively. A group of 18 experts completed each survey, whereof a subgroup of 11 experts also took part in the face-to-face discussion. Experts were dental hygienists, dentists, nursing scientists, physicians and psychologists from 14 different countries. After the final survey, consensus agreement was reached for 54 of the 57 (94.7%) items, representing the final version of the guidelines.

**Conclusion:** Available evidence was combined with practical feedback from international experts to develop clear and concise practice guidelines for daily oral care in older adults.

**Implications for practice:** The guidelines will help to improve knowledge and reduce barriers of nursing assistants to provide daily oral care.

## KEYWORDS

care of older people, nursing care, oral health, oral hygiene

## 1 | INTRODUCTION

Human lifespan is increasing in all regions of the world (Roser et al., 2019). Considering individual well-being and health system

sustainability, optimal health is preferred for these added years. One of the key factors of healthy ageing is good oral health. The latter is associated with general health and with quality of life (Bidinotto et al., 2016; Dietrich et al., 2017; Graziani et al., 2018; Iwasaki et al.,

2018; Rouxel et al., 2018; Teeuw et al., 2014; Teixeira et al., 2014; Tran et al., 2018). Over the last three decades, older adults in high-income countries keep their natural teeth longer and prevalence rates of edentulism are declining (Müller et al., 2017; Tyrovolas et al., 2016). Another trend is the increased use of oral implants to replace missing teeth (Elani et al., 2018). As a result, more care-dependent older adults have at least some natural teeth or complex dental restorations.

An effective daily oral care is indispensable to maintain good oral health. It mainly aims to prevent dental decay and gum disease by disintegration of the bacterial biofilm and application of active ingredients (Sbordone & Bortolaia, 2003). In care-dependent older adults, preventive measures are particularly relevant as curative treatment is often challenged by cognitive and physical impairment. In addition, evidence is available that daily oral care reduces the risk of aspiration pneumonia (Sjögren et al., 2016; Van Der Maarel-Wierink et al., 2013).

Older persons in professional care settings often lack the ability to perform adequate daily oral care independently. This task is usually delegated to nursing assistants who are also called nurse's aides or health care aides (Hoben et al., 2017).

Studies consistently show that oral hygiene in care-dependent older adults is deficient (De Visschere et al., 2016; Delwel et al., 2018; Yoon et al., 2018). This indicates the existence of barriers that prevent nursing assistants from providing proper daily oral care (Göstemeyer et al., 2019; Hoben et al., 2017). Adequate daily oral care requires skills to assess individual needs and to select and apply devices correctly. In addition, effective strategies are needed to cope with physical impairment and care-resistant behaviour. However, oral health-related knowledge and training are often insufficient in nursing assistants (Catteau et al., 2016; Mehl et al., 2016; Wårdh et al., 2012). This constitutes one of the main barriers to provide daily oral care (Göstemeyer et al., 2019; Hoben et al., 2017).

One component to facilitate daily oral care is the availability of clear and concise practice guidelines for nursing assistants. Scientific evidence is scarce with respect to oral care devices and approaches for older care-dependent adults. At the same time, numerous national guidelines are available that include heterogeneous or contradictory advice. While US guidelines indicate to rinse with water after brushing (National Institute of Dental & Craniofacial Research – U.S. National Institutes of Health, 2018), guidelines from the UK advise to only spit out toothpaste (Public Health England - Department of Health, 2017). A further example relates to overnight storage of removable dentures. Guidelines from the Netherlands advise dry storage (The Netherlands - Beroepsvereniging van Verpleeghuisartsen en Sociaal Geriaters, 2007), but Australian and US guidelines recommend storage under wet conditions (Centre for Oral Health Strategy – Australia New South Wales Ministry of Health, 2014; National Institute of Dental & Craniofacial Research – U.S. National Institutes of Health, 2018). These discrepancies preclude international application of the available guidelines.

### Summary statement of implications for practice

#### What does this research add to existing knowledge in gerontology?

- Clear and concise practice guidelines for daily oral care in care-dependent older adults were developed.
- The available evidence was complemented with practice-based feedback and consensus agreement from international experts.
- Contradicting national guidelines were harmonised.

#### What are the implications of this new knowledge for nursing care with older people?

- The guidelines will help to improve knowledge and reduce barriers of nursing assistants to provide daily oral care.
- By facilitating adequate daily oral care, oral health will improve. In turn, this will contribute to better general health and quality of life.

#### How could the findings be used to influence policy or practice or research or education?

- The guidelines complement the optimised oral health section that recently was developed for the interRAI suite of instruments.
- The guidelines are available for all settings where daily oral care is provided to care-dependent older adults.
- The guidelines are also applicable for education and training of nursing assistants or other direct care providers.

The interRAI suite of instruments is used in 35 countries to assess the needs and capacities of care-dependent individuals (InterRAI, 2020). For its oral health section, internationally acknowledged guidelines for daily oral care are needed.

The first version of the interRAI assessment instrument became known as 'Minimum Data Set'. It was developed during the 1980s in the United States to improve the identification of care needs in nursing home residents. The items register physical, cognitive, psychometric and sociographic strengths and needs of a person. In the following years, the interRAI research network was established and versions for other care settings were developed. For example, home care and palliative care versions became available. To harmonise these different versions, the interRAI suite of instruments was released in 2005. It consists of a core of common items that is complemented by sector-specific items. All versions share a consistent terminology and apply the same registration methods. Based on the assessment, multiple outcome measures are calculated to assist care

planning. While the scales allow an instant overview of the condition of a person, Clinical Assessment Protocols indicate specific risks and resources. Periodical use of the interRAI instruments allows to detect changes of the client and to adapt care planning. To further improve the interRAI system, its components are evaluated and updated on a regular basis (Vanneste & Declercq, 2014).

An oral health section is included in the interRAI versions for home care and for long-term care facilities. Both versions are mainly used in care for older adults. An optimised version of this oral health section was recently developed. One of its aims is the identification of clients with non-acceptable oral hygiene (Krausch-Hofmann et al., 2020). To complement this optimised oral health interRAI section, practice guidelines for daily oral care were developed in the present study. A modified Delphi approach was used to combine the available evidence with practice-based feedback and consensus from international experts.

## 2 | METHODS

### 2.1 | Preparation phase

Figure 1 provides an overview of the different study phases.

An initial draft of the guidelines was based on a review of existing guidelines on preventive oral care published by national health ministries or professional health associations from four different countries. The countries were located at three different continents where instruments of the interRAI suite are used (Centre for Oral Health Strategy – Australia New South Wales Ministry of Health, 2014; National Institute of Dental & Craniofacial Research – U.S. National Institutes of Health, 2018; Public Health England - Department of Health, 2017; The Netherlands - Beroepsvereniging van Verpleeghuisartsen en Sociaal Gerieters, 2007). Only the chapters on daily oral care were considered. Items were formulated for different domains such as *Care for Natural*

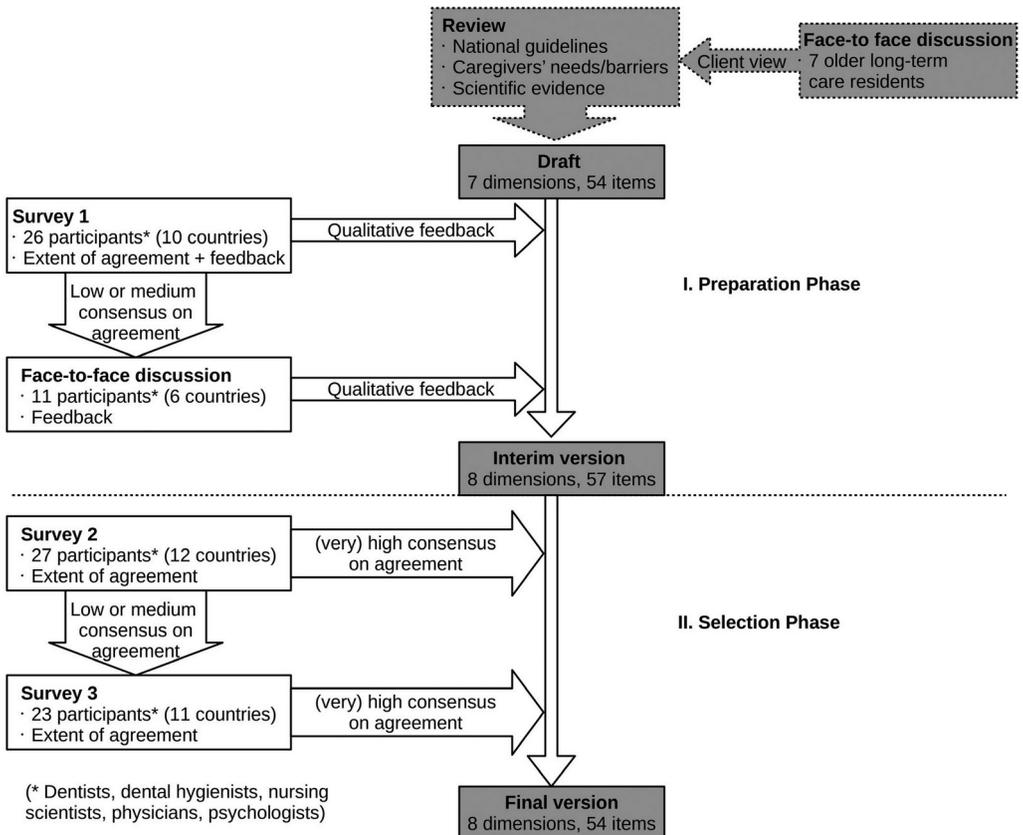


FIGURE 1 Overview of the study phases.

TABLE 1 Consensus agreement, based on Jünger et al. (2012)

Consensus on agreement	Percentage of agreement (strongly agree +agree), in %	Median	IQR
Very high	≥80	1	0
High	≥80	≤2	1
Moderate	60–79	≤2	1
Low	<60	>2	>1

*Teeth or Approaches for Clients with Care-Resistant Behaviour.* The items advised concrete devices, techniques or strategies. Reference lists of the reviewed national guidelines and additional literature were searched. The results of this search were used to formulate further items and to indicate the scientific evidence of each item in the draft. A face-to-face discussion was held with a group of seven older long-term care residents to incorporate the view of this group.

The initial draft of the guidelines was compiled by the research team of this study. The group consisted of three dentists with academic-clinical expertise in geriatric and special needs dentistry and one health care psychologist.

To recruit international experts, a call was circulated among members of the *European College of Gerodontology*. In addition, emails were sent to dental hygienists, dentists, nursing scientists, physicians and psychologists with an academic-clinical background related to oral health in care-dependent older adults. The experts had to be affiliated with an organisation located in a country where instruments of the interRAI suite were used.

The two following steps of the preparation phase aimed to revise the initial draft based on feedback from the international experts. An online survey (survey 1) and a face-to-face discussion were conducted.

In survey 1, quantitative and qualitative feedback was provided by the experts. Participants indicated the extent of agreement

with each item on a 5-point Likert scale (1 strongly agree, 2 agree, 3 nor agree/nor disagree, 4 disagree, 5 strongly disagree). They were instructed to assume that resources in terms of staffing, time and material were sufficiently available. Participants were invited to provide general and item-wise feedback and to suggest additional items.

The face-to-face discussion was conducted with a subgroup of experts during a conference meeting of the *European College of Gerodontology*. Items that reached only medium or low consensus on agreement in survey 1 were considered. The experts discussed how these items could be revised or whether they should be eliminated. Participants were further invited to suggest additional domains or items. The face-to-face discussion was moderated by one of the researchers (SKH). A co-moderator (EP) took notes of the discussion.

All qualitative feedback contributions provided by the experts in survey 1 and during the face-to-face discussion were appraised by the research team and used to revise the draft. This resulted in an interim version of the guidelines.

## 2.2 | Selection phase

The selection phase consisted of two online surveys (survey 2 and survey 3). It aimed to select those items from the interim version that reached high or very high consensus on agreement among the international experts. The same experts were invited as in the preparation phase. Both surveys collected quantitative feedback, using the 5-point Likert scale described above. Consensus on agreement was defined by three measures: percentage of the sum of the responses 'strongly agree' and 'agree', the median and the Inter Quartile Range (IQR) (Table 1) (Jünger et al., 2012).

TABLE 2 Characteristics of the international experts

Phase	Step	N	Professional background (number of participants)	Country (number of participants)
Preparation	Draft	3	Dentist (3), psychologist (1)	Belgium (4)
	Survey 1	26	Dental hygienist (4), dentist (19), nursing scientist (1), physician (1), psychologist (1)	Belgium (5), Canada (1), Chile (1), Hong Kong (1), Malta (4), Poland (1), Sweden (2), The Netherlands (5), UK (1), USA (5)
	Face-to-face discussion	11	Dental hygienist (3), dentist (7), nursing scientist (1)	Belgium (2), Chile (1), 2 Malta (2), Poland (1), The Netherlands (3), USA (2)
Selection	Survey 2	27	Dental hygienist (3), dentist (18), nursing scientist (1), physician (3), psychologist (1), other (1)	Belgium (5), Canada (1), Chile (1), Finland (1), Hong Kong (1), Malta (2), New Zealand (1), Poland (1), Sweden (2), Switzerland (1), The Netherlands (6), USA (5)
	Survey 3	23	Dental hygienist (1), dentist (18), nursing scientist (1), hysician (2), psychologist (1)	Belgium (5), Canada (1), Chile (1), Germany (1), Malta (2), New Zealand (1), Poland (1), Sweden (2), The Netherlands (5), UK (1), USA (3)

18 participants completed all surveys, and a subgroup (n = 11) also took part in the face-to face discussion.

In survey 2, participants assessed each item of the interim version. Items that did not achieve high or very high consensus on agreement in survey 2 were re-assessed in survey 3. In this last survey, experts were provided with a summary of the scientific evidence and the results of the previous steps for each item. This approach is a characteristic of Delphi studies and allows participants to reconsider their responses.

The final version of the guidelines was constituted by those items that achieved high or very high consensus on agreement in survey 3 at the latest.

Quantitative statistical analyses were performed with SPSS version 23.

### 2.3 | Ethics

Following the Belgian law (Wet inzake experimenten op de menselijke persoon, 2004), approval from a medical ethics committee was not necessary for this study. Data were collected anonymously, and participation was completely voluntarily. Participants provided consent that data would be used for education and research purposes.

## 3 | RESULTS

Table 2 shows the characteristics of the study participants. A group of 18 experts completed all surveys, whereof a subgroup of 11 experts also took part in the face-to-face discussion. Table 3 provides an overview of the results for each survey.

### 3.1 | Preparation phase

The initial draft of the guidelines consisted of 54 items on seven domains: care for natural teeth (13), care for full or partial removable dentures (9), care for the tongue (3), maintenance of oral care utensils (2), approaches for clients who need guidance or help (6), approaches for clients with care-resistant behaviour (16), and care for clients with a dry mouth (5).

Survey 1 was completed by 26 participants from 10 countries. The face-to-face discussion was conducted with a subgroup of 11 participants from 6 countries. Most participants were dentists, but other professions were represented as well. Twelve items achieved only moderate or low consensus on agreement in survey 1. These items were reviewed in the face-to-face discussion.

Qualitative feedback contributions included the concern that daily oral care required an individualised, client-centred approach. In addition, compliance with certain items was questioned due to lack of time and low awareness of the relevance of oral health among nursing assistants. Feedback further revealed that high-fluoride toothpaste is not available in every country due to heterogeneous pharmaceutical regulations. Markedly diverging opinions were found for the items on chlorhexidine and on chemical cleaning of

removable dentures. Feedback also frequently referred to wording and simplification of the items. Participants suggested to include more specific advice for clients with dysphagia. They also recommended additional items such as Sodium Lauryl Sulfate free toothpaste or adaptive aids for toothbrushes. *Preventive Oral Check-Ups* was suggested as an additional domain.

All feedback contributions of the international experts were itemised and critically appraised by the researchers who revised the draft version of the guidelines. The structure of the guidelines was not altered substantially and 13 items remained completely unchanged. An introduction was put in front, one domain and ten items were added, 29 items were adjusted, six items were merged, one item was split and two items were removed. The resulting interim version consisted of 57 items on 8 domains.

### 3.2 | Selection phase

Twenty-seven experts from 12 countries participated in survey 2. Very high or high consensus on agreement was gained for 51 items that were included in the final version of the guidelines. In survey 3, the remaining 6 items were re-assessed by 23 participants from 11 countries. The 3 items that gained very high or high consensus on agreement were also included in the final version. Supplementary file 1 shows the final version of the guidelines that consists of 54 items on 8 domains.

### 3.3 | Items not included in the final version of the guidelines

Only 3 items of the interim version did not achieve high or very high consensus on agreement. They were not included in the final version of the guidelines. Below, reasons for their inclusion in the draft and concerns of the experts are summarised.

#### 3.3.1 | Chlorhexidine application

The interim version of the guidelines advised '*Only if brushing is not possible, application of chlorhexidine solution with a damp gauze or as a spray can be considered. Chlorhexidine can cause adverse effects. Consult a dentist or a dental hygienist before use.*' Advice on chlorhexidine application was found in the Dutch guidelines for long-term care residents (The Netherlands – Beroepsvereniging van Verpleeghuisartsen en Sociaal Geriaters, 2007). Systematic literature review showed the effectiveness of chlorhexidine on *Streptococcus mutans* levels (Coelho et al., 2017). High-quality evidence of a reduction in dental plaque and gingivitis is also available (James et al., 2017). However, the experts in our study raised the concern that nursing assistants might misuse chlorhexidine to substitute daily oral care. Moreover, it was mentioned that brushing is possible as well when chlorhexidine can be applied to the mouth. Participants

TABLE 3 Consensus on agreement (CA) in the three survey rounds for each item of the guidelines

	Preparation phase		Selection phase	
	CA survey 1	Changes	CA survey 2	CA survey 3
Care for natural teeth				
Toothpaste				
With fluoride	High	Adjusted	Very high	-
Sodium Lauryl Sulfate-free	-	Additional	High	-
Amount in proportion with number of teeth	Low	Removed	-	-
Toothbrush				
Manual or powered	High	Adjusted	High	-
Size toothbrush head	High	Merged	High	-
Bristle stiffness	Low			
Adaptive aids	-	Additional	High	-
Procedures				
Timing and frequency of oral care	High	No change	High	-
Brushing technique	High	No change	Very high	-
Post-brushing rinsing	High	Adjusted	High	-
Interdental cleaning				
Frequency	High	Adjusted and merged	High	-
Devices	Low			
Additional fluoride				
High-fluoride toothpaste	High	Adjusted and merged	Very high	-
Fluoride mouth rinse	Low			
Chlorhexidine				
Indication and methods of application	Low	Adjusted	Moderate	Moderate
Care for full or partial removable dentures				
Mechanical cleaning				
Non-abrasive denture cleanser	High	No change	High	-
Denture brush	High	Adjusted	Very high	-
Chemical cleaning				
Soaking in denture-cleansing solution	Low	Adjusted	Low	Low
Procedures				
Rinsing with water after meals	High	No change	High	-
Breaking protection	High	No change	High	-
Overnight storage				
Remove from mouth	High	No change	High	-
Dry storage	Low	Adjusted	High	-
Denture-related oral care				
Denture retainers	Very high	No change	High	-
Connection bar	Very high	No change	High	-
Denture adhesive	-	Additional	High	-
Care for the tongue				
Device				
Loop-shaped tongue cleaner	Low	Adjusted	High	-

(Continues)

Table 3 (Continued)

	Preparation phase		Selection phase	
	CA survey 1	Changes	CA survey 2	CA survey 3
<b>Procedures</b>				
Indication and frequency	High	Adjusted	High	-
Cleaning technique	High	Adjusted	High	-
<b>Maintenance of oral care utensils</b>				
<b>Daily maintenance</b>				
Daily maintenance of brushes	High	Adjusted	High	-
<b>Replacement</b>				
Replacement of brushes	High	Adjusted	High	-
<b>Approaches for clients who need guidance or help</b>				
<b>Reminders and triggers</b>				
Pictures in the bathroom	-	Additional	High	-
Oral care in front of the sink	High	Item split	High	-
Oral care devices			High	-
<b>Hands-on assistance</b>				
Caregiver guides the toothbrush	High	Adjusted	High	-
Caregiver finalises oral care	-	Additional	High	-
<b>Caregiver provides oral care</b>				
Position of the caregiver	High	Removed	-	-
Position of the client	High	Adjusted	High	-
Devices to keep the mouth open	High	Adjusted	Moderate	High
Tell-show-do approach	Very high	No change	High	-
Removal of fluids	-	Additional	High	-
<b>Approaches for care-resistant behaviour</b>				
<b>Cognitively competent clients</b>				
Informed decision	High	No change	High	-
Respect for persistent refusal	Low	Adjusted	High	-
<b>Situation</b>				
Dental care routine	High	No change	Very high	-
Quiet environment	High	No change	Very high	-
<b>Approach</b>				
At eye level	High	Adjusted	Very high	-
Physical contact	Very high	No change	High	-
Smiling and humour	High	Adjusted	High	-
Distract client by talking	High	Merged	High	-
Distract client by providing objects	High			
Client initiates or completes oral care	High	Merged	High	-
Caregiver guides brushing movements	High			
Client observes oral care in the mirror	Low	Adjusted	Low	Low
Second caregiver takes over	Low	Adjusted	Low	High
<b>Communication</b>				
Simple conversation	High	Adjusted	High	-

(Continues)

Table 3 (Continued)

	Preparation phase		Selection phase	
	CA survey 1	Changes	CA survey 2	CA survey 3
Avoid 'elderspeak'	Very high	Adjusted	High	-
One-step commands and gestures	High	Adjusted	High	-
Care for clients with a dry mouth				
General treatment				
Appointment with General Practitioner	-	Additional	High	-
Additional fluoride				
High-fluoride toothpaste	High	Adjusted and merged	Very high	-
Fluoride mouth rinse	Low			
Salivary stimulation				
Lozenges	High	Adjusted	Low	High
Management of symptoms				
Moisture with water	High	Adjusted	High	-
Salivary substitutes	High	Adjusted	High	-
Lip balm	-	Additional	High	-
Regular preventive oral check-ups				
Preventive oral check-ups				
Last appointment	-	Additional	High	-
Recall frequency	-	Additional	High	-

further emphasised concerns related to accidental swallowing and adverse effects.

### 3.3.2 | Chemical cleaning of removable dentures

The interim version included the advice '*After mechanical cleaning, the denture can be soaked in water with a denture cleanser tablet. It has an additional effect on cleanliness. Use denture cleanser tablets only outside the mouth and follow manufacturers' guidelines strictly.*' The item was based on the recommendation of international experts who had considered the available evidence (Bartlett et al., 2018). A systematic review confirmed that the combination of mechanical cleaning with chemical agents resulted in optimal denture cleanliness (Papadiochou & Polyzois, 2018). The main concern of the participants in our study was that cleaning tablets might be misused to replace mechanical cleaning. It was further mentioned that clients with cognitive impairment might accidentally drink the cleaning solution. Participants also raised the concern that manufacturers' guidelines might not be followed, causing damage to denture materials.

### 3.3.3 | Client observes oral care in the mirror

The interim version advised '*Clients who resist care by not opening the mouth can be stimulated to open when oral care is provided in front of*

*a mirror. The caregiver is standing behind the person reaching around.*' This strategy was included in a non-pharmacologic, relationship-based intervention program that showed to be effective in a randomised clinical trial (Jablonski et al., 2018). Participants in our study mainly raised the concern that it might be non-ergonomic and uncomfortable for the person who provides oral care.

## 4 | DISCUSSION

Recently, an optimised oral health section was developed for the interRAI suite of instruments that is internationally used to assess needs and capacities of care-dependent individuals (InterRAI, 2020; Krausch-Hofmann et al., 2020). When clients with insufficient oral hygiene are detected, practice guidelines should be available for nursing assistants who often provide direct hygiene care tasks.

Literature shows that daily oral care is often neglected or only provided superficially in professional care settings (De Visschere et al., 2016; Delwel et al., 2018). Care-resistant behaviour of clients was identified as one of the main barriers (Göstemeyer et al., 2019; Hoben et al., 2017). Hence, a substantial part of the developed guidelines cover approaches for care-resistant client behaviour.

Evidence is scarce with regard to optimal daily oral care in older adults. Adoption of study results from younger participants requires caution. Compared to their younger counterparts, older adults often have a higher prevalence of exposed dental roots, larger interdental

spaces, and more accumulated tooth loss. In addition, salivation and other oral self-cleaning mechanisms are affected by reduced mastication activity in clients who ingest pureed food or who receive tube-feeding. Polypharmacy and senescence itself might further impact susceptibility to oral health disease in older adults (Tonetti et al., 2017).

The design of the current research ensured a stepwise and structured development of the guidelines. In the preparation phase, the available evidence was complemented with practice-based feedback from international experts. The selection phase made sure that only those items were included in the final version that were supported by broad consensus among the experts.

Online surveys are a practical and efficient method that allows participation regardless of geographical distances. At the same time, effects of peer pressure, social status, seniority, personality and interpersonal dynamics among participants are avoided (Jünger et al., 2012). To also benefit from the advantages of social interaction, a face-to-face discussion was conducted with a subgroup of the experts. It has been described that face-to-face contact encourages participants to clarify their perspectives and to think about topics more deeply (Krueger & Casey, 2000).

As the interRAI suite of instruments is used internationally, experts from different countries were invited to participate in the study. This approach allowed to take national regulations into account, for example, restricted availability of high-fluoride toothpaste in Belgium. In addition, contradicting guidelines were harmonised after weighting the different arguments. For example, guidelines from the United States advised overnight storage of removable dentures in water to prevent shrinkage (National Institute of Dental & Craniofacial Research – U.S. National Institutes of Health, 2018). In contrast, dry storage to inhibit bacterial growth is advised in the Netherlands (The Netherlands - Beroepsvereniging van Verpleeghuisartsen en Sociaal Geriaters, 2007). Randomised clinical trials are not available, but an older study reported slight evidence that supports the latter recommendation (Stafford et al., 1986). Hence, in the initial draft of the guidelines, dry storage of removable dentures was advised. In *survey 1*, this item only gained low consensus on agreement. Participants raised concerns related shrinkage of denture materials. The item was considered in the face-to-face discussion. Participants mentioned that the water for the dentures was not always renewed daily and that clients with dementia are at risk to drink it. They further argued that perforated denture boxes are available, which might imply that dentures should be stored under dry conditions. Participants suggested that even if the prosthesis is removed from the mouth for a longer period, it can be re-hydrated before use. They also mentioned that clients who store the denture under dry conditions do not complain when re-inserting it in the morning. Although the item was not substantially changed, high consensus on agreement was achieved in *survey 2*.

After *survey 3*, consensus on agreement was gained for almost all items (94.7%). However, the participants came from 14 different countries, which is only a part of all nations that are using the interRAI suite of instruments (InterRAI, 2020). Especially, countries from

Western Europe and from North America were overrepresented. In addition, different professions relevant to the topic were represented among the experts, but most participants were dentists.

Feedback provided by the experts during the preparation phase alluded the discrepancy between the ideal of an individualised, client-centred approach and general practice guidelines. However, measures in these guidelines are not mandatory. They rather provide a kit with items for optimal daily oral care. Based on the needs and capacities of the client, relevant parts can be selected when individual care is planned.

Availability of the guidelines will not automatically improve oral hygiene in clients. The guidelines aim to improve knowledge of nursing assistants, but a variety of other aspects also affect the provision of daily oral care, for example, training, time constraints, or clearness of responsibilities (Göstemeyer et al., 2019; Hoben et al., 2017).

## 5 | CONCLUSION

Practice guidelines for daily oral care in care-dependent older adults were developed. The available evidence was complemented with practice-based feedback and consensus from international experts. The guidelines are now available to complement the optimised oral health section that was recently developed for the interRAI suite of instruments.

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## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author (JD) upon reasonable request.

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## SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

Supplementary Material

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## **Supplementary material: final version of the guidelines**

### Introduction

The guidelines below provide practical advice regarding daily oral hygiene for care-dependent older individuals. If oral hygiene of the client is poor, first observe his/her own approach to determine what kind of help is needed. While for some clients verbal instructions are sufficient, others depend on hands-on assistance. The guidelines are based on scientific evidence to ensure optimal oral care. However, sometimes a modified approach is required due to the condition of the client. An adaptation or learning period might be needed before the guidelines can be fully applied.

Please note that the guidelines focus on daily oral hygiene care. They do not cover additional aspects that are as well relevant for oral health such as food counseling.

### Natural Teeth

Major dental problems are prevented by regular brushing with fluoride toothpaste and cleaning between teeth.

- Use a standard toothpaste that contains fluoride.
- Clients who frequently suffer from mouth sores may benefit from using a toothpaste free of the foaming agent Sodium Lauryl Sulfate (SLS).
- A manual or a powered toothbrush can be used. A powered toothbrush based on rotation-oscillation removes plaque more efficiently.
- Use a toothbrush with soft or medium bristles and a small head that permits easy oral access.
- Adaptive aids are available to facilitate dexterity, such as three-headed toothbrushes, foam grips or ergonomic toothbrush handles.
- Brush twice daily: before bed and on one other occasion.
- Make sure that each surface of the teeth, including the gum line, is brushed well.
- Spit out after brushing and do not rinse to maintain fluoride in the mouth.

## Chapter 3: Practice guidelines for daily oral hygiene care

- Clean between teeth with interdental brushes once a day. Interdental brushes are available in different sizes.
- Clients with obvious caries, dry mouth, or special needs, should receive extra fluoride. Consider a third brushing moment with regular toothpaste, use of high fluoride toothpaste or fluoride mouth rinse. Consult a dentist or oral hygienist for individualized advice and prescription.

### Full or Partial Removable Dentures

Denture cleaning removes plaque bacteria which is essential to oral and general health.

- Dentures should be removed from the mouth and rinsed with water after each meal.
- Hold dentures carefully while brushing. Place a clean washcloth in the sink to protect them from breakage if dropped.
- Clean the denture mechanically with a denture brush. Thoroughly remove plaque and remnants of denture adhesive.
- Use a non-abrasive denture cleanser such as liquid soap. Do not use toothpaste as it can damage the denture surface.
- After cleaning, the denture should be stored in a dry and clean box overnight.
- Clients should not keep their dentures in the mouth overnight.
- If clients use denture adhesives, use a gauze to remove remnants in the mouth.

### Denture Retainers in the Mouth

When the denture is removed from the mouth, fixed retainers can be seen in some clients. The retainers can be based on natural teeth or on implants, they can be detached or connected with a bar. Retainers require the same care as natural teeth.

- Brush the retainers twice daily with toothbrush and toothpaste.
- Use an interdental brush to clean under the connection bar once a day.

## Tongue

The tongue is the largest niche for bacteria in the mouth. Cleaning is essential to avoid bad breath.

- In clients with visible tongue coating, the tongue should be cleaned once a day.
- Use a loop-shaped tongue cleaner.
- To clean, the tongue is extended out of the mouth and stabilized with the free hand. The cleaner is placed as far as possible on the back of the tongue, slightly pressed, and slowly pulled forwards. The scraping movements are repeated several times until the coating is removed.

## Maintenance of Oral Care Utensils

- After use, rinse brushes and tongue cleaner with water and let dry in a clean cup or on a toothbrush rack.
- Replace the toothbrush when the bristles are worn out.

## Guidance or Help with Oral Care

If guidance or help with oral care is needed, choose an individualized approach depending on the needs and limitations of the client.

### Reminders

- Put pictures in the bathroom showing the different steps of brushing.
- Provide oral care in front of the sink.
- Hand the client the toothbrush to trigger procedural memory.

### Hands-on assistance

- Place your hand gently over the person's hand guiding the toothbrush.
- Let the client start brushing and finalize oral care afterwards.

### Caregiver provides oral care

- The client should be in an upright position or lie on his/her side to decrease the risk of aspiration.
- Clients who have problems to keep the mouth open, can be helped with a mouth rest or the handle of a second toothbrush placed between upper and lower teeth. It reduces the stress on the jaw joint and on the muscles.

## Chapter 3: Practice guidelines for daily oral hygiene care

- Use the tell-show-do approach. Tell what will happen, show it, and then do the oral care as you have explained.
- In clients with dysphagia, remove the fluid from the mouth after brushing with a gauze or with a suction device.

### Care-Resistant Behavior

Daily oral care requires consent. If clients are cognitively impaired, consent needs to be given by their guardian. A variety of threat-reducing techniques is available to manage care-resistant behavior in clients with dementia. Caregivers are expected to select strategies on a trial and error basis.

#### Cognitively competent clients

- Establish rapport, explore the reasons for the refusal and explain why oral care is necessary. It ensures that clients can make an informed decision.
- If the client refuses to cooperate even when well informed, this needs to be respected. Resume the discussion at a later point of time.

#### Clients with dementia

- Have a dental care routine. Same technique and utensils at the same time and place.
- Provide daily oral care in a quiet environment with a minimum of persons present.
- Approach the person at eye level and within her or his visual field.
- Establish rapport by engaging in an affirming and simple conversation.
- Use polite one-step commands, gestures and pantomiming.
- Avoid “elderspeak” (high pitch, sing-song cadence, patronizing tone, collective pronouns, and infantilizing terms).
- Smile and use humor when interacting with the client. Singing also contributes to create a safe and affirmative atmosphere.
- Distract the client by talking or have him/her hold the same item being used in mouth.
- Place your hand over the hand of the client guiding the movements or hand the client the toothbrush to initiate brushing.
- Use gentle touch judiciously to reassure the client and reduce anxiety.

## Development of practice guidelines for daily oral hygiene care

- When care-resistant behavior is escalating, the involved caregiver might be perceived as threatening. Another caregiver can try to take over as clients are more willing to cooperate after being “rescued” by the safe second caregiver.

### Dry Mouth

Saliva is necessary for a variety of oral functions such as taste, chewing or swallowing. As saliva is also crucial to prevent tooth decay, daily oral care requires particular attention in clients with a dry mouth.

- Make an appointment with a physician to diagnose causes of the dry mouth and to decide about general treatment.
- Provide extra fluoride for natural teeth. Consider a third brushing moment with regular toothpaste, use of high fluoride toothpaste or fluoride mouth rinse. Consult a dentist or an oral hygienist for individualized advice and prescription.
- Salivary substitutes applied as a gel, rinse or spray are helpful to reduce discomfort.
- Clients should sip water frequently to ensure hydration and to moisture the mouth. Water spray or thin iced water chips can be used for clients with dysphagia.
- Lozenges are tablets that dissolve slowly in the mouth. They can stimulate salivary flow, but should be free of acid and sugar and only be offered to clients who do not suffer from dysphagia.
- Apply a lubricating lip balm on dry and chapped lips.

### Regular Preventive Oral Check-Ups

Regular check-ups by a dentist or by an oral hygienist prevent (further) decline of oral health. Natural teeth, gums and functionality and fitting of the denture are examined.

- Ask clients or family members when the last preventive oral check-up was done. If this was longer than six month ago, suggest to arrange an appointment.
- The oral health professional decides about recall frequency.



# General discussion

## General discussion

Regular oral assessment is one of the cornerstones to maintain optimal oral health. For care-dependent older adults, access to dental services often is a challenge <sup>1</sup>. In professional care-settings, assessment by non-dental caregivers can help to detect oral conditions that require care <sup>2</sup>. The interRAI suite of instruments offers the opportunity to realize regular oral assessments in older persons on a large scale. The comprehensive instruments are already used in 35 countries to assess capacities and care-needs in vulnerable persons. An oral health-related section (ohr-interRAI) is included, but previous studies showed that it has only very limited value to detect oral care needs <sup>3-7</sup>.

Therefore, the main aim of this PhD was the development of an optimized ohr-interRAI section that effectively identifies older care clients who need help with their daily oral hygiene or who need to be referred to a dentist.

In the first part, underlying reasons for the failure of the current ohr-interRAI section were evaluated. In a second step, an optimized photograph-supported ohr-interRAI section and related training materials were developed and measurement properties were tested. Finally, practice guidelines for daily oral hygiene care were developed to help to improve care when poor oral hygiene was registered with the optimized ohr-interRAI section.

## **Interpretation and relevance of the study results**

### **Underlying reasons for the failure of the current ohr-interRAI section to correctly identify oral health conditions that require care**

The first study aimed to answer research question *1.1.1: Do experts consider the items of the current ohr-interRAI section complete, relevant, clearly worded and feasible to be completed by non-dental caregivers?* This research question related to content validity of the current ohr-interRAI section and was evaluated by a group of experts who had a professional background relevant for oral health in care-dependent older adults. The experts agreed on the relevance of the items on chewing, pain, gingival inflammation and damaged teeth. However, none of the items was regarded as clearly worded and only prosthesis use and pain were considered to be assessable by untrained caregivers. All experts agreed that the list of items was incomplete to assess oral care needs sufficiently. Based on these

## General discussion

findings, poor content validity of the ohr-interRAI section was concluded. This means that the instrument in its current form is not suited to detect clients who need help with their daily oral hygiene or who need to be referred to a dentist.

The second study investigated further reasons for the failure of the current ohr-interRAI section. It related to research question 1.1.2: *Are caregivers aware of the relevance of oral health? Do they seriously attempt to complete the ohr-interRAI section correctly, and what challenges do they perceive?* Focus group discussions were conducted with caregivers acquainted with the interRAI. Although participants were aware of the relevance of oral health on a general and on a personal level, it became clear that the topic had only low priority in the professional care setting. It was also shown that the approach of the caregivers to complete the ohr-interRAI section was inappropriate to accurately detect oral care needs. Remarkably, caregivers did not inspect the mouth to assess oral health. Completion of the ohr-interRAI section was further impeded by shortcomings of the instrument itself. For example, participants criticized that oral hygiene was not registered, that an *inapplicable* category was not available and that no outcome was derived from the oral health assessment to trigger care improvement. In addition, completion of the ohr-interRAI section was affected by a variety of aspects such as client characteristics and the professional background of the caregiver. Based on the findings of this study it was concluded that adequate detection of oral health-related care needs was impeded by shortcomings of the ohr-interRAI section itself and by a lack of awareness and training of caregivers.

The next study was conducted to answer research question 1.2: *Is the prevalence of missing ohr-interRAI data dependent on clients' general health status?* Available interRAI data from Belgium were used. Findings showed that the prevalence of missing oral health-related information was related to the general health status of a person. Cognitively impaired and depressive care clients had a higher risk of missing oral health-related information. The findings indicated that clear instructions are lacking on how to assess oral health in these persons. On a subject level, missing data also implied the potential under-detection of conditions that require care.

### **Development and validation of an optimized photograph-supported ohr-interRAI section and related training materials**

In an early phase of the development it was decided to integrate photographs in the optimized ohr-interRAI section to raise caregivers' awareness for oral health and to help them with the assessment. The first study was a preparatory step relating to research question 2.1: *Does the interpretation of oral health-related conditions shown on clinical photographs differ between dentists and non-dental caregivers?* A variety of oral health conditions presented on photographs was assessed by dentists and non-dental caregivers, respectively. Although mainly congruent, small differences were found between the two groups. Distance from a benchmark assessment was higher for non-dental caregivers than for dentists. Remarkably, caregivers tended to overestimate problems with oral hygiene and teeth, but they underestimated aberrations of the gums and of the soft tissues. The study concluded that comments and explanations should complement the photographs to facilitate accurate interpretation by non-dental caregivers.

The optimized ohr-interRAI section was developed in consecutive phases. The section registers subjective oral health problems but also includes items that require inspection of the mouth. For the latter, photographs were included to visualize *acceptable* and *non-acceptable* conditions. Corresponding to the interRAI Clinical Assessment Protocols (CAPs), trigger algorithms were developed to indicate whether certain care interventions (help with daily oral hygiene or referral to a dentist) were recommended. In addition, a video training was produced to emphasize the relevance of oral health and to provide instructions on how to assess oral health with the optimized ohr-interRAI section.

Psychometric properties of the optimized ohr-interRAI section and the effect of the video training were evaluated in a study with nursing home residents who were assessed by non-dental caregivers and by dentists. The study aimed to answer research questions 2.2.1: *What is the agreement between caregivers and dentists as well as the agreement among caregivers using the optimized ohr-interRAI section?* It also related to research question 2.2.2: *Does the video training affect measurement properties of the optimized photograph-supported ohr-interRAI?* For most items, prevalence data of oral health problems were comparable to other studies within similar populations.

The main part of the participants had at least one oral health problem – confirming that oral health is poor in care-dependent older adults<sup>8-14</sup>. Compared to previous versions, psychometric properties of the optimized ohr-interRAI section could be improved. However, agreement between caregivers and dentists as well as agreement among caregivers ranged between very low and moderate. Comparing the items that were based on clients' self-reports (chewing problems, pain/discomfort, dry mouth) with those items that require an oral inspection (oral/denture hygiene and condition of teeth, gums, tongue, palate, lips and cheeks), the latter achieved lower agreement values. Only small positive effects of the video training could be found.

Based on the findings of this study and taking into account the comments of the participating caregivers and dentists, the optimized ohr-interRAI section and the algorithms that activate the CAP's were further refined. The supplementary material of this PhD thesis includes the items and utilization guidelines of the refined optimized ohr-interRAI section. It further provides the two CAP's *Assistance with hygiene* and *Referral to dentist*. Activation of the CAP's depends the oral health registration with the refined optimized ohr-interRAI section.

### **Development of practice guidelines for daily oral hygiene care in care-dependent older adults**

This study related to research question 3.1: *Which guidelines for daily oral hygiene care result from the combination of available evidence with practice-based expert feedback?* The guidelines were developed to help direct care providers to improve care when poor oral hygiene is detected with the optimized ohr-interRAI section. Step-wise development started with a review of the available evidence and further included feedback from international experts in several rounds. The final version of the guidelines consists of 54 concise items on 8 domains such as *Care for natural teeth* or *Approaches for care-resistant behavior*. The guidelines will be part of the CAP *Assistance with hygiene* that is activated when *denture hygiene* and/or *oral hygiene* is not sufficient. Integration of the guidelines in the interRAI system ensures their dissemination among all care organizations working with the instruments.

## **Methodological considerations**

### **Underlying reasons for the failure of the current ohr-interRAI section to correctly identify oral health conditions that require care**

The findings of the first part of the PhD complemented each other and provided a detailed view on the limitations of the current ohr-interRAI section and how this is used. A structured method was applied to evaluate test content validity. The standard procedure was followed to quantify the relevance of the items based on expert ratings <sup>15,16</sup>. In addition, clarity of wording, feasibility and completeness of the items were determined. All experts had a background relevant for oral health in older persons, but professionals who actually complete the ohr-interRAI were under-represented in this study. For example, the expertise of nursing scientists would have been valuable to more validly assess feasibility of the items.

In the subsequent study, focus groups discussions were conducted with caregivers - such as nurses or case managers - acquainted with the completion of the ohr-interRAI section. Their experiences and problems with the assessment were discussed. Caregivers who complete the the ohr-interRAI section in everyday practice can be considered most important for this research part. However, the perspective of other parties such as care clients or management executives was neglected. It further needs to be mentioned that only a small proportion of the contacted care-organizations sent a participant to the focus group discussions. This reflects and confirms that oral health has only low priority in professional care settings for older adults <sup>17</sup>.

The study on missing oral health-related data could use a considerable dataset consisting of 7,590 interRAI assessments. Beyond analyzing the link between missing oral health data and general health, the well-established multiple imputation technique <sup>18</sup> was applied to estimate the impact of missing ohr-interRAI information. This additional part of the study generated relevant information for researchers who intend to study the relationship between oral health and general health using interRAI data.

### **Development and validation of an optimized photograph-supported ohr-interRAI section and related training materials**

The first study explored differences between dentists and non-dental professional caregivers assessing oral health-related conditions presented in photographs. A strength of this study was the large pool of high-definition close-up photographs - taken with equipment for professional digital dental photography. The pool represented a broad spectrum of a variety of oral health conditions. With regard to the participants, minimum sample size was exceeded and demographics of dentists and non-dental professional caregivers reflected actual differences between both groups in Belgium<sup>19,20</sup>. However, the sample was not representative for the respective groups and participant numbers were markedly unbalanced with about 5 times as many caregivers than dentists. It further needs to be mentioned that validity and reliability of the Visual Analogue Scale (VAS) should have been evaluated before commencing the study. Correct understanding of the terminology used to describe the different segments of the VAS can be questioned for certain groups of caregivers. Particularly care aides often receive only limited professional training in the field of oral health. Accordingly, involvement of non-dental professional caregivers in the development and pilot-testing of the VAS should have been considered.

With regard to the development of the optimized ohr-interRAI section, it is a methodological strength that the process consisted of several steps, including the a-priori determination of test content. It is also an asset that good oral health was defined as *acceptable*, allowing minor imperfections for certain items. This realistic approach takes into account that the ohr-interRAI section is mainly applied to persons who are in the last phase of their life. The integrated photographs were taken from older persons and depicted oral health pathology, but also healthy oral conditions to make sure that normal age-related oral changes are recognized correctly. It was ensured that the integrated photographs were clear for oral-health professionals. It is an additional strength that in-depth interviews with caregivers were conducted to refine the preliminary items and utilization guidelines. However, pre-testing of the optimized ohr-interRAI section was omitted. In retrospect, this was a missed opportunity that probably could have generated valuable information to improve the instrument in an early state.

Methodological properties of the optimized ohr-interRAI section and the effect of the video training were evaluated in a well-prepared study with a considerable number of 260 residents. For each resident, all oral health data were registered on the same day. Dentists were calibrated to ensure uniformity of their assessments. Each resident was assessed by 4 professional caregivers which attenuated the effects of individual caregiver characteristics. However, several limitations of the study need to be mentioned. Generalisability of the results is impeded as care homes were not randomly chosen and a convenience sample of residents and caregivers was used. In addition, the study procedure did not mimic reality, where the ohr-interRAI is only a small part amongst many other sections that need to be completed. Caregivers also were aware that their registrations would be compared to those of their colleagues and to the findings of the dentist. With regard to the items on subjective oral health, it is questionable whether the dentist registrations are a valuable benchmark to compare the caregiver registrations. It further needs to be considered that each caregiver only assessed between 24 to 30 clients. It can be expected that if caregivers had the opportunity to get used to the assessment situation and to gain more experience, their ability to recognize oral health conditions correctly may have improved. With regard to the video training the study design lacked of a formalized procedure to distribute the caregivers over the two groups. The limited effect of the video training might result from a methodological weakness in the design of the study. All participating caregivers attended a one hour session on the optimized ohr-interRAI section and on the study procedure. It can be expected that compared to a completely uninformed group, the video training may lead to larger differences. Caregivers also watched the videos only once without the option to repeat sequences. As the videos contained dense and complex information, it can be assumed that the effect on agreement would have been higher if caregivers had the opportunity to repeat sequences.

### **Development of practice guidelines for daily oral hygiene care in care-dependent older adults**

No specific formal framework was applied to develop the guidelines, but the procedure consisted of numerous elements that are suggested in manuals such as the Appraisal of Guidelines for Research and Evaluation II (AGREE

II). The study design ensured a structured multi-stage approach that combined the available evidence with profound expert experience. The participating experts represented different stakeholders relevant to the topic coming from nations where instruments of the interRAI suite are used <sup>21</sup>. The discussion with a group of older care residents made sure that the perspective of this group also was included. However, it needs to be mentioned that most experts were dentists and that not all countries using the interRAI instruments were represented among the participants. Experts from Western Europe and from North America were overrepresented. As a result, interests and concerns of the different stakeholders might have been covered only inadequately and not in a balanced way. It is a further limitation that certain aspects suggested in formal frameworks were left out such as the consideration of potential resource implications of guideline application.

### **Future perspectives**

The development of the optimized ohr-interRAI section and the associated guidelines was an important step, but it is of little significance if not implemented and tested in daily practice on an international level. The follow-up project outlined below was granted funding and first steps are already in preparation.

### **Evaluation of the effects of the use the optimized ohr-interRAI section**

The refined optimized ohr-interRAI section and the video training will be used in care homes in Belgium and in the Netherlands to evaluate its effects. The first study will be conducted in long-term care institutions working with the tablet application of the interRAI (Pyxicare). The tablet version is easy to use and allows to integrate photographs and instructions that are only one-click away <sup>22</sup>. For 2000 residents a complete interRAI assessment - including the optimized ohr-interRAI - will be undertaken every 6 month over a period of 2 years. Ohr-interRAI data will be compared to prevalence data collected in other studies and the evolution of oral hygiene and health over time will be assessed. In addition, the dataset will provide the possibility to evaluate whether oral health can be used to predict general health outcomes within the interRAI. In May/June 2020 the refined optimized ohr-interRAI section

was implemented in the Pyxicare and a call for participation in a pilot study was sent to all users of the software in Belgium and in the Netherlands.

The second study will be a two-year longitudinal three-arm randomized controlled trial with a minimal sample size of about 280 participants. While in group A the interRAI will be used with the current oral health items, group B will apply the refined optimized version and group C will additionally use the videos to train the participating caregivers. Quantitative as well as qualitative outcomes will be collected to evaluate the effects: Ohr-interRAI data will be compared with professional oral examinations. In addition, actions related to assistance with daily oral hygiene care and referral to professional dental care will be registered. As knowledge and attitudes of professional caregivers affect quality of care <sup>23</sup>, validated questionnaires and focus groups will be applied at several points in time for more in-depth understanding of caregivers' attitudes towards the oral health assessment. Directors of the care organizations also will be surveyed.

In the third study, interRAI data will be linked with the Federal database of the Intermutuality Agency that consists of registrations of all delivered health care services and medications in Belgium. This step will allow to compare previous use of dental care services with the consumption since the start of the intervention on an individual level.

Based on the above studies, further refinement of the optimized ohr-interRAI items, the utilization guidelines, the trigger algorithms and the video training will be considered.

### **International incorporation and validation**

Currently, components of the interRAI instruments are used in 35 countries and it is the next logical step to internationally implement and validate the optimized ohr-interRAI section. Because of national and cultural specifics, the instrument must first be reviewed within the context of those different countries. Among the countries where the interRAI is used, an international network will be set up with partners expertized in geriatric oral health. Interest to participate was already expressed by research groups from Sweden, Switzerland, New-Zealand, Finland, and Canada. In collaboration with the members of the interRAI consortium, the optimized ohr-interRAI

## General discussion

and the associated materials will be translated into the different languages of the countries willing to participate.

In the first study, an international expert panel will be organized to discuss the optimized ohr-interRAI section and the associated video training to enhance clarity and feasibility. If necessary, country specific modifications will be made.

In a second study, the optimized ohr-interRAI will be used within the interRAI in the involved countries over a period of at least one year. The numbers of care-dependent older people that will be included will depend on the use of the instrument within the respective countries. The generated international database will be used to test the optimized ohr-interRAI items as predictors for general health outcomes and to compare oral health across countries.

A third international study will evaluate the process of the oral health assessment. This research will provide insight in how caregivers connect with residents and how they assess and register oral health within the interRAI. To allow for a comprehensive view, focus group discussions will be combined with surveys among caregivers.

### **Further optimization and anchoring of the optimized ohr-interRAI within the interRAI suite of instruments**

Based on the results of the above studies, adjustments will be made in order to further fine-tune the instrument and the video-training. These results will be presented to the interRAI Instruments and Scales Committee. After approval the instrument will be mounted on the interRAI intra-web and spread among organizations and countries that use the interRAI assessments.

## **Impact and relevance**

By including an effective oral health-related section within the interRAI, oral health is regarded a part of the general health assessment, underlining its relevance. Ideally, its use – combined with the associated video training - will increase awareness, knowledge and attitudes of caregivers towards oral health. Valid interRAI data further allow in-depth analyses on the interaction between oral health and general health. An increased understanding of the

latter and discussion within the health care community might also contribute to oral health awareness. The optimized ohr-interRAI section detects clients with insufficient oral hygiene and offers clear practice guidelines for professional caregivers on how to provide daily oral care. By improving oral hygiene, a decline in oral pathology can be expected. The latter will decrease curative care needs and in turn, provide an economic benefit for the health care system. As the optimized ohr-interRAI mandates caregivers to inspect the oral cavity and recommends referral to a dentist if necessary, curative care needs will be met more effectively. The above mentioned effects all refer to the overall goal to contribute to better oral health in care-dependent older people which in current everyday care is often a blind spot<sup>24</sup>. This gain will also help to improve general health and well-being, further adding to the aforementioned economic benefit.

With regard to research opportunities, large interRAI databases with valid longitudinal oral health information hold a significant scientific potential to gain better insight into the interactions between oral and general health<sup>25,26</sup>. They further allow the possibility to incorporate oral health in general health predictors, e.g., for malnutrition, which in turn can be valuable to align care strategies and oral health policies advice.

The final aim of the PhD and the follow-up research project is to anchor the optimized oral health section within the interRAI suite of instruments and consequently contribute to better oral health in care-dependent older persons internationally. But indeed, the oral health assessment within the interRAI can only be a small piece of the puzzle. To improve oral health in older care-dependent adults on a large scale, a variety of efforts is required at different levels of the educational- and of the health care system. At the moment, professional training of nurses and care aides is often not sufficient with regard to oral health<sup>27,28</sup>. Future students should be sensitized for the relevance of the topic, and trained on how to recognize oral disease, how to manage non-cooperative behavior, et cetera. In older adults the consumption of dental services decreases, while at the same time, their other health care contacts are increasing<sup>29</sup>. This emphasizes the need to also sensitize and educate family physicians and geriatricians. Communication with patients should routinely cover oral health practices, followed by a short inspection of the mouth using a tool for non-dental professional caregivers such as the

optimized ohr-interRAI section. If necessary, patients can receive oral health counseling or be referred to an oral health professional <sup>30</sup>. Finally, establishing a geriatric dentistry training in the regular curriculum of undergraduate dental students is essential to demount reservations and to prepare them to treat this often challenging patient population <sup>31,32</sup>. At the level of the health care system, it is vital to facilitate the co-operation and collaboration between this different health care providers <sup>33</sup>. In addition, life-long attendance of regular preventive dental services should be promoted and refunded. Health politics should further consider to establish oral health as a quality indicator for long-term care institutions. At the same time, care organizations need to be supported to improve oral care. For example in Belgium, the project *Mondzorglijn* bundles the forces of academia, professional dental associations and governmental institutions to help long-term care facilities establishing a sustainable preventive oral health policy <sup>34</sup>. Further initiatives such as the foundation *De Mond Niet Vergeten* in the Netherlands <sup>35</sup>, an increase of geriatric dentistry-related research in recent years <sup>32</sup> as well as the fact that the presented PhD and the follow-up project received public funding, indicate a growing attention for oral health in care-dependent older adults.

## Conclusion

The first part of this PhD research revealed that the current ohr-interRAI section is not suited to detect oral care needs. In addition, caregivers who complete this section are lacking awareness and training to correctly assess oral health. In the second part of the PhD an optimized photograph-supported ohr-interRAI section and a related video training were developed. Psychometric properties of this optimized ohr-interRAI section were improved compared to previous versions. Nevertheless, it also became clear that further refinement was necessary. In the third part of the PhD, practice guidelines for daily oral care were developed to complement the optimized ohr-interRAI section. In a follow-up research project a further refined version of the ohr-interRAI section will be implemented in everyday care and its effects will be evaluated. Anchoring the optimized ohr-interRAI section within the interRAI suite of instruments will contribute to better oral

health in care-dependent older persons. This carries the potential to improve general health and well-being of this vulnerable population.

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## General discussion

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# Supplementary material

Supplementary material

## **A Refined optimized ohr-interRAI section**

The refined version will be used in the follow-up project of this PhD [in Dutch].

### **Bedoeling**

Vaststellen van nood aan

- hulp met de mond- of prothesehygiëne
- verwijzing naar tandarts

### **Algemene Richtlijnen**

#### **Communicatie**

- Vertel aan de cliënt dat je vragen zal stellen over de mond en dat je in de mond zal kijken.
- Leg uit dat een gezonde mond belangrijk is voor de algemene gezondheid en de levenskwaliteit.
- Bevraag de cliënt zelf. Schakel mantelzorgers en verpleging enkel in, indien de cliënt niet in staat is om zelf te antwoorden.

#### **Inspectie van de mond**

- Draag wegwerphandschoenen.
- Vraag om eventueel aanwezige gebitsprotheses uit te nemen. Help hiermee indien nodig.
- Zorg dat het hoofd van de cliënt gesteund is.
- Zorg voor voldoende verlichting, bijvoorbeeld een zaklamp.
- Zorg voor een goed zicht, door wangen en lippen opzij te houden met je vinger of met de steel van een tandenborstel.
- Kijk nauwkeurig naar de verschillende vlakken van alle tanden, tandvlees, tong, gehemelte, wangen en lippen.
- Als je twijfelt, selecteer dan de meer 'ongezonde' categorie

## Items en bijkomende uitleg

### a. Kauwfunctie

#### Items en antwoordmogelijkheden

Hoe hebt u kunnen kauwen in de voorbije dagen?

1. Geen kauwproblemen. Alle soorten van voedsel kunnen gekauwd worden.
2. Kauwproblemen. Bepaalde soorten van voedsel kunnen niet gegeten worden omwille van kauwproblemen.
3. Niet te beoordelen.
4. Niet van toepassing (bv. maagsonde of aangepaste voeding omwille van slikproblemen).

#### Bijkomende uitleg

- Beoordeel de kauwfunctie zoals de cliënt dagelijks eet. Als de cliënt geen prothese heeft of ze niet draagt bij het eten, vraag dan hoe het kauwen gaat zonder de prothese. Draagt de cliënt wél een prothese bij het eten, vraag dan naar de kauwfunctie mét de prothese.
- Indien de voeding wordt gemalen omdat de cliënt niet goed kan kauwen, registreer dan 'kauwproblemen'.
- Enkel als de cliënt niet kan antwoorden: doe navraag bij mantelzorger/verpleging of observeer de cliënt gedurende de maaltijd.
- Mogelijke aanwijzingen voor kauwproblemen: de cliënt fronst, vernauwt/sluit ogen, trekt bovenlip omhoog, perst lippen samen, is rusteloos, beperkt de kauwbewegingen, eet heel traag, eet plots minder, eet enkel zacht voedsel, hard en taai voedsel blijven liggen op het bord.

## **b. Ongemak en pijn**

### **Items en antwoordmogelijkheden**

Had u pijn of ongemak in de mond in de voorbije dagen?

1. Nee.
2. Ja.
3. Niet te beoordelen.

### **Bijkomende uitleg**

- Registreer ongemak/pijn ongeacht de situatie wanneer dit zich voordoet (in rust, gedurende de maaltijd of mondhygiëne) en ongeacht de onderliggende oorzaak. Ook een uitneembare gebitsprothese kan leiden tot ongemak/pijn.
- Enkel als de cliënt niet kan antwoorden: doe navraag bij mantelzorger/verpleging of observeer de cliënt.
- Mogelijke aanwijzingen voor ongemak/pijn in de mond: cliënt fronst, vernauwt/sluit ogen, trekt bovenlip omhoog, heeft geopende mond, perst lippen samen, verzet zich tegen de zorg, vermijdt aanraking van het aangedane gebied, wrijft of masseert over het aangedane gebied, is rusteloos, heeft beledigend taalgebruik, gebruikt pijnwoorden zoals ‘auw’, schreeuwt, roept, kreunt, beperkt de kaakbewegingen, weigert de prothese, kwijlt.

### **c. Droge mond**

#### **Items en antwoordmogelijkheden**

Had u een gevoel van een droge mond in de voorbije dagen?

1. Nee.
2. Ja.
3. Niet te beoordelen.

#### **Bijkomende uitleg**

- Het gevoel van een droge mond kan zich uiten in rust of gedurende de maaltijd.
- Enkel als de cliënt niet kan antwoorden: doe navraag bij mantelzorger/verpleging of observeer de cliënt.
- Mogelijke aanwijzingen voor een droge mond: cliënt heeft problemen met eten en slikken van droog voedsel, moeite met praten, droge lippen.

#### d. Hygiëne van de uitneembare gebitsprothese

##### Items en antwoordmogelijkheden

Beoordeel het steunvlak van de uitneembare gebitsprothese.

1. Minder dan  $\frac{1}{3}$  van het steunvlak is bedekt door plaque of tandsteen.



2.  $\frac{1}{3}$  of meer van het steunvlak is bedekt door plaque of tandsteen.



3. Niet te beoordelen.

4. Niet van toepassing (heeft of draagt geen uitneembare gebitsprothese).

##### Bijkomende uitleg

- Spoel de prothese even af onder de kraan om achtergebleven voedselresten te verwijderen.
- Indien de cliënt twee prothesen draagt (boven en onder): noteer de score van de minst goed gepoetste prothese.
- Steunvlak: vlak waarmee de prothese op het tandvlees steunt.
- Plaque: witte of gelige, zachte, kleverige massa, afschraapbaar met de tandenborstel.
- Tandsteen: gele of bruine verharde laag, niet afschraapbaar met de tandenborstel.

## e. Mondhygiëne

### Items en antwoordmogelijkheden

Beoordeel de minst goed gepoetste regio in de mond.

1. Minder dan  $\frac{1}{3}$  van het oppervlak van de tanden of de protheseverankeringen is bedekt door plaque of tandsteen. Er is eventueel verkleuring.



2.  $\frac{1}{3}$  of meer van het oppervlak van de tanden of de protheseverankeringen is bedekt door plaque of tandsteen.



3. Niet te beoordelen.

4. Niet van toepassing (geen tanden of protheseverankeringen in de mond).

### Bijkomende uitleg

- Bekijk de verschillende vlakken van alle tanden en protheseverankeringen. Let ook op de ruimtes tussen de tanden.
- Beoordeel de regio van de mond met de minst goede hygiëne.
- Protheseverankeringen: baar of knopjes die vast zitten in de mond. Deze bieden houvast aan de uitneembare prothese.
- Plaque: witte of gelige, zachte, kleverige massa, afschraapbaar met de tandenborstel.
- Tandsteen: gele of bruine verharde laag, niet afschraapbaar met de tandenborstel.
- Verkleuring: heeft in tegenstelling tot plaque en tandsteen geen volume en vormt geen probleem voor de mondgezondheid.

## f. Toestand van de tanden

### Items en antwoordmogelijkheden

1. Alle tanden zijn intact, eventueel met vullingen, slijtage of verkleuring.



2. Tand(en) zijn afgebrokkeld of vertonen tandbederf, defecte vullingen of wortelresten.



3. Niet te beoordelen.

4. Niet van toepassing (geen tanden of tandresten).

### Bijkomende uitleg

- Kijk naar de verschillende vlakken van alle tanden.
- Slijtage: bijt- en kauwvlakken van de tanden zijn verkort, vaak schijnt de onderliggende gele laag van de tanden er wat door.
- Verkleuring: volledig platte laag, maar het tandoppervlak is intact.
- Tandbederf: geel, oranje tot donkerbruin verkleurde gaatjes, grote gaten kunnen leiden tot breuk van de tand.
- Defecte vulling: vulling uitgevallen of gebroken, spleten of tandbederf tussen tand en vulling.
- Wortelresten: het kroongedeelte van de tand is niet meer aanwezig. Enkel de wortel staat nog in het kaakbot.

### **g. Toestand van het tandvlees**

#### **Items en antwoordmogelijkheden**

1. Tandvlees is roze en stevig, eventueel lichte afwijking in kleur of textuur.



2. Op 1 of meerdere plaatsen roodheid, zwelling, glasachtig voorkomen, letsels, spontane bloeding.



3. Niet te beoordelen.

#### **Bijkomende uitleg**

- Let op algemene en gelokaliseerde afwijkingen.
- Tandvlees: weke weefsels rond tanden of protheseverankeringen.
- Indien er geen tanden of protheseverankeringen aanwezig zijn: bekijk de delen van de kaken waar normaal de tanden staan.

## h. Toestand van de tong

### Items en antwoordmogelijkheden

1. Tong is roze, vochtig en gezond.



2. Op 1 of meerdere plaatsen rood, droog, zwelling, letsels, vlekken.



3. Niet te beoordelen.

### Bijkomende uitleg

- Vraag aan de cliënt om de tong uit te steken. Bekijk de boven- en zijkant.
- Vraag dan om de tong tegen het gehemelte te krullen. Bekijk nu de onderkant van de tong en het slijmvlies onder de tong.
- Een gezonde tong is vaak wat ruw aan de bovenkant. Ook kleine groefjes en een wit dun beslag is normaal. De zij- en onderkant zijn gladder en er lopen paarse aders.

**i. Toestand van gehemelte en binnenzijde van wangen en lippen**

**Items en antwoordmogelijkheden**

1. Gehemelte en binnenzijde van wangen en lippen zijn glad, vochtig en roze.



2. Op 1 of meerdere plaatsen rood, droog, zwelling, letsels, vlekken.



3. Niet te beoordelen.

**Bijkomende uitleg**

- Kijk naar de verschillende delen van het gehemelte en de binnenzijde van wangen en lippen.

## **B CAP assistance with hygiene**

Refined version that will be used in the follow-up project of this PhD [in Dutch]

### **Activatie van de CAP**

#### **Items**

K5

d. Hygiëne van de uitneembare gebitsprothese

e. Mondhygiëne

#### **Activatie**

Indien 1 of meerdere van de volgende problemen aanwezig zijn, dan is de outcome 1. Anders is de outcome 0.

- Hygiëne van de uitneembare gebitsprothese: d=2
- Mondhygiëne: e=2

#### **Uitleg per outcome**

0

- Niet geactiveerd
- Behoud dagelijkse mondhygiëne
- De zorgactiviteiten omtrent de dagelijkse hygiëne van mond en uitneembare gebitsprothese(s) worden behouden en hoeven niet aangepast te worden.

1

- Geactiveerd
- Aanpassing dagelijkse mondhygiëne
- De dagelijkse hygiëne van de mond en/of uitneembare gebitsprothese(s) is niet acceptabel. Een aanpassing van de zorgactiviteiten is noodzakelijk.

#### **Probleem**

Een effectieve dagelijkse mondhygiëne is onmisbaar om de mond gezond te houden. Het risico om tandbederf en tandvleesontsteking te ontwikkelen daalt als tanden en protheses regelmatig gepoetst worden. Voor oudere zorgafhankelijke personen zijn preventieve maatregelen bijzonder belangrijk omdat hun fysieke en cognitieve beperkingen de behandeling bij de tandarts vaak bemoeilijken. Daarnaast reduceert een goede mondhygiëne het risico op een longontsteking en draagt het bij om een slechte ademgeur bij de cliënt te voorkomen.

## Algemene zorgdoelen

Mond en uitneembare gebitsprothesen dagelijks reinigen om plaque en voedselresten te verwijderen.

## Richtlijnen

### Introductie

Deze richtlijn biedt praktisch advies met betrekking tot de dagelijkse mondhygiëne voor zorgafhankelijke oudere personen. Is de hygiëne van mond of gebitsprothese onvoldoende, observeer eerst de eigen aanpak van de cliënt om na te gaan, welke hulp noodzakelijk is. Voor sommige cliënten zullen verbale instructies volstaan, terwijl anderen actieve hulp nodig hebben. De richtlijn is gebaseerd op wetenschappelijke studies voor een optimale mondverzorging. Afhankelijk van de conditie van de cliënt zal echter in sommige gevallen een gemodificeerde aanpak nodig zijn. Eventueel is ook een periode van aanpassing of leren vereist voordat alle adviezen volledig toegepast kunnen worden. Let op, de focus van de richtlijn is de dagelijkse hygiëne van mond en uitneembare gebitsprothesen. Bijkomende factoren voor een gezonde mond, zoals bijvoorbeeld voedingsadvies, worden in deze richtlijn niet besproken.

### Natuurlijke tanden

Tandbederf kan worden voorkomen door regelmatig te poetsen met een fluoride-houdende tandpasta en door tussen de tanden te reinigen

- Gebruik een standaard tandpasta met fluoride.
- Het gebruik van een tandpasta zonder de schuimende substantie Natrium Lauryl Sulfaat (NLS) kan helpen bij cliënten met een droge mond of bij cliënten welke regelmatig afters hebben.
- Gebruik een manuele of elektrische tandenborstel. Een elektrische tandenborstel die gebruik maakt van een draaiend-oscillerende beweging verwijdert plaque efficiënter.
- Gebruik een tandenborstel met zachte of medium haren. Een kleine borstelkop kan gemakkelijk overal in de mond aan.
- Aangepaste hulpmiddelen zijn beschikbaar om het gebruiksgemak te verhogen. Voorbeelden hiervan zijn driekoppige tandenborstels, schuimgrepen, of ergonomische grepen voor de tandenborstel.
- Poets twee keer per dag: voor het slapen gaan en op één ander moment.
- Zorg dat elk oppervlak van de tand tot aan de tandvleesrand goed gepoetst wordt
- Spuw het teveel aan tandpasta uit na het poetsen, maar spoel de mond niet om het fluoridegehalte in de mond te behouden.

- Poets één keer per dag tussen de tanden met interdentale ragers. Deze zijn beschikbaar in verschillende maten.
- Cliënten met duidelijke tandbederf, droge mond of waarbij de mondhygiëne moeilijk verloopt, hebben extra fluoride nodig. Dit kan door een derde poetsmoment, het gebruik van tandpasta met hoge fluorideconcentratie of mondspoelmiddel met extra fluoride. Raadpleeg een tandarts of mondhygiënist voor persoonlijk advies en voorschrift.

### **Volledige en partiële uitneembare gebitsprothesen**

Door reinigen van de uitneembare gebitsprothesen worden bacteriën verwijderd. Dit is essentieel voor de gezondheid van de mond en de algemene gezondheid.

- Verwijder de gebitsprothese na iedere maaltijd en spoel af met water.
- Hou de gebitsprothese voorzichtig vast tijdens het poetsen. Leg een zuivere handdoek in de wasbak om de prothese te beschermen bij vallen.
- Poets de gebitsprothese mechanisch met een protheseborstel. Verwijder grondig plaque en resten van kleefpasta.
- Gebruik een niet-abrasief (niet schurend) reinigingsmiddel zoals vloeibare, niet geparfumeerde zeep. Gebruik geen tandpasta, aangezien deze de gebitsprothese kan beschadigen.
- Laat de gebitsprothese 's nachts niet in de mond.
- Na het poetsen wordt de gebitsprothese 's nachts bewaard in een schoon en droog doosje.
- Indien cliënten kleefpasta gebruiken, verwijder de mogelijke resten ervan in de mond met een gaasje.

### **Protheseverankeringen in de mond**

Sommige cliënten hebben niet-uitneembare protheseverankeringen in de mond. Deze zijn bevestigd op natuurlijke tanden of op implantaten. Protheseverankeringen hebben dezelfde zorg nodig als natuurlijke tanden.

- De protheseverankeringen worden twee keer per dag geпоetst met een tandenborstel en met tandpasta.
- Poets één keer per dag onder de baar met een rager.

### **Tong**

De tong is de grootste niche voor bacteriën in de mond. Reiniging van de tong is essentieel om een slechte adem te voorkomen.

- Bij cliënten met zichtbaar tongbeslag, wordt de tong één keer per dag gereinigd.

## Supplementary material

- Gebruik een lusvormige tongschraper.
- Om de tong te reinigen, laat de cliënt de tong uitsteken en stabiliseer je deze met de vrije hand. Gebruik hiervoor eventueel een gaasje. De tongschraper wordt zo ver mogelijk achter op de tong geplaatst en zachtjes duwend vooruit getrokken. Herhaal deze beweging verschillende keren tot het tongbeslag verwijderd is.

### **Onderhoud van het materiaal**

- Spoel na gebruik de borstels en de tongschraper af met water en laat ze – de borstelkop rechtop - drogen in een schone beker of in een tandenborstelrekje.
- Vervang de borstels wanneer de haartjes uit elkaar gaan staan.

### **Ondersteuning of hulp bij de dagelijkse mondzorg**

Ondersteuning of hulp bij de dagelijkse mondzorg vraagt een geïndividualiseerde aanpak, gebaseerd op de noden en beperkingen van de cliënt.

Zorgverlener motiveert en helpt herinneren

- Hang afbeeldingen in de badkamer met de verschillende stappen voor de dagelijkse mondhygiëne.
- Laat de tanden aan de wastafel poetsen.
- Geef de tandenborstel aan de cliënt om het procedureel geheugen aan te spreken.

Zorgverlener helpt mee poetsen

- Leg je hand rustig over de hand van de cliënt en stuur de tandenborstel.
- Laat de cliënt starten met het poetsen van de tanden en finaliseer de mondhygiëne nadien.

Zorgverlener neemt mondzorg over

- De cliënt zit rechtop of bevindt zich in zijligging om het risico op aspiratie te verminderen.
- Plaats het handvat van een tweede tandenborstel tussen de bovenste en onderste tanden om de cliënt te helpen de mond open te houden.
- Gebruik de tell-show-do benadering. Vertel wat er zal gebeuren, doe het voor en voer dan de mondhygiëne uit zoals je hebt uitgelegd.
- Bij cliënten met dysfagie, verwijder de vloeistoffen in de mond na het poetsen met een gaasje of via aspiratie.

## **Omgaan met weerstand**

Dagelijkse mondzorg vereist toestemming van de cliënt of diens vertegenwoordiger. Een aantal technieken zijn beschikbaar om met weerstand tegen de zorg om te gaan.

### Wilsbekwame cliënten

- Creëer een vertrouwensband met de cliënt en achterhaal de oorzaak van de weigering. Geef uitleg over het belang van de mondhygiëne, zodat de cliënt een geïnformeerde beslissing kan nemen.
- Blijft de cliënt de mondzorg weigeren, dan dient dit gerespecteerd te worden. Herneem de discussie op een later moment.

### Wilsonbekwame cliënten

- Zorg voor een duidelijke mondzorgroutine. Gebruik dezelfde materialen en technieken op hetzelfde moment en dezelfde plaats.
- De dagelijkse mondhygiëne gebeurt liefst in een rustige omgeving met zo weinig mogelijk personen aanwezig.
- Benader de cliënt op ooghoogte en binnen haar of zijn gezichtsveld.
- Bouw een goede relatie op door een positieve en eenvoudige conversatie aan te gaan.
- Gebruik vriendelijke één-staps instructies en gebaren.
- Vermijd kinderlijk taalgebruik (hoge stem, zingend ritme, neerbuigende toon, wij/ons-termen, en verkleinwoorden).
- Lach en gebruik humor wanneer je omgaat met de cliënt. Zingen draagt ook bij tot een veilige en positieve sfeer.
- Leid de cliënt af door te praten of geef de cliënt hetzelfde materiaal als wat je op dit moment ook in de mond gebruikt.
- Plaats je hand over de hand van de cliënt om de poetsbewegingen te begeleiden of geef de cliënt een tandenborstel om het poetsen te initiëren.
- Raak de cliënt zachtjes aan om deze gerust te stellen en angst te verminderen.
- Als de weerstand escaleert, laat dan een andere zorgverlener de taak overnemen. Cliënten werken gemakkelijker mee na ‘gered’ te worden door een veilige tweede zorgverlener.

## **Droge mond**

Speeksel speelt een rol bij het spreken, proeven, kauwen en slikken en draagt bij om tandbederf te voorkomen. De dagelijkse mondhygiëne bij cliënten met een droge mond heeft extra aandacht nodig.

## Supplementary material

- Maak een afspraak met een arts om de oorzaak van de droge mond te diagnosticeren en te behandelen.
- Voorzie extra fluoride voor natuurlijke tanden. Dit kan door een derde poetsmoment, het gebruik van tandpasta met een hoge fluorideconcentratie of mondspoelmiddel met fluoride. Raadpleeg een tandarts of mondhygiënist voor persoonlijk advies en voorschrift.
- Speekselvervangers toegediend als gel, spoeling of spray kunnen helpen om het ongemak te verminderen.
- Cliënten drinken best regelmatig water voor de hydratatie en het bevochtigen van de mond. Waterspray of dunne ijsschilfers kunnen gebruikt worden bij cliënten met dysfagie.
- Suikervrije zuigtabletten kunnen gebruikt worden om de speekselvloed te stimuleren. Deze mogen enkel aangeboden worden aan cliënten zonder dysfagie.
- Smeer een bevochtigende lippenbalsem op droge gebarsten lippen.

### **Regelmatige preventieve controles bij de tandarts**

Regelmatige preventieve controles door een tandarts of mondhygiënist zijn essentieel om mondgezondheidsproblemen te voorkomen. Natuurlijke tanden, tandvlees, maar ook pasvorm en functie van de uitneembare gebitsprotheses worden nagekeken.

- Vraag aan de cliënt of familieleden wanneer het laatste preventieve tandartsbezoek was. Stel voor om een nieuwe afspraak te maken als dit langer dan 6 maanden is geleden.
- De tandarts of mondhygiënist geeft advies over de frequentie van de controleafspraken.

## C CAP referral to dentist

Refined version that will be used in the follow-up project of this PhD [in Dutch]

### Activatie van de CAP

#### Items

J7c. Terminaal stadium van ziekte, 6 maanden of minder te leven  
K5

- a. Kauwfunctie
- b. Ongemak en pijn
- c. Droge mond
- e. Mondhygiëne
- f. Toestand van de tanden
- g. Toestand van het tandvlees
- h. Toestand van de tong
- i. Toestand van gehemelte en binnenzijde van wangen en lippen

#### Activatie

Indien 1 of meerdere van de volgende problemen aanwezig zijn, dan is de outcome 1. Anders is de outcome 0.

- Kauwproblemen: (a.=2)
- Pij/ongemak: (b.=2)
- Droge mond bij niet terminaal zieke cliënt met slechte mondhygiëne: (c.=2 en J7c.=Nee en e.=2)
- Tandprobleem bij niet terminaal zieke cliënt: (f.=2 en J7c.=Nee)
- Tandvleesprobleem bij niet terminaal zieke cliënt: (g.=2 en J7c.=Nee)
- Probleem thv de tong bij niet terminaal zieke cliënt: (h.=2 en J7c.=Nee)
- Probleem thv de gehemelte/wangen/lippen bij niet terminaal zieke cliënt: (i.=2 en J7c.=Nee)

#### Uitleg per outcome

0

- Niet geactiveerd
- Afspraak met tandarts niet noodzakelijk
- Er is geen noodzaak aan een directe afspraak met de tandarts. Regelmatige preventieve controles bij de tandarts blijven echter wel noodzakelijk.

1

- Geactiveerd
- Afspraak met tandarts noodzakelijk.
- Er dient een afspraak met de tandarts te worden gemaakt om de problemen in de mond verder te diagnosticeren en zo nodig te behandelen.

## Probleem

Problemen in de mond zorgen zijn gerelateerd aan de algemene gezondheid en het welzijn van een persoon. Voor zorgafhankelijke personen zijn langdurige behandelingen vaak niet haalbaar. Vandaar is het belangrijk om ongemakken en ontstekingen in een vroeg stadium te herkennen en door te verwijzen naar een tandarts. De tandarts kan de geregistreerde problemen verder diagnosticeren en zo nodig behandelen. Op deze manier wordt achteruitgang van de mondgezondheid voorkomen.

## Algemene zorgdoelen

Cliënten met ongemakken of aandoeningen in de mond tijdig doorverwijzen naar een tandarts.

## Richtlijnen

- Leg uit dat er een probleem werd opgemerkt in de mond en raad aan om een afspraak bij de tandarts te maken.
- Indien de cliënt geen vaste tandarts heeft, help eventueel om de dichtstbijzijnde tandarts te vinden en ga na of de praktijk toegankelijk is voor de cliënt. Eventueel dient ook het vervoer voor de cliënt georganiseerd te worden.
- Is de cliënt niet in staat om zelf een afspraak te regelen, vraag hulp bij de familie of maak een afspraak voor de cliënt als je hier toestemming voor hebt.
- Voor cliënten met uitgesproken cognitieve en motorieke beperkingen kan een huisbezoek door de tandarts ingepland worden.

## D Summary

Human lifespan is increasing in all regions of the world. Ideally, these added life years are spent in good health. A healthy mouth, free of infection and with an adequate number of teeth, contributes to well-being and healthy aging. However, oral health is often poor in frail older persons who are not able to perform adequate daily oral care. Access to professional dental services is also challenging for this population which causes that oral health problems are often not detected in time. In professional care settings, oral health assessment by non-dental professional caregivers can help to detect care needs.

The interRAI suite of instruments is used internationally to assess care needs and health risks of vulnerable persons. An oral health-related section (ohr-interRAI) is included in the versions used in long-term care and in the home care setting. Ideally, this section detects persons who need assistance with daily oral care or who need to be referred to a dentist. However, the current ohr-interRAI section and related precursor versions fail to achieve this goal.

1. The first part of the PhD explored the underlying reasons for the failure of the current ohr-interRAI section to adequately detect oral care needs.

Content validity was evaluated by a group of experts who had a professional background relevant for oral health in care-dependent older individuals. The experts agreed that the ohr-interRAI section was incomplete to assess oral care needs sufficiently. It further became clear that items were lacking in relevance, clarity of wording and feasibility to be completed by non-dental caregivers.

Focus group discussions with caregivers revealed that adequate detection of oral health-related care needs was impeded by shortcomings of the ohr-interRAI section itself and by a lack of awareness and training of caregivers.

Analysis of available interRAI data from Belgium showed that the prevalence of missing oral health-related information was related to the general health status of the care client. This result confirmed that clear instructions and training are lacking on how to assess oral health.

2. In the second part of the PhD, a new optimized photograph-supported ohr-interRAI section and an associated video training were developed and tested.

A preparatory study revealed small differences between dentists and professional non-dental caregivers assessing oral health-related conditions shown on photographs. It was concluded that comments and explanations should complement the photographs to facilitate accurate interpretation by non-dental caregivers.

The optimized ohr-interRAI section was developed in consecutive phases. The nine items included self-reported oral health complaints of the client, but inspection of the mouth was also mandatory. Visualizing photographs were selected based on the assessment by a group of experts and dentists. The video training emphasized the relevance of oral health and provided instructions on how to assess oral health with the optimized ohr-interRAI section. A study with 260 nursing home residents showed that psychometric properties of the optimized ohr-interRAI section were improved compared to previous versions. However, caregiver-dentist agreement and agreement among caregivers only ranged between very low and moderate. Small positive effects of the video training were found. Based on these findings, the optimized ohr-interRAI was further modified and refined.

3. In the third part of the PhD, clear and concise practice guidelines for daily oral care were developed for the optimized ohr-interRAI. A modified Delphi study was conducted to complement the available evidence with feedback from international experts. The guidelines are now available to help to improve care when poor oral hygiene is detected with the optimized ohr-interRAI section.

In a follow-up research project, the refined version of the optimized ohr-interRAI section will be implemented and its effects will be evaluated internationally.

## E Samenvatting

De menselijke levensverwachting neemt toe in alle delen van de wereld. Idealiter worden deze extra levensjaren in goede gezondheid doorgebracht. Een gezonde mond, vrij van infecties en met voldoende tanden, draagt bij aan welzijn en gezond ouder worden. Kwetsbare ouderen hebben echter vaak een slechte mondgezondheid omdat ze hun dagelijkse mondverzorging niet meer adequaat kunnen uitvoeren. Daarnaast is het voor deze populatie moeilijk om naar de tandarts te geraken waardoor mondgezondheidsproblemen niet op tijd gedetecteerd worden. In professionele zorgomgevingen kunnen niet-tandheelkundige zorgverleners bijdragen om zorgbehoeften in de mond op te sporen.

Het interRAI instrumentarium wordt internationaal gebruikt om zorgnoden en gezondheidsrisico's van kwetsbare personen te beoordelen. Een sectie met betrekking tot mondgezondheid (oral health-related interRAI = ohr-interRAI) is opgenomen in de versies die worden gebruikt in de residentiële zorg en in de thuiszorg. Het doel van de ohr-interRAI sectie is de identificatie van personen welke hulp nodig hebben bij de dagelijkse mondhygiëne of welke doorverwezen moeten worden naar een tandarts. De huidige ohr-interRAI sectie en zijn voorlopers bereiken dit doel echter niet.

1. In het eerste deel van de PhD werden de onderliggende redenen voor het falen van de huidige ohr-interRAI sectie geëxploreerd.

De inhoudsvaliditeit werd bepaald door een groep experts met een professionele achtergrond relevant voor de mondgezondheid van zorgafhankelijke ouderen. De experts bevonden de ohr-interRAI sectie onvolledig om zorgbehoeften in de mond adequaat in te schatten. De individuele items beschouwden ze als onvoldoende relevant en niet duidelijk om effectief ingevuld te worden door niet-tandheelkundige zorgverleners.

Focusgroeps gesprekken met zorgverleners bevestigden dat de detectie van mondgerelateerde zorgbehoeften werd belemmerd door tekortkomingen van de ohr-interRAI sectie zelf. Daarnaast waren de zorgverleners niet voldoende bewust van het belang en niet getraind om de mondgezondheid adequaat te beoordelen.

Analyse van beschikbare interRAI data uit België wees uit dat de prevalentie van ontbrekende mondgezondheidsgegevens gerelateerd was aan de algemene gezondheidstoestand van een persoon. Het resultaat van deze studie bevestigde het ontbreken van duidelijke instructies en training voor zorgverleners om de ohr-interRAI sectie in te vullen.

2. In het tweede deel van de PhD werd een nieuwe geoptimaliseerde foto-ondersteunde ohr-interRAI sectie en een bijbehorende videotraining ontwikkeld en getest.

Een voorbereidende studie vond verschillen tussen tandartsen en niet-tandheeskundige professionele zorgverleners bij het beoordelen van mondgezondheidsgerelateerde foto's. Er werd geconcludeerd dat foto's toegelicht moeten worden om correcte interpretatie door niet-tandheeskundige zorgverleners te waarborgen.

De geoptimaliseerde ohr-interRAI sectie werd in opeenvolgende fasen ontwikkeld. Een deel van de negen items verwees naar zelf-gerapporteerde mondgezondheidsklachten van de cliënt, maar inspectie van de mond was eveneens verplicht. Visualiserende foto's werden geselecteerd op basis van de beoordeling door een groep experts en tandartsen. De videotraining bestond uit negen videoclippen. Deze benadrukten de relevantie van mondgezondheid en gaven instructies voor het beoordelen van de mondgezondheid met de geoptimaliseerde ohr-interRAI sectie. Het nieuwe instrument en de videotraining werden getest in een studie met 260 bewoners van Vlaamse woonzorgcentra. In vergelijking met eerdere versies werden de psychometrische eigenschappen van de geoptimaliseerde ohr-interRAI sectie verbeterd. De overeenstemming tussen zorgverleners en tandartsen en de overeenstemming tussen de verschillende zorgverleners was echter zeer laag tot matig. Er werden kleine positieve effecten van de videotraining gevonden. Op basis van deze bevindingen werd de geoptimaliseerde ohr-interRAI sectie verder aangepast en verfijnd.

3. In het derde deel van deze PhD werden praktijkrichtlijnen ontwikkeld voor de dagelijkse mondzorg van zorgafhankelijke ouderen. Een Delphi-gebaseerde methode werd gebruikt om de beschikbare wetenschappelijke evidentie aan te vullen met feedback van internationale experts. De

richtlijnen geven praktisch zorgadvies indien inacceptabele mondhygiëne werd vastgesteld met de geoptimaliseerde ohr-interRAI sectie.

In een vervolgonderzoek zal de verfijnde versie van de geoptimaliseerde ohr-interRAI sectie op internationaal niveau geïmplementeerd en geëvalueerd worden.



## **F Acknowledgments and conflict of interest**

### **Scientific acknowledgment**

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### **Personal contribution**

Stefanie Krausch-Hofmann contributed to the design, data acquisition, data analysis, and data interpretation of the studies included in this doctoral thesis. The thesis is written by Stefanie Krausch-Hofmann and reviewed by promoter prof. Duyck and by the co-promoters prof. Declerck, prof. Declercq and prof. De Lepeleire. All manuscripts presented in the thesis were written by the PhD candidate and revised by all co-authors.

### **Conflict of interest**

Stefanie Krausch-Hofmann declares that all studies were conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## G List of publications

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**Krausch-Hofmann S**, Declerck D, Declercq A, De Lepeleire J, Duyck J. Associating Oral and General Health Using the InterRAI. International Association of Dental Research - General Session & Exhibition, Cape Town, South Africa, 25-28 June 2014.



## H About the author

Stefanie Krausch-Hofmann was born in Lauchhammer (Germany) in 1980. She attended secondary school in Großenhain (Germany) where she graduated in 1999. In 2005, she obtained a degree in Sociology at Technical University of Dresden (Germany).



After completing the State Examination Dutch as a Second Language in 2006 at University of Amsterdam (The Netherlands), she studied Dentistry at KU Leuven (Belgium). In 2011, she obtained a Master's degree in Dentistry and in 2013 she completed the training Postgraduate Studies in General Dentistry (with greatest distinction) at KU Leuven.

In 2013, she started her Doctoral Education and became a member of the Research Group Population Studies in Oral Health at the Department of Oral Health Sciences of KU Leuven.

She combined her doctoral research with her work as a general dental practitioner in dental surgeries in Kortenberg (Belgium) and in Maastricht (The Netherlands).



# Personal acknowledgments

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**"It's invaluable to have a friend who shares your interests and helps you stay motivated." (Maryam Mirzakhani)**

In the past years, I have sometimes imagined the day of my PhD defense. In my mind I was standing in a large hall looking into the many faces of jury members, supervisors, colleagues, friends and family. In my mind there was a convivial reception and a noble dinner afterwards. The COVID-19 pandemic is now thwarting my plans and I have to defend under somewhat less glamorous circumstances.

However, I am relieved and proud that now the book is in front of me and that I am actually defending today. I also feel deeply grateful to all of those who have helped me and who contributed to the success of this work with their ideas, feedback, motivation and distraction. It is impossible to list all the names, but there are some people I want to mention here in particular.

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