Academiejaar 2011-2012

On-site oral health care in LTC with a mobile dental unit: an assessment of the treatment backlog

Seyed Reza Miremadi

Promotor: Dr. Luc De Visschere
Co-promotor: Prof. Dr. Jacques Vanobbergen

Masterproef voorgedragen in de Tweede Master in het kader van de opleiding tot TANDARTS
Foreword

First and foremost, I would like to thank God for giving me the power to believe in myself and pursue my dreams. I am thankful to my parents for their unconditional love and support throughout my life and particularly during the recent years that we have been away from each other. Their encouragements have always made my most difficult times look easy.

I would also like to thank my supervisor Dr. Luc De Visschere and my co-supervisor Prof. Dr. Jacques Vanobbergen from the bottom of my heart for letting me work with them and benefit from their guidance. You always made time for me, no matter how busy you were. I deeply appreciate you for painstaking reading of many drafts and your constructive comments.

I am indebted to Drs. Barbara Janssens, Mrs. Bea Withouck and Mrs. Katrien Leloup. Your helps made a huge contribution to this project and your wonderful personalities made every moment of our co-operation a great pleasure for me.

Moreover, I would like to sincerely acknowledge other staff members of the department, especially Cindy and the staff members of the nursing homes we visited for their contribution. Last but not least, I would like to thank all my fellow friends and the academic and non-academic staff members of the university hospital of Ghent for their contribution; I will always cherish the memories I had with you.
Table of contents

Abstract  2
Abstract (Dutch)  3
Introduction  4
Methods and materials  6
Results  10
Discussion  16
Conclusion  22
References  23
Abstract

Introduction: The percentage of the elderly people in Flanders is increasing. Providing them with proper health care is becoming a major challenge. Oral health of this age group has been reported to be very low, especially among the institutionalized ones. An estimation of the treatment backlog and identifying the influencing factors are the first steps in tackling this issue. Moreover, the need for a simple practical oral health index specifically for this group is felt. The purpose of this study was to cross-sectionally evaluate the oral health of this population and the influencing factors on that.

Methods and Materials: A cross-sectional trial was carried out on 143 dentate institutionalized individuals, whereby several clinical parameters were registered and analyzed. A compound oral health index was developed and analyzed.

Results: Forty-three percent of the subjects had carious lesions with a tendency of more caries among individuals with dementia. The mean number of residual roots per subjects was 1.8 (± 3.1), again with a higher frequency among the subjects with dementia. A mean plaque score of 2.13 was found with higher scores in men. Calculus was observed in 81% of the subjects. A DPSI score of 3+ was found in 53% of the cases while 15.4 of the cases had a DPSI score 4. Twenty-eight percent of subjects wore a denture and more than half of them needed some sort of prosthetic treatment. The average score of “Oral Health Index” was 4.6 out of 9. The level of dependency of the residents was not found to be of significant influence.

Conclusion: There is an urgent need for dental treatment among the target group, irrespective of their dependency level. The new index used in this study can be helpful for the assessment of the oral treatment need. Further investigation is required to elucidate its clinical applicability.
Abstract (Dutch)

Introductie: Onderzoek uitgevoerd in Vlaanderen (regio Gent) door de afdeling Maatschappelijke Tandheelkunde van de Universiteit Gent heeft aangetoond dat de mondzorg van ouderen in Vlaamse woonzorgcentra ontoereikend is. Een inschatting van de mondgezondheid en beïnvloedende factoren is een eerste stap om dit probleem op te lossen. Deze studie probeert een analyse uit te voeren van de mondgezondheid en de behandelachterstand bij de bovenvermelde populatie alsook het identificeren van beïnvloedende factoren.

Materiaal en methode: Een cross-sectionele analyse van de mondgezondheid werd uitgevoerd bij 143 ouderen (met natuurlijke tanden) die in de woonzorgcentra verblijven in Oost- en West-Vlaanderen. Naast de mondgezondheid werden andere relevante parameters geregistreerd. Op basis van de verzamelde gegevens, werd een samengestelde mondgezondheidsindex (OHI) ontwikkeld.

Resultaten: Drieënveertig ouderen hadden elementen met tandbederf en er was een trend aanwezig waarbij er meer gecarrieerde tanden werden aangetroffen bij personen met dementie. Het gemiddelde aantal wortelresten was 1,8 (± 3,1) en dit aantal was groter bij personen met dementie. De steekproef had een gemiddelde plaque score van 2,13 met een hogere score bij mannen dan bij vrouwen. Bij 81% van de ouderen, werd tandsteen aangetroffen. Bij 81% van de ouderen, werd tandsteen aangetroffen. Een DPSI-score van 3+ werd gevonden in 53% van de onderzochte personen, terwijl 15,4% van de gevallen een score 4 had. Een uitneembare gebitsprothese werd in 28% van de gevallen geregistreerd, waarvan 51,2% had aan een prothetische behandeling. De gemiddelde score van de mondgezondheidsindex was 4.6 op een schaal van 0 tot 9. Er kon geen significante correlatie aangetoond worden tussen deze index en de zorgafhankelijkheid van de oudere.

Conclusie: De behandelachterstand op vlak van mondzorg bij kwetsbare ouderen in woonzorgcentra is groot. Deze nood aan curatieve mondzorg is onafhankelijk van hun graad van zorgafhankelijkheid. De klinische toepasbaarheid van een nieuw ontwikkelde samengestelde mondgezondheidsindex dient verder onderzocht te worden.
Introduction

Due to the tremendous improvements in standards of hygiene and the level of health care, the average life expectancy in Europe has increased by about 10 years in the last 50 years and is higher than in most other regions of the world [1]. Taking the relatively lower birth rate among modern European families into account, it is obvious these countries are facing a rapidly graying population. The same trend is present in Belgium and by 2020 more than 20% of the Belgian population will be 65 years or older and 5.7% will be over 80 years, with the expectation for 2050 to be 27% and 10.6% respectively[2]. Such a demographic shift implies fundamental adjustments to the health care system, since a higher percentage of older people equals higher morbidity and care dependency. Besides, due to the recent advancements, contemporary dentistry has a drastically altered approach than before, putting an extra focus on tooth longevity. Furthermore, dental implants have been successfully implemented in dentistry, showing longevities close to restorations on natural teeth[3]. Consequently, the rate of edentulousness among patients has been highly reduced; which in turn indicates a higher pressure on oral health care resources.

Forasmuch as aging can be accompanied with certain physical and/or mental limitations, maintaining a meticulous oral hygiene and providing them with an efficient oral health care are crucial for the elderly.

The utmost importance of oral health in this group can be pointed out from different aspects as oral and systemic health are closely and mutually related[4]. Periodontal disease, as one of the most common intra-oral infections, has been associated with an increased risk (1.47–2.63 times higher) for stroke[5]. There is also evidence showing a direct correlation between periodontal health and glycemic control in type 2 diabetic patients. Moreover, several studies have demonstrated the beneficial effect of periodontal treatment on metabolic control of type 2 diabetic patients[6, 7]. Oral health can affect respiratory diseases too. There is good evidence (I, grade A recommendation) that improved oral hygiene and frequent professional oral health care reduce the progression or occurrence of respiratory diseases among high-risk elderly adults living in nursing homes and especially those in intensive care units (ICUs)[8].

Medication prescribed for general conditions, can also affect oral health their side effects. For instance, more than 400 medications cause xerostomia as an unwanted side effect, which is a major hindering factor in establishing an effective oral hygiene and a risk factor for tooth caries. Other medications such as phenytoin, cyclosporine and calcium channel blockers are associated with gingival enlargement that interferes with oral hygiene and sometimes
demands surgical treatments [9, 10]. In addition, oral health-related quality of life in older
individuals is significantly related to oral health condition through several factors such as the
number of occluding pairs of natural teeth among the dentate and denture stability and
retention among the edentate[11, 12].

In spite of the aforementioned points, the significance of oral health among the frail elderly is
often overlooked. Numerous studies have pointed out the very poor oral hygiene and limited
access to dental care among both housebound and institutionalized elderly living in different
countries[13-22]. According to a cross-sectional study in 2006, there were 62,000 people
older than 75 years, residing in retirement houses and nursing homes in Flanders (Dutch
speaking part of Belgium), which equaled to 15% of people in the aforementioned age group
at the time of the study. Like similar studies, very low levels of oral health were observed
among the Flemish study population[23].

Despite the numerosity of such studies, most of them tend to be pure descriptive and there is
not much data evaluating a possible correlation between oral health and influencing factors
among the target group.

The present study was carried out as a cross-sectional analysis of the oral health of the above-
discussed population to identify the oral health condition and influencing factors of
institutionalized elderly.

**Scientific Hypothesis**

The scientific hypotheses of the current study were:

1- The study population exhibits very low levels of oral health.

2- The Care Level of the individual can significantly affect his oral health.

**Aim and Objectives**

The overall aim of the current study was to perform a cross-sectional assessment of the oral
health condition and hence the treatment backlog among the institutionalized older people in
the nursing homes of Flanders, Belgium. Another objective of the study was to evaluate
whether there is a significant correlation between oral health and other measured factors of
the individuals participating in the study, in particular the care level. In order to simplify the
assessment of the oral health components and the need for treatment, a new multi-aspect
index for oral health was used in this study. This trial also aimed at performing a preliminary
analysis of the practicability of this index.
Methods and Materials:

Population and sample:
All institutionalized older people who were visited by the Gerodent team of the university hospital of Ghent, Belgium during 10 visits to nursing homes were included in the study. The Gerodent is the name of a project run by university hospital of Ghent that provides the institutionalized elderly in East- and West-Flanders with on-site dental care by means of a mobile dental unit. The inclusion criteria was the presence of at least 2 natural teeth with clinically visible crowns. Data were collected from 143 individuals residing in 13 nursing homes in the Flanders region, Belgium. All individuals or the person legally responsible for them received oral and written information regarding the study and were asked to sign the informed consent form. No subject rejected to participate in the study. Ethical approval was obtained from the ethics committee of the University Hospital Gent.

Outcome variables and instrumentation:
The outcome variables of oral health included dental plaque, periodontal condition, number of carious teeth, number of residual roots and the condition of removable dentures. The mentioned variables were all measured through clinical examination by two pre-trained investigators, one performing periodontal and plaque measurements while the rest of the measurements were carried out by the other examiner. Explanatory variables of each subject were gathered through a questionnaire. The data were subsequently transferred to a digital databank (Baltes®). Dental plaque was assessed using the Silness-Loë plaque index (PI) (score range: 0-3)[24]. The DPSI index (Dutch periodontal screening index, score range: 0-4) [25] was used to score the periodontal condition of each sextant (table 1). The highest DPSI score among the sextants of each patient was considered as the patient DPSI score. Caries was detected by an experienced investigator through both tactile and visual evaluations. The number of residual roots was assessed by clinical evaluation by means of direct observation of the root, palpation or clinically related symptoms such as fistula. No radiographs were taken to serve this purpose. During the clinical examination, additional data for each patient were registered in the examination form: gender, age, care dependency level (Katz index, [26] (table 2)), number of medications taken, removable dentures (Presence or Absence) and the condition of the dentures.
Table 1. DPSI values and their corresponding state of periodontium

<table>
<thead>
<tr>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>healthy periodontium</td>
</tr>
<tr>
<td>1</td>
<td>bleeding on probing</td>
</tr>
<tr>
<td>2</td>
<td>calculus and/or overhanging restoration</td>
</tr>
<tr>
<td>3-</td>
<td>4-5mm pocket depth, no recession at the location of pockets</td>
</tr>
<tr>
<td>3+</td>
<td>4-5mm pocket depth, with recession at the location of pockets</td>
</tr>
<tr>
<td>4</td>
<td>≥6 mm pocket depth</td>
</tr>
</tbody>
</table>

Table 2. Categories of care dependency scale according to Katz index

The condition of dentures was classified according to the sort of intervention that was required for the dentures. Table 3 shows an overview of the categorical explanatory variables and their different levels.

Table 3. Overview of the categoric explanatory variables
Including a range of oral health variables, a compound index was created called the “Oral Health Index” (OHI) and calculated for each individual. This was a multi-aspect index to evaluate the condition of natural dentition, periodontium, oral hygiene and removable dentures and to exhibit the eventual need for an intervention. Each parameter was assigned to a score range and the oral health index of the individual was calculated as the sum of these scores, ranging from 0 (very good oral health condition) to 9 (very bad oral health condition). Due to the magnitude of the effects of periodontal status on general health, the periodontal vector was assigned a higher score range, hence a higher weight in calculating the index. An OHI score less than 3 was regarded as an acceptable state of oral health, while a score of 6 or higher pertained to a high need for dental care. Table 4 shows the scoring system of this variable.

<table>
<thead>
<tr>
<th>Natural Dentition</th>
<th>Periodontium</th>
<th>Oral Hygiene</th>
<th>Removable Denture</th>
</tr>
</thead>
<tbody>
<tr>
<td>no caries or residual roots: 0</td>
<td>DPSI 0-1: 0</td>
<td>PI 0: 0</td>
<td>no removable denture or removable denture with no changes required: 0</td>
</tr>
<tr>
<td></td>
<td>DPSI 2: 1</td>
<td>PI 2: 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>DPSI 3,3+: 2</td>
<td>PI 3: 2</td>
<td></td>
</tr>
<tr>
<td>1-3 teeth with caries and/or residual roots: 1</td>
<td>DPSI 4: 3</td>
<td></td>
<td>denture needs adaptation: 1</td>
</tr>
<tr>
<td>4≥ teeth with caries and/or residual roots: 2</td>
<td></td>
<td></td>
<td>denture renewal required: 2</td>
</tr>
</tbody>
</table>

* Dutch Periodontal Screening index
** Silness-Loe plaque index

Table 4. Different parameters of the “Oral Health Index” and their scoring system

**Calibration session**

The investigator who performed the periodontal and plaque measurements was calibrated prior to the start of the study. Four patients suffering from chronic periodontitis were enrolled for this purpose. Duplicate measurements (n=462) for PI, PPD and CAL were gathered with an interval of 30 minutes between the first and the second recording. Intra-examiner reliability was good to excellent for PI (85 % identical agreement; Wilcoxon signed ranks test: p>0.05;
Spearman’s correlation: $r=0.88; \ p<0.001$), PPD (91 \% identical agreement; paired t-test: $p>0.05$; Pearson’s correlation: $r=0.94; \ p<0.001$) and CAL (87 \% identical agreement; paired t-test: $p>0.05$; Pearson’s correlation: $r=0.90; \ p<0.001$).

**Statistical Analysis**

The data were analysed using the Statistical Package for the Social Sciences (SPSS) software version 20.0 for Windows® and a p-value of $\leq 0.05$ was considered as significant for all statistical tests in this study. Means and standard deviations were calculated and inter-group differences were tested by cross-tabulation, analysis of variance, Wilcoxon Rank test, Mann-Whitney U-test and Independent Samples Kruskal-Wallis test, depending on the nature of the variable.
Results

One-hundred and forty three individuals were included in the study with a mean age of 82.7 years (SD 7.8, Range: 53-98) with three-quarters (76.2%, n=109) of them being woman and each individual taking an average of 8 (± 4) medications. The majority of the residents suffered from dementia with around 60% of them categorized in care levels “C” and “Cd”. The distribution of the residents in different care levels is illustrated in Table 5.

<table>
<thead>
<tr>
<th>Care level (Katz index)</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>6</td>
<td>4.2</td>
</tr>
<tr>
<td>A</td>
<td>12</td>
<td>8.4</td>
</tr>
<tr>
<td>B</td>
<td>39</td>
<td>27.3</td>
</tr>
<tr>
<td>C</td>
<td>21</td>
<td>14.7</td>
</tr>
<tr>
<td>Cd</td>
<td>65</td>
<td>45.5</td>
</tr>
<tr>
<td>total</td>
<td>143</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Table 5. Table 5. Distribution of individuals in different care level categories (Katz Index)

The mean number of teeth in each individual was 13.6 (± 7.0) with an average of 5.6 (± 4.3) teeth in the maxilla and 8.0 (± 3.8) teeth in the mandible. Furthermore, untreated caries tended to be a frequent finding with an average of 1.4 (± 2.2) carious teeth per patient, which was equivalent to 12% (± 19) of all teeth in each individual. At subject level, 43% of the individuals had carious lesions. It was also slightly higher in subjects with dementia amounting to 1.58 for the “C,Cd” care level subgroup, while it was 1.28 and 1 for “O,A” and “B” subjects respectively. The average number of residual roots per individual was 1.8 (± 3.1), with upper jaw tending to harbor a higher average number of residual roots than the lower jaw (1.0 (± 2.0) vs. 0.80 (± 1.8)). In addition, patients with a higher level of care dependency tended to have more residual roots, since the groups “O,A”, “B” and “C,Cd” had on average 0.8 (± 1.4), 1.4 (± 2.3) and 2.1 (± 3.6) residual roots respectively. However, this trend was statistically not significant. The mean number of tooth restorations per individual was 2.3 (± 3.3) with relatively more restorations per female residents than male residents (2.9 (± 3.5) vs. 1.0 (± 2.0)). The dental status of the study population is shown in table 6.
Table 6. The dentition status of the study population

Plaque scores tended to be relatively high, considering the average plaque score being 2.13 on a scale of 3. Buccal sides showed significantly lower plaque scores than the lingual side (p<0.001). Moreover, female individuals manifested slightly less plaque than men. However, the difference was not of statistical significance. An overview of the data concerning the dental plaque and the distribution across buccal and lingual sides and across gender is shown in tables 7 and 8 and figure 1.

Table 7. Plaque scores by tooth aspect (Silness-Loë index)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Median</th>
<th>IQ range</th>
</tr>
</thead>
<tbody>
<tr>
<td>buccal aspect</td>
<td>2.04§</td>
<td>0.76</td>
<td>2.00</td>
<td>1.17</td>
</tr>
<tr>
<td>lingual aspect</td>
<td>2.21§</td>
<td>0.66</td>
<td>2.00</td>
<td>0.83</td>
</tr>
<tr>
<td>total plaque</td>
<td>2.13</td>
<td>0.68</td>
<td>2.08</td>
<td>0.95</td>
</tr>
</tbody>
</table>

§ Significant differences between variables according to the Wilcoxon Signed Rank Test (p<0.001)
<table>
<thead>
<tr>
<th>Gender</th>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Median</th>
<th>IQ range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>buccal plaque</td>
<td>2.24 (p=0.75)</td>
<td>0.72</td>
<td>2.33</td>
<td>1.17</td>
</tr>
<tr>
<td></td>
<td>lingual Plaque</td>
<td>2.34 (p=0.231)</td>
<td>0.59</td>
<td>2.33</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>total Plaque</td>
<td>2.29 (p=0.79)</td>
<td>0.64</td>
<td>2.25</td>
<td>1.00</td>
</tr>
<tr>
<td>Women</td>
<td>buccal plaque</td>
<td>1.98</td>
<td>0.77</td>
<td>2.00</td>
<td>1.13</td>
</tr>
<tr>
<td></td>
<td>lingual Plaque</td>
<td>2.18</td>
<td>0.68</td>
<td>2.00</td>
<td>0.73</td>
</tr>
<tr>
<td></td>
<td>total Plaque</td>
<td>2.08</td>
<td>0.70</td>
<td>2.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

*Significant differences according to Mann-Whitney U Test*

Table 8. The distribution of plaque score across gender

![Figure 1](image_url)  
**Figure 1.** The distribution of plaque score by gender

The dependency levels of individuals according to Katz index were classified once into two major groups and once into three major groups, as shown in table 2. Howbeit, despite a slight tendency to higher plaque scores in the highly dependent individuals, the inter-group differences were statistically not significant in neither of classifications. The distribution of average plaque score across care levels is depicted in figure 2.
Calculus was found in 81 percent of subjects. Furthermore, more than half of the residents (53.1%) had a DPSI score of 3+ while DPSI scores 2, 4 and 3- came next in the order of frequency with 24.5%, 15.4% and 5.6% respectively. Only 1.4 percent of patients had a DPSI score 1 and there was no patient with DPSI score 0. Figure 3 illustrates the percentage of different DPSI scores. There was also no significant correlation between different care levels and DPSI scores (p=0.430).

Only less than one-third of the study population (28.7%) wore a removable denture. Nevertheless, more than half of them required some sort of intervention. There was no difference between patients with different care levels in terms of prosthetic treatment need. Table 9 shows the denture condition of the individuals.

Table 9. Denture condition of the individuals

<table>
<thead>
<tr>
<th>Required intervention</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>no treatment</td>
<td>48.8</td>
</tr>
<tr>
<td>repair and relining</td>
<td>7.3</td>
</tr>
<tr>
<td>major alteration</td>
<td>36.6</td>
</tr>
<tr>
<td>renewal</td>
<td>4.9</td>
</tr>
</tbody>
</table>

The Oral Health Index ranged from 1 to 7 with an average of 4.6 (± 1.4). Only 6.3% of the subjects had an OHI score below 3 while 65.1% had a score of 3, 4 or 5. Furthermore, 27.3%
of the individuals scored 6 or 7. The most frequent OHI scores were 5 and 4 with frequency percentages of 25.9% and 25.2% respectively. The score1 had the lowest frequency among the registered values, recorded in only 0.7% of the cases. Figure 4 illustrates the distribution of different OHI scores in the study population.

Figure 4. The percentage of different OHI scores among the study population

Among the subjects with care dependency level “O,A”, 5.6% presented an OHI score lower than 3, while this score was observed in 5.3% and 7.1% of “B” and “C,Cd” subjects respectively. Furthermore, 38.9% of the individuals in the “O,A” group had a score equal or higher than 6, while 20.6% of “B” individuals and 27.9% of the “C,Cd” subjects had this score. Despite the mentioned differences, no statistically significant relationship between OHI scores and the care dependency level of the patient could be established (figure 5). However, the gender was significantly (p=0.009) correlated with OHI, as female individuals exhibited significantly lower OHI scores than male individuals. Table 10 exhibits the OHI in all individuals and per gender. During the clinical examination, two individuals were diagnosed with mucosal lesions; one being a precancerous mucosal lesion and the other one was a case of bisphosphonate-related osteonecrosis of the jaw (BRONJ). However, due to the low frequencies of such cases, no statistical analysis was performed.
<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>SD</th>
<th>Median</th>
<th>IQ range</th>
</tr>
</thead>
<tbody>
<tr>
<td>OHI (all individuals)</td>
<td>4.6</td>
<td>1.4</td>
<td>1.0</td>
<td>7.0</td>
</tr>
<tr>
<td>OHI (men)</td>
<td>5.2 (p=0.008)¶</td>
<td>1.3</td>
<td>5.0</td>
<td>1.3</td>
</tr>
<tr>
<td>OHI (women)</td>
<td>4.5¶</td>
<td>1.4</td>
<td>4.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

¶ Significant differences between the groups in Mann-Whitney U test

**Table 10.** Oral Health Index per gender

![Box plot showing the distribution of Oral Health Index across different care dependency levels.](image)

**Figure 5.** The distribution of Oral Health Index across different care dependency levels.
Discussion

This study reports cross-sectional data on dental and periodontal status and oral hygiene of dentate elderly people living in nursing homes. The average number of teeth per individual was 13.6 with a slightly higher average number of teeth in men than women. This is somewhat higher than the data obtained from similar studies. Gluhak and co-workers[27] evaluated 681 patients in an Austrian population and reported a mean number of 9.9 teeth per patient and a higher number of teeth among men than women (12.8 vs. 8.8). Peltola et al.[28] investigated 260 elderly patients in Finland and found on average 12.4 teeth per patient. Lamy and co-workers[29] performed a study on 276 individuals in the Wallonian part of Belgium and the mean number of teeth was 10.4. In a similar study by De Visschere et al.[23], the oral status of 359 Flemish elderly people was evaluated and the mean number of teeth per patient was 10.34. The relatively higher number of teeth in our study may be partly due to the inclusion of residual roots in the total number of teeth and partly due to the increasing number of residual teeth in elderly population groups over time. Furthermore, since the measurements are performed prior to any treatment, hopeless teeth due to terminal periodontal destruction or caries are also counted in the total number of teeth. Taking these factors into account, the average number of teeth in our study will regress after accurate dental care and maybe be in line with the results of similar studies.

The mean number of teeth with carious lesions in our study was 1.4 with a slightly higher prevalence among men than women. When calculated in percent, it amounts to 11 (± 19) percent of residual teeth. That is higher than the values reported by some other studies. Adam and co-workers[30] reported a mean number of 1.11 and 0.8 decayed teeth among their study groups while Simunkovic and coworkers[31] found on average 1.03 carious teeth per person.

There are not many studies declaring the prevalence of caries at tooth level, since most studies have reported the number of caries either in the form of DMFT or as prevalence ratio at a subject level. Our results showed that 43% of the subjects suffered from tooth decay, which is within the wide range of results on this subject stated by different studies. Cohen et al.[32] found a caries prevalence of 34.7% while Samson and co-workers[33] declared it as 72%. A cross-sectional investigation by Lamy et al. on a Belgian group of elderly individuals revealed that 53.3% of their subjects had caries[29]. Such differences between the studies may be partially due to different susceptibility of individuals to developing caries. In this regard general health status, living conditions and lifestyle and the amount of saliva are of major
influence. Another important factor in this context is the number of different medications taken by the subjects, with xerostomia as possible side effect. A high percentage of elderly patients have an exacerbated health state which is associated with taking various medications, as in our study with the mean number of 8 (± 4) medications per subject. This in turn increases the risk of drug-induced xerostomia and developing tooth decay. In our study, demented subjects exhibited a relatively higher number of decayed teeth than subjects without dementia. This was confirmed by the study of Ellefsen et al.[34], whereby the number of coronal and root surfaces with caries was significantly higher in subjects with a diagnosis of dementia.

The average DMFT in our study population amounted to 19.8 (± 6.8) with a lower mean DMFT among men than women (19.1 (±7.4) vs. 21.6 (±6.6)). These results are notably lower than those reported by some other cross-sectional studies in Europe. Gluhak and co-workers[27] declared a mean DMFT score of 25.6 in an Austrian population while Nitschke et al.[35] and Samson et al.[33] reported mean DMFT scores of 26.4 and 23.2 in German and Norwegian study populations, respectively. Such discrepancy can be explained by differences in the subjects’ age, habits and lifestyles, general health, level of disability and even methodologies used for caries assessment.

Oral hygiene was very poor among the study subjects as the mean plaque score of the subjects was 2.13 (± 0.68) on a scale of 3. This is confirmed by the results of some other studies using the same plaque index. De Visschere et al.[23] investigated Belgian subjects and the mean plaque score was 2.17 (± 0.75). Frenkel and co-workers[36] performed a similar study in England and obtained a mean plaque score of 2.3 (± 0.7). Jäger et al.[37] evaluated the residents of nursing homes in Germany and stated that 67.2% of their dentate subjects scored higher than 2 on the Silness-Loë plaque index. Nevertheless, our results are in contrast with the findings of Kuc et al.[18] that investigated Canadian subjects and reported a mean plaque index of 1.3 (± 0.9). Although other studies also reported high plaque scores, a meticulous comparison between their results and the findings of this study is not possible due to different protocols and index used for plaque measurement. Our results showed a significantly higher efficiency in plaque control on the buccal sides than on the lingual side. This is probably because of better visibility and accessibility on the buccal aspect. Likewise, female individuals manifested slightly less plaque than men. This may have contributed to the lower prevalence of caries in our female subjects. In addition, when dividing the subjects by their care dependency level, the cluster of elderly people with dementia had a slightly higher mean plaque score. The same trend was found by Adam and co-workers who reported a mean
plaque score of 2.14 (± 0.73) in moderately to highly demented subjects while the subject without dementia or with mild dementia, had an average plaque score of 1.33 (± 0.60)[30]. Similarly, Warren et al.[38] observed lower levels of oral hygiene among severely demented subjects in comparison to those without dementia. This gives rise to the hypothesis that dependent patients do not get an efficient assistance from nurses and caregivers, which is probably due to their lack of knowledge and oral health care skills and the relatively low cooperation of individuals with dementia.

Supragingival calculus was found in 81% of the subjects. These results lie within the same range as reported by Frenkel et al.[36] who found calculus in 82% of their subjects and De Visschere and co-workers[23] who reported this value as 76.7%. Nonetheless, lower values were declared by Cohen et al.[32] and Sweeney et al.[39], spotting calculus in 55% and 57% of their dentate cases.

The periodontal measurements of this study were carried out using the Dutch Periodontal Screening Index (DPSI) that emphasizes on the clinical attachment loss along with periodontal inflammation. Fifty-three percent of the residents participating in the current study had a DPSI score 3+ which can be interpreted as periodontitis. A DPSI score 2 was found in 24.5% of the patients that corresponds to a group of patients having supragingival calculus with no deep pockets. Although the nature of periodontitis in this age group is mostly chronic, it still very much implies a periodontal intervention. Taking into account that 81% of our subjects had calculus, one can interpret that in the majority of cases whereby calculus is present, it is accompanied with a deepened pocket at a patient level. This means that the dentist should be cautious when observing calculus and check for deep periodontal pockets.

Numerous studies have investigated the periodontal condition of older individuals, however, different indices have been utilized which makes a valid comparison difficult. Gluhak and co-workers performed a basic periodontal evaluation and found an average score of 1.9 for men and 2.1 for women. This means that the periodontal destruction was more pronounced in their study group than in the present study group, since their score 2 corresponded with the presence of calculus, bleeding and a probing pocket depth of >5 mm. Jager et al.[37] used the CPITN index to assess the periodontal condition of a German population. Forty-two percent of their study population had a CPITN score 4 that stands for the presence of ≥6mm periodontal pockets. This is while the same index was used in a study by Samson et al. on Norwegian elderly people and 50% of them scored 2, pointing out the absence of deepened pockets. Only 8% of their subjects exhibited ≥6mm pockets and 35% of them had 4-5mm pockets. Such discrepancies between the studies can primarily be due to the nature of
periodontitis, being a multifactorial disease. Numerous parameters such as the oral hygiene of the patient over the years, genetic susceptibility and systemic conditions can broadly influence the prevalence of periodontitis. Besides, the treatment approach of the previous dentists can influence the results of such cross-sectional trials. In other words, in radical approach by the dentist teeth showing moderate signs of periodontal destruction are extracted, leaving the patient with a lower score in periodontal indices. Another explanation for a low proportion of old patients with very deep pockets, is the chronic nature of the periodontal disease, which means the progressive destruction has been present for years. Thus when observing oral health of older people, one can conclude that the teeth with extensive periodontal deterioration may have already been lost.

Around twenty-nine percent of the cases wore a removable denture, either partial denture or full denture with natural teeth in the opposite jaw. However, a high proportion of denture-wearers had a need for prosthetic treatment. Major alteration in the denture such as adding an extra tooth and rebasing, were required in 36.6% of the patients with denture. This was followed by repair and relining of the denture in 7.3% of the cases and denture renewal in 4.9% of them. The current literature regarding this subject is heterogeneous, since studies have different approaches for this matter. Although denture status and the need for denture treatment are closely related, one can hardly make a comparison between the two, since they are not identical variables. Among the studies that measured the denture status, is the trial of Lamy et al.[29] that assessed the retention and stability of the dentures. He concluded that lower dentures are less stable and less retentive than their upper counterparts, since in 59% of cases, lower dentures did not have a good retention and in 52% of the cases they did not have a good stability. The same variables were evaluated by Söderpalm Andersen and co-workers[40] in Swedish elderly people and again the lower denture scored worse. Twenty-six percent of the subjects had a lower denture with poor retention and 23% of the subjects had a lower denture with poor stability. Frenkel et al.[36] reported the prevalence of denture soreness as 27.8% and of the ill-fitting dentures as 26.7%. Nitschke and co-workers[35] evaluated the denture treatment need and declared it as 65%. Sweeney et al.[39] found a denture treatment requirement in 7% of their edentulous subjects. Cohen and co-workers[32] performed a treatment-based analysis too and found the need for denture relining in 45.2% of the subjects. The major discrepancies between these results can be due to numerous reasons. Besides from the different approaches of the studies, differences in the type of denture (partial or full, material, etc.) can be influencing on the associated complications and consequently the need for denture treatment. Furthermore, the variances between the reimbursement systems
for new denture in different countries can play a role in these differences. Oral health Index was a new variable defined in this trial in order to assess different parameters pertaining to the oral health of the individuals. It was introduced to estimate the extent of patient’s need for dental intervention. The mean oral health score of the subject in this study amounted to 4.6. Only 6.3% of the subjects had an OHI score below 3, corresponding to an acceptable level of oral health. This is while 65.1% had a score of 3, 4 or 5, exhibiting a moderately high need for dental intervention. Finally, 27.3% of the individuals scored 6 or 7, which was regarded as a very high need for dental treatment. When analyzing the OHI scores by different care dependency levels, a higher percentage of the subjects in the “O,A” group showed a score of 6 or higher comparing to “B” and “C,Cd” group, implying a very high need for dental intervention. However, this difference was not statistically significant. Further analysis revealed contrasting results to the scientific hypothesis of this trial as the care dependency level of the individuals was not shown to be of influence on the oral health and patients of all care levels showed comparably high needs for dental treatment. Howbeit, gender turned out to be of significant influence, as women had significantly higher levels of oral health than men.

The lack of significant relationship between oral health parameters and care dependency is not in accordance with the results of similar studies that have found a worse state of oral health parameters among the individuals with higher dependency level than independent ones [41-43]. Nonetheless, in the present study the subjects with higher care dependency, scored worse in terms of number of carious lesions, number of residual roots and plaque index, which is in line with such studies. In fact, the DPSI and the need for prosthesis treatment were the only variables in the current study that did not follow this trend. The number of individuals with a denture in this study was relatively lower in comparison to similar studies, as there were only 41 patients with a removable denture included. One might argue that there might have been an inter-group statistical significance like other variables, if the analysis was carried out on a higher number of cases. Furthermore, most of the studies reporting significant difference in terms of periodontal status, have measured gingivitis, bleeding or the number of ≥4mm pockets which are absolutely not comparable with our methodology of periodontal evaluation [41-43]. Thus, as long as the variables are not the same or at least closely related, making comparisons between different reports is irrelevant.

So far, several composite indices for oral health have already been developed. However, most of these indices are not age-specific and therefore there is less focus on the frequent complications among the elderly. Furthermore, the informativeness and practicality of an
index are often difficult to combine, since evaluating numerous parameters can be a challenge with older subjects. Moreover, when treating older patients and particularly individuals with dementia, an index based on objective measurements can be more practical and accurate, in comparison to the ones involving subjective opinion of the patient. In this regard, indices such the Oral Health Status Index\cite{44}, the Index of Dental Need\cite{45}, the index devised by Nikias and co-workers\cite{46} and the oral health index (OHX) published by Burke and Wilson\cite{47} have been introduced and sometimes modified to new ones. Nonetheless, the lack of an index fitting to the above-mentioned criteria is very much felt. The oral health index used in this study is solely applicable to dentate subjects. However, it was an effort to prepare an easy treatment-based index, particularly tailored for the elderly patients. Future efforts are required to elucidate clinical repeatability and the weaknesses.
Conclusion

Patients with older age, particularly those living in nursing homes are usually neglected in terms of oral health care. This is while a high percentage of them suffer from very low levels of oral health and the treatment backlog is enormous. There was no correlation found between the care dependency level of the elderly individuals and their oral health status, since they all share a high need for dental treatment. The oral health index introduced in this study was used to evaluate different oral parameters of the dentate elderly and assess the need for dental treatment. Nevertheless, further investigation is required to scrutinize the clinical accuracy and applicability of it.
References


