

Department of General Practice and Primary Health Care

Faculty of Medicine

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**ORAL AND NUTRITIONAL PROBLEMS AMONG RESIDENTS IN
ASSISTED LIVING FACILITIES**

Riitta Saarela

ACADEMIC DISSERTATION

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Supervisors

Professor Kaisu Pitkälä, MD, PhD
Department of General Practice and Primary Health Care
University of Helsinki, Finland

Docent Helena Soini, RN, DSc
Department of General Practice and Primary Health Care
University of Helsinki, Finland
and
Department of Social Services and Health Care
City of Helsinki, Finland

University lecturer Kaija Hiltunen DDS, PhD
Institute of Dentistry
University of Helsinki, Finland

Reviewers

Professor Liisa Suominen DDS, PhD
Institute of Dentistry
University of Eastern Finland, Finland

Docent Satu Männistö, PhD
National Institute for Health and Welfare,
Department of Chronic Disease Prevention,
Helsinki, Finland

Opponent

Docent Pertti Karppi, MD, PhD
University of Helsinki, Finland

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LIST OF ORIGINAL PUBLICATIONS

- I. Saarela RKT, Soini H, Muurinen S, Suominen MH, Pitkälä KH. Oral hygiene and associated factors among frail older assisted living residents. *Spec Care Dent* 2013; 33:56-61.
- II. Saarela RKT, Soini H, Hiltunen K, Muurinen S, Suominen MH, Pitkälä K. Dentition status, nutrition and mortality among frail older service housing residents. *J Nutr Health Ageing* 2014; 18:34-38.
- III. Saarela R, Lindroos E, Soini H, Muurinen S, Suominen M, Pitkälä K. Chewing problems and mortality. *J Am Geriatr Soc* 2011; 59:181–183.
- IV. Lindroos E, Saarela RKT, Soini H, Muurinen S, Suominen MH, Pitkälä KH. Caregiver-reported swallowing difficulties, malnutrition, and mortality among older people in assisted living facilities. *J Nutr Health Ageing* 2014; 18:718-722.
- V. Saarela RKT, Lindroos E, Soini H, Hiltunen K, Muurinen S, Suominen MH, Pitkälä KH: Dentition, nutritional status and adequacy of dietary intake in older service housing residents. *Gerodontology*. 2014 Aug 28. doi: 10.1111/ger.12144. [Epub ahead of print]

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ABBREVIATIONS

ADL	Activities of Daily Living	mOHI	modified Oral Hygiene Index
BMI	Body Mass Index	NH	Nursing Home
CI	Confidence Interval	NIP	Nutrient Intake Profile
CDR	Clinical Dementia Rating	NSI	Nutrition Screening Initiative
CPI	Community Periodontal Index	NuSc	Nutrition Score
CRP	C-Reactive Protein	OHRQOL	Oral Health Related Quality of Life
DMFT	Decayed, Missing, Filled Teeth	OR	Odds Ratio
FDS	Functional measure of Dental Status	PEM	Protein-Energy Malnutrition
GOHAI	General Oral Health Assessment Index	POHC	Professional Oral Health Care
HEI	Healthy Eating Index	POP	Posterior Occluding Pair
HR	Hazard Ration	PT	Number of Present Teeth
IADL	Instrumental Activities of Daily Living	ROAG	Revised Oral Assessment Guide
LT	Long-Term care ward	SD	Standard Deviation
MNA	Mini Nutritional Assessment	SGA	Subjective Global Assessment
		WHO	World Health Organisation

ABSTRACT

This study formed part of a developmental project in the Helsinki Metropolitan Area of Finland during 2003–2011 that aimed to develop nutritional care in long-term care facilities. The aim of this study was to assess tooth brushing/denture cleaning habits, dentition, chewing problems, and swallowing difficulties and their associations with nutritional status and eating habits. Furthermore, the aim was to explore the prognostic value of dentition, chewing problems and swallowing difficulties in relation to mortality. In addition, the adequacy of the dietary intake of energy, protein, and other nutrients was examined.

Of all the residents in assisted living facilities (N = 2188) in the cities of Helsinki and Espoo, 67% (1475) participated in this study in 2007. Trained registered nurses familiar with the residents assessed each participant and collected demographic data, the medical history, information on the functional and cognitive status, tooth brushing/dentition cleaning habits, dentition, oral symptoms, eating habits and diets. The nutritional status was assessed with the Mini Nutritional Assessment (MNA). In addition, 343 volunteer residents provided one-day food diaries. Their energy, protein, and nutrient intakes were calculated from these detailed food diaries and compared with the recommendations of the Finnish National Nutrition Council as a measure of dietary adequacy. Information on three-year mortality was retrieved from central registers on 6 July 2010.

The mean age of the residents was 83 years and 79% of them were women. The educational level was low; 56% of the residents had a primary school level of education or less. In activities of daily living, most residents (84%) required at least prompting or assistance in dressing, hygiene and the keeping of personal effects, or required considerable help with personal care, often involving incontinence. Over half of the residents (55%) had cognitive impairment.

Edentulousness was common; more than half of the residents (52%) had lost all their teeth, while 7% (n = 94) were totally edentulous without prosthesis. Of the residents, 17% did not clean or had not cleaned their teeth/dentures daily. According to the MNA, 13% were malnourished, 65% were at risk of malnutrition and 22% were well nourished. Edentulousness without prostheses and infrequent tooth brushing were associated with malnutrition, oral symptoms and infrequent use of oral health care services.

Residents with chewing problems (n = 287) were older, had more comorbidities and were more likely to be malnourished according to the MNA, to be dependent in activities of daily living (ADL) and to have poorer subjective health than those without chewing problems. In logistic regression analysis including age, sex, MNA class and the Charlson's Comorbidity Index as covariates, chewing problems still independently predicted mortality (OR = 1.46, 95% CI = 1.10–1.93). Of the residents, 12% (n = 173) had swallowing difficulties and they were more likely to be malnourished than those residents without swallowing difficulties. Swallowing difficulties also had an independent predictive value for mortality (OR = 1.49, 95% CI = 1.04–2.12).

Large proportions of volunteer participants in the subsample that provided one-day food diaries received less than the recommended amounts of energy, protein or micronutrients. The dietary intake of protein was significantly lower among edentulous subjects without dentures than those with natural teeth. In the adjusted (age, gender and Charlson's comorbidity index) logistic regression model, being in Group 1 (edentulous participants without dentures) and Group 2 (edentulous participants with some removable dentures in one or both jaws) predicted a poorer protein intake (<60 g/day; OR 2.4, 95% CI 1.0–5.7, p = 0.042 and OR 1.6, 95% CI 1.0–2.6, p = 0.045, respectively) compared with the reference Group 3 (dentulous participants all or some natural teeth and with or without removable dentures in one or both jaws; OR = 1)

Oral problems were common among frail older residents in assisted living facilities and they were associated with nutritional problems. These findings suggest the need for co-operation between nursing staff and oral care personnel.

1. INTRODUCTION

Life expectancy is steadily increasing and the proportion of people aged 65 years or older is growing. There are nowadays more than a million individuals aged 65 years or older living in Finland, and the size of the oldest old population is growing particularly rapidly (Official Statistics of Finland 2014). It is predicted that the number of people aged 85 years or older will increase from 130 000 in 2013 to 230 000 by the year 2030. The number of people with memory disorders will also increase in the future as the population ages (Sosiaali- ja terveystieteiden ministeriö 2012). This will lead to a greater need for long-term care and increasing costs of social and health care, since about 80% of patients in long-term care have memory problems or diagnosed dementia. There have been changes in the structure of the service system in the 2000s in Finland (Sosiaali- ja terveystieteiden ministeriö 2011, Väyrynen et al. 2013) The proportion of older people residing in institutional care has steadily decreased and a growing number of older people live in their own home independently or with home care services for as long as possible. A large number of nursing home beds have been replaced by more home-like care in assisted living facilities. These assisted living facilities are provided to those older people who no longer manage in their own homes with home care services. In these facilities, older people live in their own flat or room and nursing care is provided 24 hours a day.

In Finland, 1.1% of people aged 75 years or older were in long-term care wards in a health centre or hospital in 2012 (Väyrynen et al. 2013). The respective proportions in assisted living facilities with 24-hour assistance and in nursing homes for older people were 6.1% and 2.6%. The national target according to a quality recommendation is that by 2017, only 2-3% of people aged 75 or over would be cared for in nursing homes or receive long-term care in health centre wards (Sosiaali- ja terveystieteiden ministeriö 2013). The target for assisted living with 24-hour assistance was that 6-7% of people aged 75 or older would be receiving these services, while the respective target for regular home care was 13–14%. In Helsinki, all these targets were not met in 2013 (Soini 2014). Of individuals aged 75 years or over, 2.9% were in long-term care wards. The respective figure for assisted living with 24-hour assistance was 5.9% and for regular home care services 12.4%.

Long-term care in a health centre ward or hospital also includes oral health care services. However, in assisted living facilities, regular oral health care services are rarely provided and residents have to pay fees for such services. Residents in assisted living facilities are also dependent on the help of

care-givers or relatives to ensure the regular use of oral health care services. Such services are provided by the public and private sectors. For those using private oral health care services, part of the treatment cost will be covered by health insurance.

Many individuals grow older with their own natural teeth. In 1980, almost 70% of 75-year-old or older females and 55% of males had lost all their natural teeth, whereas in 2000 the figures had fallen to 58% and 49%, respectively (Suominen-Taipale 2004). In 2011, the proportion of edentulous females aged 75 years or older had fallen to 47%, and the proportion of edentulous males was 29% (Koskinen et al. 2012). Among the dentate, the number of remaining teeth is also increasing; fewer people need removable dentures (Suominen et al. 2012), and the number of people with sophisticated fixed constructions such as crowns, bridges and implants is increasing (Lofquist et al. 2000). It is important to ensure that natural teeth and these constructions are well maintained and clean. However, functional decline and impaired motor function, as well as memory problems and decreased vision may lead to a situation where elderly individuals no longer manage to perform their daily oral hygiene procedures themselves, and regular attendance of dental care services may be forgotten. Oral health may collapse, especially if an individual suffers from dry mouth (Turner & Ship 2007). Older people are not always aware of their oral health (Siukosaari 2013). The increasing number of natural teeth in the older population is also resulting in a higher level of treatment needs and a higher burden on oral health care services. In addition, the increasing group of dependent dentate older people has created an increasing need for oral health care (Department of Health, United kingdom 2005) Unfortunately, oral health care still remains a neglected and low priority area of nursing care these days (Miegel & Wachtel 2009, Willumsen et al. 2012).

The oral health of dependent older people remains poor, although oral diseases are highly preventable. Good oral hygiene, healthy nutrition and regular visits to dental care services are crucial to maintain good oral health (MacEntee et al. 2011). A poor oral condition is associated in many ways with the quality of the diet, nutrition and overall well-being (Soini et al. 2006, Saunders et al. 2007). Malnutrition of older people has many undesirable consequences such as sarcopenia, functional and cognitive decline, increased morbidity, longer stays in hospitals and increased mortality (Bauer et al. 2013). However, nursing staff poorly recognize malnutrition and it is consequently often left untreated (Suominen et al. 2009). Furthermore, malnutrition may cause both human suffering and an economic burden to society.

Malnutrition is a common and complex problem among institutionalized older people (Kaiser et al. 2010). Multi-professional co-operation is essential to tackle this nutritional problem. We need nurses, geriatricians, nutritionists and dental care professionals to work together to improve the oral health and nutrition of dependent older people (Soini et al. 2006).

In recent years, there has been increasing interest in studying the nutrition and nutritional care of dependent older people. In 2003, a developmental research project was started in the Helsinki Metropolitan Area to improve the nutritional care of older residents in institutional care (Suominen et al. 2005, Soini et al. 2011). As part of this project, this thesis study aimed to describe the oral health condition and its association with nutritional status, nutrient intake and three-year mortality of residents in assisted living facilities in Helsinki and Espoo in 2007.

2. REVIEW OF LITERATURE

2.1 Oral health in older people

The World Health Organisation (WHO) defines oral health as a state of being free from chronic mouth and facial pain, oral and throat cancer, oral sores, birth defects such as a cleft lip and palate, periodontal (gum) disease, tooth decay and tooth loss, and other diseases and disorders that affect the oral cavity (WHO 2014). Risk factors for oral diseases include poor oral hygiene, an unhealthy diet, tobacco use and harmful alcohol use. Good oral health means comfortable and functional dentition, good oral hygiene and the absence of disease, and it allows individuals to continue in their desired social role (Locker 1997).

Although poor oral health is largely preventable (Griffin et al. 2012), recent studies have indicated that oral health continues to be poor among older people (Peltola & Vehkalahti 2005, Gluhak et al. 2010, Hopcraft et al. 2012b). Oral health is especially poor among individuals with dementia (Chalmers & Pearson 2005, Adam & Preston 2006, Zenthofer et al. 2014), and among those with chronic conditions (Hopcraft et al. 2012b) and disabilities (Catovic et al. 2003). Findings concerning gender differences in oral health have been contradictory (Peltola et al. 2004, Montal et al. 2006, Hopcraft et al. 2012a).

Table 1 provides an overview of findings from epidemiological studies exploring the oral health status and respective treatment needs of older people. Irrespective of the setting (institutional care vs. home dwelling) or geographical area, a large proportion of older people suffer from oral health morbidity. Most previous studies using clinical oral examination to explore the oral health of older people have been cross-sectional and descriptive. Although most studies have used clinical oral examination to describe the oral health status of older people, they have included a relatively low number of participants, and their representativeness therefore remains questionable.

Poor oral health may reduce general well-being and quality of life in older people (McGrath & Bedi 1999, Nitschke & Muller 2004, Peltola et al. 2005). In particular, poor self-rated oral health and a lower number of teeth have associated with the prevalence of having problems suggesting a poorer oral health-related quality of life (Dahl et al. 2011).

Table 1. Overview of findings from epidemiological studies exploring the oral health status of older people

Study	Participants	Methods	Findings	Context, comments
Community-dwelling older people				
Nevalainen et al. 1997	N = 338 76-, 81-, 86-y-olds	Clinical oral examination	38% had mucosal lesions, 6% angular cheilitis, 25% denture-related inflammation, 7% ulcers.	Helsinki Aging Study (random population-based sample N = 898).
Meurman et al. 1997	N = 184 patients in geriatric hospital Mean age 81 y	Clinical oral examination, saliva samples, Panoramic X-rays and blood tests Interview	Dentogenic infections in 71% of the dentate patients. 96% poor periodontal condition. Edentulous patients more frequently had positive salivary yeast counts than the dentate patients (84% vs. 66%).	Descriptive study of acutely hospitalized older patients (Harjula hospital in Kuopio), Finland
Saunders and Friedman 2007	N = 641; Mean age 79 y; 74% females	Interview	Substantial oral health morbidity: 43% edentulous, 12% had ≥ 25 teeth. 77% dentures. 59% dry mouth, 5% pain, 40% need for dental treatment. 35% last dental visit > 5 years ago	Cognitively intact Medicare patients in the US having 2+ ADL or 3+ IADL disabilities and residing in community.
Komulainen 2013	N = 321. Mean age 82 y; 71% females	Clinical oral examination Interview Intervention (n = 165): individually tailored personal guidance	48% edentulous, 59% periodontal disease, 46% caries, 26% oral pain or discomfort, 13% mucosal lesions, 45% dry mouth, 20% denture stomatitis.	Geriatric Multidisciplinary Strategy for Good Care of the Elderly intervention study in Kuopio Finland
Institutionalized older people				
Mojon et al. 1999	Nursing home; N = 324. Mean age 85 y; 70% females	Clinical oral examination	48% edentulous; 45% of these denture stomatitis or denture-induced ulcers. Of the dentate, 79% caries, 48% retained roots, 91% periodontal problems (CPI ≥ 2).	Nursing home in Geneva. Poor oral health was associated with poor nutrition.
Frenkel et al. 2000	22 nursing homes, N = 421. Mean age 84 y; 78% females	Clinical oral examination Interview	71% edentulous, 33% stomatitis, 82% calculus, 63% root caries, 22% reported a current dental problem. 71% last dental attendance > 5 years ago.	Nursing homes in Bristol, U.K. assessed oral health needs of nursing home residents
Simons et al. 2001	Residential home N = 164 dentates. Mean age 81 y; 82% females	Clinical oral examination Interview	Mean number of coronal decayed surfaces 2.4. 53% had root decayed surfaces, 32% retained roots, 40% denture stomatitis, 29% angular cheilitis, 19% reported difficulties in eating, 35% dry mouth; mean time since last seen by a dentist 5.2 years.	11 residential homes in England
Catovic et al. 2003	Nursing homes N = 175. Mean age 77 y; 62% female	Clinical oral examination	23% edentulous, 87% were in need of prosthodontic treatment. Lower ADL score was associated with a poor condition of dentures. Only 20% had dental attendance within past 5 years.	Six nursing homes in Croatia
Peltola et al. 2004	Long-term hospital N = 260. Mean age 83 y; 75% female	Clinical oral examination	Edentulous 42%, 18% of them without dentures. 25% denture stomatitis, 19% angular cheilitis, 76% of dentate had treatment needs; 37% filling therapy, 49% periodontal therapy.	Laakso long-term hospital in Helsinki, Finland
Adam et al. 2006	Nursing home N = 135; demented: mean age 86 y; non-demented: 81 y	Clinical oral examination. DMFT (Decayed, Missing, and Filled Teeth) Questionnaire	70% of the demented edentulous; 63% of the non-demented. Mean number of decayed teeth: 0.80 for demented and 1.11 for non-demented. No difference in the DMFT scores or other oro-dental parameters, except for denture stability.	4 nursing homes in United Kingdom Compared oral health of people with (n = 81) and without dementia (n=54): small sample size
Continues				

Study	Participants	Methods	Findings	Context, comments
Montal et al. 2006	Geriatric hospitals N = 321. Mean age 83 y; 72% females	Clinical oral examination, DMFT Questionnaire	27% edentulous. Mean number of decayed teeth 3.7 for men and 2.8 for women. Need for treatment was high. 53% needed prosthesis, 45% extractions, and 31% conservative treatments. 56% chewing disorder, 33% of them swallowing difficulties.	2 hospitals in Montpellier, France
Sweeney et al. 2007	Nursing and residential homes N = 288. 72% females	Clinical oral examination Telephone interviews of institutions.	Annual screening of dentist for 85% of nursing homes and 76% of residential homes. In clinical exam: 74% edentulous; 38% mucosal lesions. 47% treatment needs, 6% urgent need.	10 nursing/residential homes in Scotland
Unlützer et al. 2007	Residential home N = 193. Mean age 75 y for males, 79 y for females; 51% female	Clinical oral examination	67% edentulous, 12% of them without dentures. 7.3% functional dentition (≥ 20 teeth), 21% untreated coronal caries, 18% root caries, and 65% calculus. Treatment need was high. Subjects visited dentist only when they had a complaint.	Low educated residents in one residential home in Ankara, Turkey
Glühak et al. 2010	Nursing homes N = 409. Mean age 85 y; 82% female	Clinical oral examination	52% edentulous. 81% required prosthetic treatment, 48% of dentate needed surgical treatment. 84% acute periodontal inflammation, 29% acute pain during the preceding year.	Nine nursing homes in Styria, Austria
Hopcraft et al. 2010	Nursing home, N = 275. 7% 75 y or older; 65% female	Clinical oral examination: Community Periodontal Index (CPI)	Periodontal health was poor: >50% of the residents had calculus present. 36% periodontal pockets ≥ 4 mm, 10% periodontal pockets ≥ 6 mm. 25% had visited a dentist in the past two years.	Dentate residents in 31 nursing homes in Victoria, Australia
Hopcraft et al. 2012	Nursing homes N = 510. Mean age 80 y; 69% females	Clinical oral examination	53.9% were dentate; dentate subjects had a mean 14.4 teeth present and 2.66 decayed teeth. Female residents were more often dentate and wore dentures when required. Edentulous residents more often had chronic conditions than the dentate.	Melbourne, Australia. Largest study using clinical oral examination.
Chen et al. 2013	Nursing homes N = 902. Mean age 77 y (no dementia) to 83 y; (dementia); 73% females	Clinical oral examination	40% of functionally impaired residents, 29% of dementia patients were edentulous. 80–92% of residents had caries or retained teeth; no difference between demented and functionally impaired.	Large study comparing demented and functionally impaired residents in nursing homes in St Paul, Minneapolis, USA.
Cohort studies				
Suominen-Taipale et al. 2004	N = 656. 75+; females 68%	Clinical oral examination Panoramic X-rays and laboratory tests, Survey	Edentulous 60% of females and 50 % males. 31% denture stomatitis. 32% had a dental visit during the last year.	The Health 2000 Survey; population-based study in Finland
Vilstrup et al. 2007	N = 191. 85-y-old cohort: 78% community dwelling, 7% nursing home residents, 14% in sheltered housing; 59% females	Clinical oral examination Interview: functional ability (Mob-H scale); cognitive function (the Mini-Mental State Examination)	49% had natural teeth. Participants with disabilities and cognitive impairment had more active coronar and root caries compared with subjects without. No differences in edentulousness, mean number of teeth or prevalence of root and coronal caries among participants living in the community compared with those living in institutions.	85-year-old cohort including both home-dwelling and institutionalized older people in Glostrup, Denmark
Heegaard et al. 2011	N = 783. 65+ y; Mean age 75 y for males, 76 y females; 59% females	Clinical oral examination Interview	Edentulous 12%, in age group ≥ 79 years 21%. Edentulousness was more prevalent among males than females and increased with age. Mean number of carious tooth surfaces 1.8.	The Copenhagen Oral Health Senior cohort, based on 65+ participants from Copenhagen City Heart Study

2.1.1 Edentulousness

In European countries, the number of edentulous individuals has declined over the years and the proportion of individuals who retain their teeth until late in life has substantially increased in recent decades (Muller et al. 2007). Muller et al. (2007) conducted a systematic review of studies exploring edentulousness in European countries. Most studies have been cross-sectional and have used postal questionnaires or interviews as the methods to investigate edentulousness. A few have repeated several cross-sectional surveys on several cohorts over the years (Heath 1992, Osterberg et al. 2000). They have consistently demonstrated that edentulousness is decreasing (Muller et al. 2007). This trend has also been found in repeated cross-sectional Finnish studies (Suominen-Taipale et al. 1999).

Edentulousness among older individuals has been more common in Finland than other Nordic countries. In three cities in Sweden, Denmark and Finland, the prevalence of edentulism in the 1990s among 75-year-old subjects was 27%, 45% and 58%, respectively (Osterberg et al. 1995). In a Swedish study in Göteborg, the proportion of dentate individuals among 70-year-olds increased from 49% in 1971/72 to 93% in 2000/01 (Osterberg et al. 2006). According to a large and representative national Health 2000 survey in Finland, 58% of women and 49% of men aged 75 years or older were edentulous (Suominen-Taipale 2004). Eleven years later, in 2011, the respective figures were 47% and 29% (Koskinen et al. 2012). The proportion of the population aged 75 years or older using removable dentures also decreased from 2000 to 2011 at the population level. In women, the change between these years was from 79% to 70%, while in men the respective decrease was from 74% to 60%.

Institutionalized older people have more compromised oral health than those of the same age living in the community (Muller et al. 2007). The proportion of edentulous subjects varied from 23% to 74% among institutionalized older people (Table 1). In a Finnish study on older long-term hospital patients, it was found that 42% of the patients were edentulous (Peltola et al. 2004). In nursing homes in Helsinki, 14% of the residents were totally edentulous without dentures, while in long-term care hospitals the respective figure was 27% (Soini et al. 2006).

The marked decrease in the number of edentulous individuals and increase in the number of remaining natural teeth in the dentate population means an increase in oral diseases and dental treatment needs, and an increased burden on the health care system (Beikler & Flemmig 2011). Moreover, oral self-care will become much more demanding (Ettinger 2007).

2.1.2 Oral diseases

The main chronic oral diseases are caries and periodontal diseases. Caries is the primary cause of tooth loss in all age groups (Fure 2003). The prevalence of dental caries has declined over the past decades among older people (Suominen-Taipale 2004, Murray 2011). In Denmark, more than half of 85-year-olds were found to have at least one coronal tooth surface with active caries (Vilstrup et al. 2007). In Finland, a large survey among the adult population demonstrated that caries is most common among the oldest age group of 75 years or older (Koskinen et al. 2012). In this age group, 23% of the female and 51% of the male dentate individuals have at least one carious tooth. In institutional care, caries appears to be a very common and serious problem (Table 1) (Frenkel et al. 2000, Simons et al. 2001, Marchini et al. 2006, Montal et al. 2006, Unluer et al. 2007, Iglesias Corchero & Garcia Cepeda 2008, Hopcraft et al. 2012b, Chen et al. 2013). Root caries is especially common. The proportion of subjects with root caries in institutional care has varied from 18% in Turkey to 63% in United Kingdom (Frenkel et al. 2000, Simons et al. 2001, Unluer et al. 2007). The study population in Turkish study was younger than in studies in the United Kingdom, which may explain the observed difference in the prevalence of root caries. Caries has been reported to be associated with reduced functional ability and cognitive impairment (Avlund et al. 2004, Syrjala et al. 2007, Vilstrup et al. 2007).

Periodontal diseases, gingivitis and periodontitis are inflammatory conditions of the gingiva and alveolar bone. Periodontitis is a more severe disease, leading to irreversible loss of periodontal ligament and alveolar bone. Although periodontal health has improved over the past decades (Suominen-Taipale 2004, Hugoson et al. 2008), periodontal diseases have been reported to be common among older people (Meurman et al. 1997, Suominen-Taipale 2004). In the Health 2011 study in Finland, the proportion of people aged 75 years or older with periodontitis was 85% among dentate females and 70% among dentate males (Koskinen et al. 2012). Periodontal diseases are also common and serious problems among institutionalized older people (Table1) (Frenkel et al. 2000, Marchini et al. 2006, Unluer et al. 2007, Hopcraft et al. 2012b). Periodontal pathogens have been linked to several systemic diseases. Recent studies have shown that oral infections are linked, for instance, to cardiovascular morbidity (Janket et al. 2003, Scannapieco et al. 2003, Mantyla et al. 2013), hypertension (Desvarieux et al. 2010), metabolic syndrome (Hyvarinen et al. 2014) and aspiration pneumonia (Paju & Scannapieco 2007). It has also been suggested that the control of plaque and oral infections could reduce the risk of deaths from aspiration pneumonia (Awano et al. 2008, El-Solh 2011). On the other hand, the presence of oral inflammation may also increase the

risk of disability by contributing to a loss of muscle strength (Hamalainen et al. 2004). Older people were found to be not fully aware of their periodontal status (Siukosaari 2013), and only 30% of the subjects with periodontal disease considered themselves in need of periodontal treatment.

A decline in salivary secretion may lead to various mucosal lesions, which are common among older denture wearers. Early Finnish studies have reported a prevalence of denture stomatitis of 35% to 48% (Mikkonen et al. 1984, Nevalainen et al. 1997). Among the Finnish population in 2000, over a half of the denture wearers had some type of mucosal lesion and 30% had denture stomatitis (Suominen-Taipale 2004). Mucosal lesions were found in 13% and denture stomatitis in 21% of older people in Eastern Finland (Komulainen 2013). In institutionalized older people, the proportion of those reported to have denture stomatitis has ranged from 25% to 40% (Table 1) (Frenkel et al. 2000, Simons et al. 2001, Peltola et al. 2004). Stomatitis is characterized by inflammation and erythema of the oral mucosal areas covered by the denture. Denture stomatitis is most often asymptomatic; only a minority of sufferers experience pain, itching or a burning sensation (Gendreau & Loewy 2011). The current view is that the aetiology of denture stomatitis is multifactorial. Poor denture hygiene, pathogenic *Candida* infection and continual wearing of dentures appear to be the predominant associated aetiological factors for denture stomatitis (Kulak-Ozkan et al. 2002, Gendreau & Loewy 2011). Furthermore, many older people suffer from angular cheilitis and poor-fitting dentures, which exacerbate oral mucosal trauma and irritation (Nevalainen et al. 1997, Simons et al. 2001, Peltola et al. 2004).

2.1.3 Oral symptoms

The term '*dry mouth*' refers to either or both the sensation of a dry mouth (xerostomia) and the situation where the output of saliva is low (Cassolato & Turnbull 2003). Saliva is very important to oral health and quality of life. Dry mouth is associated with oral diseases (caries, gingivitis and mucosal lesions) and oral problems such as difficulties in chewing, swallowing, the use of dentures, tasting or speaking (Nevalainen et al. 1997, Turner & Ship 2007). These consequences may seriously affect the quality of life and result in poor diet, malnutrition and decreased social interaction (Soini et al. 2003, Cassolato & Turnbull 2003, Soini et al. 2004).

Dry mouth is a common problem among older people. The prevalence of dry mouth in representative samples of older population (in Finland, Sweden, the USA, Canada and Australia)

ranged from 12% to 47% (Thomson 2005). In Finland, 45% of community-dwelling older people reported having the feeling of a dry mouth and 36% had decreased saliva secretion based on clinical oral examination (Komulainen 2013). Estimates of the prevalence of dry mouth are not strictly comparable because of different definitions, questions and methods used. Studies on dry mouth are rare in institutional care, but they suggest that it is highly prevalent (Soini et al. 2003, van der Putten et al. 2003).

The elderly usually have multiple medical conditions that predispose to polypharmacy. The use of multiple drugs is often associated with use of drugs having anticholinergic properties, and may therefore produce anticholinergic-associated adverse effects (Tune 2001, Rudolph et al. 2008, Chatterjee et al. 2010, Teramura-Gronblad et al. 2011, Lampela et al. 2013, Uusvaara 2013), placing the elderly at greater risk of dry mouth and its consequences. In the Finnish Helsinki Ageing study, a reduced salivary flow was observed if the number of continuously used drugs was four or more (Narhi et al. 1992). Other causes of dry mouth include radiation therapy for head and neck cancer or certain diseases such as Sjögren's syndrome, diabetes and Alzheimer's disease (Narhi et al. 1992, Cassolato & Turnbull 2003). Saliva helps in swallowing, digestion and taste (Cassolato & Turnbull 2003, Turner & Ship 2007).

The ability to chew depends on factors such as the number of remaining teeth, the quality of prosthetic restorations, masticatory muscle mass and function and the salivary flow rate (Budtz-Jorgensen et al. 2001). Chewing function is associated with food selection, dietary quality (Lee et al. 2010), nutritional status (Feldblum et al. 2007), osteoporosis (Laudisio et al. 2007), functional ability (Avlund et al. 2001) and the quality of life (Inukai et al. 2010). Adequate natural dentition or prosthetic appliances and a sufficient amount of saliva are important in the chewing process (Budtz-Jorgensen et al. 2001). Poor chewing function is compensated for by using a greater number of chewing strokes prior swallowing. This leads to the situation where older people need more time to finish their meals. Saliva binds the food fragments together as a coherent bolus that can be safely swallowed. Dry mouth reduces chewing comfort, as the food will tend to stick to the mucosa rather than together (Budtz-Jorgensen et al. 2001).

The majority of Finnish older people have experienced partial or total loss of teeth (Koskinen et al. 2012). A greater number of chewing problems have been found in older people who are edentulous or have fewer than 20 teeth (Budtz-Jorgensen et al. 2001, Suominen-Taipale 2004). In hospitalized older people, poor chewing capacity determined by a specialist dentist was found in over half of the

patients (Peltola & Vehkalahti 2005). In nursing homes, about a quarter of the residents had chewing problems (Soini et al. 2006).

Normal swallowing is the efficient and safe movement of a bolus from the mouth to the stomach without aspiration (Easterling & Robbins 2008). Dysphagia is a condition in which there are difficulties or discomfort in swallowing (Rofes et al. 2011). The prevalence of dysphagia among institutionalized older people is very high, and is estimated to be up to 60% (Easterling & Robbins 2008, Rofes et al. 2011). Degenerative disorders, such as stroke, Parkinson's disease, Alzheimer's disease and other forms of dementia are associated with dysphagia (Rofes et al. 2011). The consequences of dysphagia for older people may be dehydration, malnutrition, weight loss, aspiration pneumonia and a poor quality of life (Hudson et al. 2000, Dion et al. 2007, Leow et al. 2010, Poisson et al. 2014). Decreased masticatory ability and low salivary flow are related to dysphagia (Poisson et al. 2014).

2.2 Oral health behaviour among older people

2.2.1 Use of dental care services in community-dwelling older people

Appropriate dental care services are an important part of maintaining good oral health. There is evidence that discrepancies exist between oral treatment needs and use of dental services among older people (Ettinger et al. 1988, Gilbert et al. 2003). Older people use dental services at a lower rate than younger age groups (Dolan & Atchison 1993, Koskinen et al. 2012). Consultation rates for dentate older people have reported to be significantly higher than for edentulous older adults (Macek et al. 2004, Brothwell et al. 2008, Arcury et al. 2012). Older adults with low cognitive function are at risk of less frequent use of dental care services (Wu et al. 2007).

One commonly used indicator of the utilization of dental services is whether individuals in a population have had at least one visit to dental care within the past 12 months. In 1999, 71% of dentate US adults aged 65 years and older reported a dental visit in the previous year (Macek et al. 2004). The respective figure among edentulous adults was 18%. In a multiethnic sample of rural US adults aged 60 years or older between years 2006–2007, 37% of dentate subjects and 10% of edentulous subjects reported that they had visited a dentist in the previous year (Arcury et al. 2012). In general, those participants not receiving care were those who most needed care. This phenomenon has been referred to as the “paradox of dental need” (Gilbert et al. 2003). In Finland,

the proportion of older adults who have used dental care services within the previous 12 months have increased in the last decade. In 2011, 49% of individuals aged 75 years or over reported a dental care visit in the previous year (Koskinen et al. 2012). The respective figure in 2000 was 32% (Suominen-Taipale 2004). Edentulous older adults visited a dentist within the previous 12 months less often than dentate subjects (Suominen-Taipale 2004, Koskinen et al. 2012).

Several factors may influence the use of dental services among older adults (Holm-Pedersen et al. 2005). The number of natural teeth has been reported to be a major determinant of dental attendance (Suominen-Taipale et al. 2001, Holm-Pedersen et al. 2005). The barriers to dental care include the cost of dental care, low income, a low level of education, a lack of the perceived need for care, functional limitations, cognitive decline, transportation problems and fear (Dolan & Atchison 1993, Strayer 1995, Avlund et al. 2001, Avlund et al. 2004, Holm-Pedersen et al. 2005, Kiyak & Reichmuth 2005, Arcury et al. 2012, Niesten et al. 2013).

2.2.2 Treatment needs and use of dental care services in institutionalized older people

While the rate of edentulism has decreased in the older population, the needs for dental treatment are high among institutionalized older people (Table 1) (Peltola et al. 2004, Montal et al. 2006, Unluer et al. 2007, Gluhak et al. 2010). For example, Gerritsen and colleagues (2011) found that the majority of residents (72%) of Dutch nursing homes had dental treatment needs (Gerritsen et al. 2011). Professional cleaning, oral hygiene instructions and tooth or root extractions have been reported to be the main needs (Ferro et al. 2008). The use of dental care services among institutionalized older people has received less attention, but the regular use of the dental care services appears to be rare, despite the extensive dental care needs (Table 1) (Frenkel et al. 2000, Catovic et al. 2003, Marchini et al. 2006, Hopcraft et al. 2012b). In the United Kingdom, among nursing home residents, only 13% had visited a dentist within the previous 12 months, while 70% had not seen dentist in over five years (Frenkel et al. 2000). Similar results have been reported in Croatia (Catovic et al. 2003). One in five nursing home residents had visited a dentist within the previous five years and 39% not seen a dentist in at least 10 years. In Turkey, institutionalized older people reported visiting a dentist only when they had a complaint (Unluer et al. 2007). Of the dentate nursing home residents in Australia, 14% had a dental visit in the previous year, but information on the last dental visit was obtained from only 20% of residents (Hopcraft et al. 2012b).

2.2.3 Tooth brushing and oral hygiene among community-dwelling older people

Good oral hygiene is essential to prevent oral diseases such as caries, periodontal disease and mucosal lesions. The recommendation of tooth brushing twice a day with fluoride toothpaste is widely accepted, but weakly realized. With increasing age, effective tooth brushing may become more difficult to perform due to cognitive and functional decline, reduced vision, and a decline in the sense of touch and manual dexterity (Morishita et al. 2001, Marchini et al. 2006).

Table 2 provides an overview of the findings from studies exploring tooth brushing/denture cleaning and oral hygiene among older people. In the Danish adult population, 68% of the dentate brushed their teeth at least twice a day and 32% once a day or less frequently. Especially in oldest age group (65 years or older), only half of the individuals brushed their teeth twice a day (Christensen et al. 2003). In Lithuania, 26% of dentate public dental office patients aged 65 years and older reported tooth brushing at least twice a day and 38% less than once a day (Vysniauskaitė & Vehkalahti 2009). Women, as well as younger and more highly educated respondents reported twice daily tooth brushing more frequently than their counterparts. Twice daily tooth brushing was associated with better oral hygiene and periodontal health in the elderly subjects. In the Scottish Health Survey, 71% reported tooth brushing twice a day or more often, indicating good oral hygiene, and 24% reported once a day tooth brushing among adult population (35 years or older) (de Oliveira et al. 2010). Participants who brushed their teeth less often than twice a day were older, more likely to be men, had a lower social status and a high prevalence of risk factors (smoking, physical inactivity, obesity, hypertension and diabetes).

According to findings from the Health 2000 survey in Finland, twice a day tooth brushing appeared to be less common than in Denmark and in Scotland, since 61% of dentate adults brushed their teeth at least twice daily as recommended, and 8% brushed their teeth less than once daily (Suominen-Taipale 2004). Among older individuals, tooth-brushing activity has improved in Finland over the past decade (Koskinen et al. 2012). In 2000, 38% of male and 59% of female subjects aged 75 years or older reported tooth brushing at least twice a day. The respective figures 11 year later were 46% and 68%. In 2014, a Finnish study found that the tooth brushing frequency had further improved among males, since 49% of them reported twice a day tooth brushing (Kaikkonen et al. 2014). Those with a low level of education less often reported tooth brushing at least twice a day.

The frequency of tooth brushing or denture cleaning does not necessarily indicate efficient cleaning (Kulak-Ozkan et al. 2002, de Castellucci Barbosa et al. 2008). Effective plaque removal requires a

degree of manual dexterity and visual acuity that is often reduced among elderly individuals. In Finland, the state of oral hygiene was poor among people aged 65 years or older in 2000 (Table 2) (Suominen-Taipale 2004). Clinical oral examination of these individuals revealed a high level of dental plaque in 14% of females and 30% of males. On the other hand, about 40% of females and 22% of males had clean teeth. Clean dentures were observed only in 43% of all denture wearers. The cleanliness of the teeth and dentures was associated with the frequency of tooth brushing and cleaning of dentures (Suominen-Taipale 2004). In Eastern Finland, recent studies have shown that oral and denture hygiene is still poor among community-dwelling older people (Syrjala et al. 2012, Komulainen 2013). Syrjälä et al. (2012) explored oral hygiene in a sample of demented and non-demented older people. Almost half of the subjects had poor oral and denture hygiene. Patients with Alzheimer's disease and those with other types of dementia had an increased likelihood of carious teeth, teeth with deep periodontal pockets, and poor oral and denture hygiene compared with non-demented persons (Syrjala et al. 2012). Komulainen (2013) found that 33% of community-dwelling old people had poor oral hygiene and 46% poor denture hygiene. In addition, impaired functional ability was associated with poor oral hygiene and infrequent tooth brushing (Komulainen 2013). Similarly, the frequency of tooth brushing was lower in the subjects with low ADL than those with a better functional ability among dependent home care patients in Japan (Morishita et al. 2001).

Table 2. Overview of findings of studies exploring tooth brushing/denture cleaning frequencies and oral hygiene among older people

Study	Participants	Methods	Findings	Context, comments
Cross-sectional population based studies				
Nevalainen et al. 1997	N = 338; 76-, 81-, and 86 y-olds	Clinical oral examination. Self-report of denture hygiene methods and frequency of denture cleaning. Interview	96% with complete dentures and 98% with removable dentures + some natural teeth reported cleaning their dentures ≥ 1 / day. 38% had mucosal lesions, which were associated with cleaning of oral mucosa.	Helsinki Aging Study in Finland Oral hygiene self-reported.
Christensen et al. 2003	N = 5802; aged 16+ y; 12% 65+ y; 51% females	Interview	Among 65+, tooth brushing ≥ 2 /day was less frequent (54%) than among younger individuals. Among 65+ denture wearers, 36% cleaned their dentures twice a day, 48% once a day and 16% less than once a day.	Danish population-based study.
Suominen-Taipale et al. 2004	N = 1460; 65+ y; 68% females	Clinical oral examination Interview	38% of male and 59% of female subjects tooth brushing ≥ 2 /day. 40% of females and 22% of males had clean teeth. High level of dental plaque in 14% of females and 30% of males. Clean dentures 43% of all denture wearers.	The Health 2000 Survey in Finland; population-based study.
Syrjälä et al. 2012	76 demented and 278 without dementia. Mean age 82 y; 71% females	Clinical oral examination. Interview	67% of demented patients had poor oral hygiene compared with 37% among non-demented patients. Respective figures for poor denture hygiene were 63% and 42%.	Random sample of older population in Kuopio, Finland
Cross-sectional studies among institutionalized older people				
Frenkel et al. 2000	Nursing homes N = 412; Mean age 84 y; 78% females	Clinical oral examination Interview	82% unable to clean their dentures; staff cleaned dentures for 64%. Unhygienic dentures in 95% of subjects. Of dentate subjects, 75% were unable to clean their teeth, yet none received regular assistance. Plaque levels high, calculus and root caries common.	22 randomly selected nursing homes in Bristol, U.K.
Simons et al. 2001	Residential homes N = 164 dentate residents; Mean age 81 y; 82% females	Clinical oral examination. Saliva examination (yeasts, mutans streptococci and lactobacilli). Interview	31% able to clean their teeth twice a day without requesting help. They had significantly fewer yeasts, root caries, restoration on the root, lower Plaque Index, Gingival Index, active root caries and better denture hygiene status.	Residential homes in West Hertfordshire, U.K.
Catović et al. 2002	Nursing homes N=175. Mean age 77 y; 62% females	Clinical oral examination	Half of the female and 40% of male subjects had plaque index Class III (poor hygiene). Low ADL was associated with poor oral hygiene	Six nursing homes in Croatia
Peltola et al. 2004	Long-term hospital N = 260; mean age 83 y, 75% females	Clinical oral examination by special dentist	58% were dentate. Denture hygiene was good in 19%, moderate 44% and poor 37%, and for worse men than for women. Dental hygiene was poor in all dentition regions.	All patients in Laakso long-term care hospital, Helsinki, Finland. Denture hygiene was not associated with denture stomatitis.
Montal et al. 2006	Geriatric hospital N = 321; mean age 83, 72% females	Clinical oral examination. Questionnaire	Dental hygiene satisfactory in 40%, self-dependent patients had better oral hygiene and less calculus than those needing help. Denture hygiene satisfactory in 42% of cases.	2 hospitals in Montpellier, France
De Visshere et al. 2006	Nursing homes, N = 359, mean age 85 y, 78% females	Clinical oral examination. Questionnaire for health care workers.	Oral hygiene was poor: the mean dental plaque score was 2.17 and the mean denture plaque score was 2.13 The degree of dependency and management of the institution were associated with dental plaques.	19 nursing homes in Ghent, Belgium
Continues				

Study	Participants	Methods	Findings	Context, comments
Sweeney et al. 2007	Nursing + residential homes; N = 288; 37% 85 y+; 72% females	Clinical oral examination by qualified dental surgeon. Staff interviews.	Most staff members had received no formal training in mouth care. Mouth care was poorly documented. 79% dentate patients required oral hygiene treatment.	Care homes in Glasgow, Scotland.
Unluer et al. 2007	Residential home N = 193; Mean age 75 y (males), 79 y (females), 51% fem.	Interview Clinical oral examination	Oral self-care was poor, with 85% not having a toothbrush (85%) and inadequate oral-hygiene habits. Almost one-third of the residents who had a toothbrush brushed their teeth only occasionally. Of residents, 65% had calculus, indicating poor oral hygiene.	Low educated residents in one residential home in Ankara, Turkey
Gluhak et al. 2010	Nursing home N = 409, mean age 85 y; 82% female	Clinical oral examination: oral and prosthetic hygiene (mOHI, 0-4).	Oral hygiene was poor: mOHI for men was 2.3 and women 2.5. 64% of subjects carried out oral hygiene measures themselves, 29% by nurses and 7.5% by the patient and nurse together	Nine nursing homes in Styria, Austria
Hopcraft et al. 2012	Nursing home N = 274 dentate residents. 77% 75 y or older, 65% females	Clinical oral examination: Visual Plaque Index, modified Community Periodontal Index Questionnaire (tooth brushing habits).	34% brushed their teeth ≥ 2 day and 48% once/day. Nearly half of the residents who did not require assistance cleaned their teeth twice daily, while only 9% of those requiring assistance were having their teeth cleaned twice daily. Poor oral hygiene.	Dentate residents in 31 nursing homes in Victoria, Australia. Oral hygiene was strongly associated with the prevalence of periodontal disease.
Prospective follow-up and intervention studies				
Adachi et al. 2002	Nursing homes N = 141 residents needing daily care Mean age 84 y 74% females	Intervention group (N = 77): professional oral health care (POHC) given by dental hygienists weekly for 2 years. Controls (N = 64): normal care.	Occurrence of fevers of 37.8 °C in the POHC group was found to be significantly lower than in the non-POHC group. Prevalence of fatal aspiration pneumonia was significantly lower in POCH group than in the non-POCH group. Numbers of <i>C. albicans</i> in the samples after POHC were significantly less than those of without POHC.	Two nursing homes in Tokyo, Japan. Only 30 elderly in the POHC group and 33 without POHC were followed throughout the 24 months of study.
Abe et al. 2006	Nursing homes, N = 145, Mean age 83y	Clinical oral examination: plaque, saliva, number of febrile days over a period of one year.	Dentate patients with poor oral hygiene had higher salivary bacterial counts, higher numbers of febrile days, and more episodes of pneumonia than those with a good score for dental hygiene.	Japanese nursing homes.
Peltola et al. 2007	Long-term hospital N = 205; Mean age 83 y; 76% females	Group A: dental hygienist provided oral hygiene measures once/3wks. Group B: nursing staff were trained in daily oral hygiene of patients. Group C = controls	The proportion of subjects with poor dental hygiene decreased from 80% to 48% in group B. The best outcome in both denture and dental hygiene occurred when nursing staff on the wards maintained oral hygiene (group B).	Laakso long-term care wards (10) were randomly divided into three groups. 11 months follow-up. 75 died during follow-up.
Komulainen 2013	N = 321 Mean age 83 y; 71% females	Clinical oral examination Interview Intervention group (n = 165): individually tailored personal guidance, 2 y follow-up	69% tooth brushing ≥ 2 /day, 70% denture cleaning ≥ 2 /day. Good oral hygiene in 33%, good denture hygiene in 54%. Impaired functional ability was associated with poor oral hygiene and infrequent tooth brushing. Improvements in oral health were found in both groups, but the effect of the intervention was not significant.	Geriatric Multidisciplinary Strategy for the Good Care of the Elderly (GeMS) study. Random sample of persons 75+ y. Randomizes into intervention group and control group.
Zenthofer et al 2013	Long-term care home N = 102; Mean age 81 y; 78% females	Group 1: professional cleaning teeth/dentures + instructions, group 2: re-motivation by dentist, group 3: staff education, group 4: controls: normal oral hygiene practices. Single-blind. Intervention 12 wks.	Compared with controls, denture hygiene, plaque and gingival bleeding indices were significantly lower in the intervention groups over the 12-week study period. Estimates of effects between controls and each intervention group were comparable among the three therapy groups, even though two of the groups received further help and instructions. 3-year follow-up showed that all indices were significantly worse than at the last study recall.	Southwest long-term care homes in Germany. Oral examinations 2, 6 and 12 weeks + 3-year follow-up. Small sample with non-demented subjects needing only moderate care.

2.2.4 Oral hygiene in institutionalized older people

The evidence suggests that poor oral hygiene among institutionalized older people is a major problem, but good oral care has significant benefits for oral health, overall general health and the quality of life of frail elderly individuals (Coleman 2002, Pino et al. 2003). Residents in long-term facilities often depend on nursing personnel in carrying out daily oral hygiene activities (Frenkel et al. 2000, Simons et al. 2001). Tooth brushing and denture cleaning frequencies have received little attention among institutionalized older people (Table 2). In institutional care, only 31–44% of dentate residents reported tooth brushing twice a day (Simons et al. 2001, Hopcraft et al. 2012b). On the other hand, about 60% of caregivers have reported once-a-day brushing of teeth and cleaning of dentures performed for the institutionalized older people (Cornejo-Ovalle et al. 2013).

The level of oral and denture hygiene of institutionalized older people is frequently described as inadequate (Table 2). These studies based on clinical oral examinations have measured the level of hygiene using various plaque and gingival indices, the presence of calculus or food debris and saliva samples. Oral hygiene has been shown to be better among those with dentures than those with any natural teeth left (Henriksen et al. 2004). Many older people in long-term care have a reduced ability to maintain their hygiene and need help with oral hygiene activities (Frenkel et al. 2000, Simons et al. 2001, Montal et al. 2006). However, regular assistance from nursing staff is not always available (Frenkel et al. 2000). The level of oral and denture hygiene were poorer in these dependent subjects needing assistance (Simons et al. 2001, Catovic et al. 2003, De Visschere et al. 2006, Montal et al. 2006, Zuluaga et al. 2012). Uncooperative residents had the worst oral hygiene and had more caries (Zuluaga et al. 2012). Dependency was also associated with the prevalence of oral diseases, which are preventable with adequate oral hygiene, such as calculus (Montal et al. 2006), periodontal disease (Hopcraft et al. 2012b), root caries and stomatitis (Simons et al. 2001). In addition, dependency was associated with the poor condition of dentures (Catovic et al. 2003) and a high number of yeasts and lactobacilli in saliva (Simons et al. 2001).

2.2.5 Associations of poor oral hygiene with negative health outcomes

Poor oral hygiene has been found to be associated with negative health outcomes such as an increased risk of cardiovascular disease and inflammation. In the nationally representative Scottish Health Survey (n =11869), participants who reported poor oral hygiene (never/rarely brushed their teeth) had

a 70% higher risk of a cardiovascular disease event and increased concentrations of both C-Reactive Protein (CRP) and fibrinogen compared with patients who brushed their teeth twice a day (de Oliveira et al. 2010).

Recent reviews have suggested an association between poor oral hygiene and pneumonia (Azarpazhooh & Leake 2006, Pace & McCullough 2010). Especially among institutionalized older people, poor oral hygiene is associated with negative health outcomes such as febrile days and pneumonia (Abe et al. 2006, Pace & McCullough 2010). Among Japanese nursing home residents (n = 145), dentate patients with poor oral hygiene (based on the Dental Plaque Index) had higher numbers of febrile days and more episodes of pneumonia than those with a good oral hygiene (Abe et al. 2006).

Sjögren and colleagues conducted a systematic review of the preventive effect of oral hygiene on pneumonia in older people in hospitals and nursing homes (Sjogren et al. 2008). They concluded that approximately one in 10 cases of death from pneumonia in nursing home residents may be prevented by improving oral hygiene. In Japanese nursing home residents, enhanced professional oral hygiene care given by a dental hygienist weekly for two years prevented respiratory infections and death from pneumonia (Adachi et al. 2002). However, in a Finnish long-term hospital, the best outcome for oral cleanliness (dental and denture hygiene) occurred when nursing staff on the wards maintained oral hygiene as a part of the routine daily care procedures after training and hand-on instructions from dental care staff (Peltola et al. 2007).

2.2.6 Barriers to maintaining adequate oral hygiene

It has been suggested that there are many barriers to performing adequate oral hygiene activities among dependent individuals in institutional care (Willumsen et al. 2012). The attitudes of nursing staff towards oral care, the workload and lack of time may lead to a low priority of oral health care in nursing (Chalmers et al. 1996, Wardh et al. 2000, Gil-Montoya et al. 2006, Miegel & Wachtel 2009, Cornejo-Ovalle et al. 2013, Willumsen et al. 2012), and tooth brushing is considered to be a troublesome activity in nursing home care (Dharamsi et al. 2009, Wardh et al. 2012). A Swedish study found that the majority (87%) of the nursing staff considered oral hygiene tasks unpleasant (Forsell et al. 2011). A Norwegian study reported similar findings (Willumsen et al. 2012). Although many nurses agreed that mouth care is within their daily remit, they did not carry out mouth care daily, and routine documentation of mouth care was rare (Sweeney et al. 2007). Resident factors such as the self-determination, care-resistant behaviour and uncooperativeness were also reported as barriers to

managing oral health care in long-term care facilities (Chalmers et al. 1996, Forsell et al. 2011, Jablonski et al. 2011, De Visschere et al. 2013).

Inadequate education and training on how to provide oral hygiene activities among nursing staff has also been reported as a barrier to maintaining oral hygiene in residents (Chung et al. 2000, Vanobbergen & De Visschere 2005, Miegel & Wachtel 2009, Cornejo-Ovalle et al. 2013). A positive association was found between nurses' personal oral hygiene habits and their commitment to maintaining good oral hygiene for their patients (Ashkenazi et al. 2013). The theoretical knowledge of oral diseases has to be improved in order for nursing staff to understand oral procedures, and to help them identify early oral problems and understand the impact of oral health on general health (Catteau et al. 2013). Oral health care education offered to nursing personnel has resulted in a better perceived ability, opportunity and knowledge of oral health (Paulsson et al. 2001). Education has also led to improvements in oral hygiene and the oral health status of residents (Isaksson et al. 2000, Peltola et al. 2007, Sloane et al. 2013), but the opposite results have also been obtained (Simons et al. 2000). The positive results, however, often seemed to be short term (Zenthofer et al. 2013).

2.3 Nutrition in older people

Good nutrition is a key factor in healthy ageing. Good nutrition is a state of equilibrium in which the nutrient intake and requirements are in balance. Malnutrition occurs when the nutrient intake is less than the requirements (Jeejeebhoy 2000). Nutritional problems have been shown to increase with ageing (Brownie 2006), but they are not inevitable consequences of ageing (Guigoz 2006). Many factors are associated with an impaired nutritional status in older age. Malnutrition can occur because of decreased intake, malabsorption or increased metabolism (Morley 1998). Decreased mobility, diseases, medications and decreased smell and taste may lead to a loss of appetite and inadequate eating (Morley 2012). Depression, dementia, decreased vision, and chronic pain are highly prevalent among older people and are risk factors for malnutrition (Morley 2012, Muurinen et al. 2014). Social factors such as isolation, poverty, loss of the spouse and alcoholism may also reduce food intake (Inzitari et al. 2011). Functional impairment, dependency and the need for assistance increase the risk of malnutrition in older age (Dion et al. 2007). If the independency of eating decreases, the amount of food eaten and energy intake tend to decrease (Suominen et al. 2005). Poor oral health, chewing problems, swallowing difficulties (Suominen et al. 2005, Vanderwee et al. 2010) and dry mouth are common problems among older people and may make it difficult to eat (Soini et al. 2006).

The need for energy decreases with age due to decreased mobility, but the need for nutrients, such as protein, may increase (Bauer et al. 2013). To maintain physical functioning, older people need more dietary protein than younger people (Gaffney-Stomberg et al. 2009, Wolfe 2012). A low energy and protein intake lead to weight loss and malnutrition. A low intake of protein may lead to the loss of muscle mass and strength (sarcopenia) (Morley et al. 2010, Cruz-Jentoft et al. 2010) and reduced bone mass (osteoporosis) (Genaro Pde & Martini 2010, Houston et al. 2008). These conditions may result in functional impairments and disability (Janssen et al. 2002, Covinsky et al. 1999), an increased incidence of falls and fractures (Rolland et al. 2008), decreased immune function (Lesourd 2006), poor wound healing and ultimately increased morbidity, mortality (Morley & Silver 1995, Covinsky et al. 1999, Landi et al. 2013) and longer hospital stays (Van Nes et al. 2001), and higher health-care costs (Janssen et al. 2004, Freijer et al. 2013). According to new Finnish national nutrition recommendations, the average daily intake of protein should be at least 1.2 to 1.4 g/kg BW/d in people aged 65 years or older (Valtion ravitsemusneuvottelukunta 2014). There is also evidence that the use of high protein oral nutritional supplements (>20% energy from protein) produce clinical, nutritional and functional benefits with economic implications (Cawood et al. 2012).

Assessment of nutritional status

Many screening tools have been developed and used to assess nutritional status. Subjective Global Assessment (SGA) (Detsky et al. 1987), the Nutrition Screening Initiative (NSI) (Posner et al. 1993) and the Mini Nutritional Assessment (MNA) (Vellas et al. 1997) are comprehensive assessment methods. The MNA was specifically developed for determining the risk of malnutrition in older populations and for identifying those who may benefit from early intervention (Guigoz et al. 2002). The key benefit of the MNA is reported to be its detection of the risk of malnutrition at an early stage, before changes in albumin levels or weight occur (Guigoz 2006). The MNA has largely been used for screening the nutritional status among older people in different settings (Guigoz 2006, Bauer et al. 2008, Kaiser et al. 2010). These review studies have demonstrated considerable differences between settings. The mean prevalence of malnutrition was reported to be 2–6% in community-dwelling and 20–39% among hospitalized older people. In institutional care, the range was from 5% to 70%, reflecting the heterogeneity of residents (Bauer et al. 2008). The major underlying factor for malnutrition is the level of dependency, not necessarily age.

A similar trend can be seen in Finnish and Swedish nutritional studies among older people (Saletti et al. 2000, Soini et al. 2011). In Finland, the malnourished group and the at-risk group were even larger than in previous studies. Figure 1 illustrates the nutritional status of resident in different settings in the

Metropolitan Area of Helsinki. In long-term care facilities, over half of the residents (56%) were malnourished. The respective figures in nursing homes, assisted living facilities and among community-dwelling older people were 28%, 13% and 8%, respectively. In the combined data set, the prevalence of malnutrition was 28% (Soini et al. 2011). In Swedish studies, 21–30% of residents in assisted living facilities were assessed as malnourished and 49–59% were at risk of malnutrition (Saletti et al. 2000, Odlund Olin et al. 2005). Nutritional problems are often poorly recognized and left untreated (McWhirter & Pennington 1994, Mowe et al. 2008, Suominen et al. 2009).

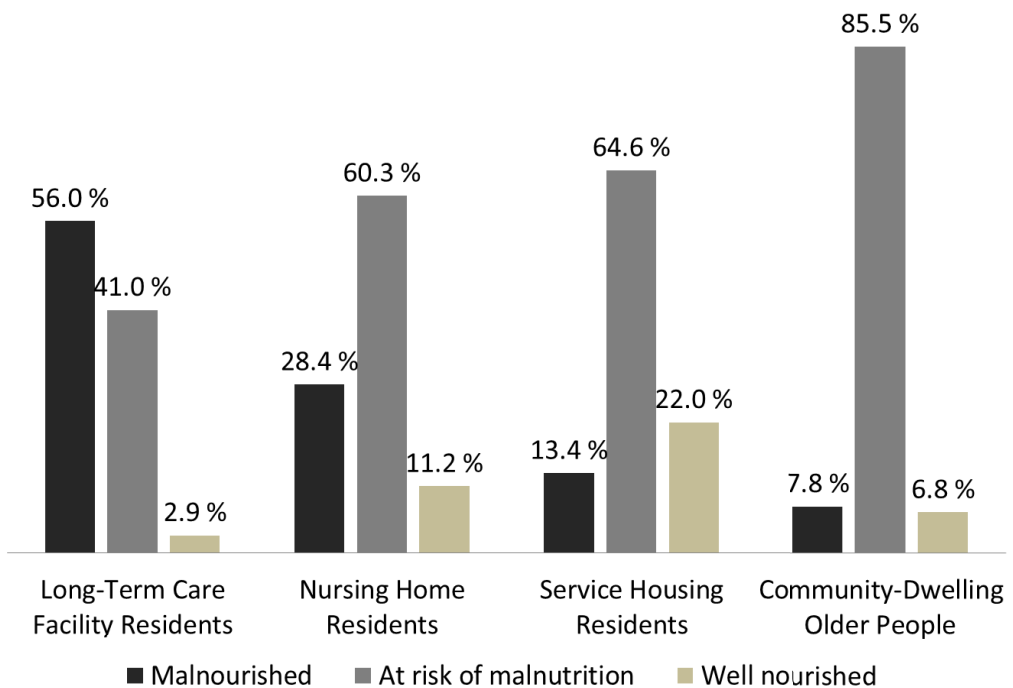


Figure 1. Comparison of nutritional status according to the MNA in various populations in the Metropolitan Area of Helsinki. Long-term care residents in 2003 in all long-term care wards (n=1087); nursing homes in 2003 (n = 1987); residents in assisted living facilities 2007 (n=1475); community-dwelling older people from the DEBATE study in 2000 (n = 400) (Soini et al. 2011).

Some biochemical markers such as serum albumin have also been used as indicators of poor nutritional status (Jeejeebhoy 2000). However, serum albumin declines only in advanced malnutrition, and is thus insensitive to old-age malnutrition. The body mass index (BMI) and involuntary weight loss have also been used to measure nutrition. Regular weight monitoring is a simple way to follow up

weight changes and the nutritional status. Regular weight monitoring of residents once a month is recommended in institutional care (Suominen & Valtion ravitsemusneuvottelukunta 2010). Furthermore, nutrient intake information has been used to measure eating habits and the adequacy of the diet (de Groot et al. 1999).

2.4 Oral health and nutrition

The relationship between nutrition and oral health is multidirectional. Nutritional factors play a role in the development and prevention of oral diseases and tooth loss. On the other hand, the state of oral health affects the ability to maintain an adequate nutritional status (Saunders et al. 2007). The digestion process starts in the oral cavity with the chewing and swallowing of food. Good masticatory function and oral comfort are a prerequisite for adequate nutrition (Budtz-Jorgensen et al. 2001). A wide variety of measurements and definitions has been used to assess the oral health status. The number of natural teeth, number of functional units, edentulism, denture use, masticatory function, self-assessed chewing ability, and the number of oral health problems such as chewing problems, swallowing difficulties and dry mouth are some of these measures used in studies.

2.4.1 Chewing ability and eating difficulties

Edentulous people have difficulties in chewing hard or tough food, even when wearing dentures (Hutton et al. 2002, Tsakos et al. 2010). Tooth loss reduces masticatory function and may lead to detrimental changes in the diet (Joshipura et al. 1996, Hung et al. 2003). Masticatory function has shown to be poorest in subjects wearing complete dentures (Krall et al. 1998, Veyrone et al. 2007, Mishellany-Dutour et al. 2008). Complete denture wearers have also reported a poor self-assessed chewing ability and difficulties in eating foods that are hard to chew (Greksa et al. 1995, Budtz-Jorgensen et al. 2000), such as meat, nuts, fruits (Anastassiadou & Heath 2002), carrots and tossed salads (Nowjack-Raymer & Sheiham 2003). Poor-fitting dentures may negatively affect the nutritional status and nutrient intake (Dormenval et al. 1999, Marshall et al. 2002). Shinkai and coworkers (2001) did not find relationships between the dentition status and chewing-related factors and diet quality (Shinkai et al. 2001).

The number of teeth has been used as one measure of masticatory function, but it may give an overestimation of the masticatory potential, because it does not take into account the functional

arrangement of the teeth. Hildebrandt et al. (1997) suggested the number of functional units as a more accurate measure of masticatory potential than merely the number of teeth in the dentition. They found that subjects with reduced numbers of functional units tended to report difficulty in chewing, swallowing and avoidance of foods that were difficult to chew (Hildebrandt et al. 1997). Those with 0–10 teeth had unhealthier diets and consumed less fruit, meat and beans and oils, and more energy from solid fat, alcohol and added sugar, compared with those with 11+ teeth (Savoca et al. 2010a).

Eating difficulties may lead to changes in dietary habits and avoidance of foods, which may lead to a lower quality of the diet (Ekelund 1991, Marcenés et al. 2003, Daly et al. 2003, Quandt et al. 2010, Savoca et al. 2010b), malnutrition and a decline in the general health status (Walls et al. 2000). An early Finnish study by Ekelund (1989) found that 41% of residents in nursing homes were unable to eat some food they liked to eat, e.g. crisp bread, because of their teeth.

Some older people process their food to make it easier to chew when mastication is limited (Quandt et al. 2010, Savoca et al. 2010b, Anastassiadou & Heath 2002). Those modifying more foods had healthier diets than those who modified less foods (Savoca et al. 2010b). There is also risk of ‘over preparation’ of fresh foods (e.g. removal of the skin from fruits and vegetables) or overcooking of vegetables. This kind of food preparation may negatively affect the intake of key nutrients such as dietary fibre and vitamins C and E (Walls & Steele 2004). However, perceived chewing ability has been shown to have a lower impact on fruit and vegetable intake than psychosocial factors such as attitude, self-identity and knowledge of the recommended intake (Bradbury et al. 2008).

2.4.2 Oral health and nutrient intake

Table 3 provides an overview of studies exploring oral health and diet quality, food and nutrient intakes. A wide range of indicators have been used to measure oral health such as the number of teeth, number of posterior occluding pairs, edentulousness and denture use. Nutrient intake data were based on dietary recalls (24-hour /4-day). A food frequency questionnaire has been used to explore intake of various foods. Large studies among community-dwelling people using nutrient intake measures based on dietary 24-hour recalls have found associations with compromised dentition status and lower intakes of specified nutrients (Appollonio et al. 1997, Marshall et al. 2002, Sahyoun et al. 2003, de Andrade et al. 2009, Ervin & Dye 2009, Cousson et al. 2012, Ervin & Dye 2012). In France, it was found that full denture wearers had lower intakes of fibre, magnesium, phosphorus, calcium, iron folate and thiamin, riboflavin and pantothenic acid than fully dentate individuals based on a three-day

dietary record (Cousson et al. 2012). Joshipura et al. (1996) observed that edentulous subjects consumed less fibre and carotene, and more cholesterol, saturated fat and calories than participants with 25 or more teeth (Joshipura et al. 1996). In a longitudinal analysis, they found that tooth loss was associated with detrimental changes in the diet. Furthermore, edentulous subjects had lower intakes of protein, intrinsic and milk sugars, calcium, non-heme iron, thiamine, riboflavin, niacin, pantothenic acid, and vitamins C and E than dentate subjects (Sheiham & Steele 2001). It has been shown that those with fewer natural teeth left were less likely to have adequate nutrient intakes and receive recommended amounts of nutrients (Marshall et al. 2002). On the contrary, Ervin et al. (2009) stated that having a functional dentition did not contribute substantially to better overall quality of the diet or a higher nutrient intake (Ervin & Dye 2009). Prosthodontic replacement of missing teeth could improve the diets of older adults (Krall et al. 1998), but opposite results have also been obtained (Hildebrandt et al. 1997, Wostmann et al. 2008).

The intake of protein tends to decline with an impaired dentition status among older people (Sheiham & Steele 2001, Marshall et al. 2002, Osterberg et al. 2002, de Andrade et al. 2009, Marcenes et al. 2003), but contradictory findings have also been reported (Ervin & Dye 2009, Cousson et al. 2012). The differences may be due to the variety of measurements of oral condition.

Studies on the oral health and nutrient intake in institutional older people are scarce. Marcenes and coworkers (2003) found consistently lower mean intakes of most nutrients in institutionalized older people than in community-dwelling older adults in a small sample of British adults aged 65 years or older. There was a little difference between edentate and dentate subjects in general, but plasma ascorbate levels were lower for edentulous than for dentate subjects (Marcenes et al. 2003). Suzuki et al. (2005) suggested that the number of teeth may associate with intakes of energy and some nutrients (Suzuki et al. 2005).

Table 3. An overview of studies exploring oral health and nutrient intakes among community-dwelling older populations

Study	Participants	Methods	Findings	Context, comments
Appollonio et al. 1997	N = 1137 Cohort of 70–75 y 67% females	Clinical oral examination: Functional measure of dental status (FDS): Interview: Nutrient intake (24-h dietary recall)	90% inadequate intake of folates, thiamine, vitamin B6, 10% inadequate protein intake. Association between the dental status and the intake of micronutrients, not macronutrients. Denture wearers had an intake very similar to adequate dentition and better than inadequate dentition.	Cohort of urban older people in Brescia, Italy.
Sheiham & Steele 2001	N = 753 65+ y	Clinical oral examination: number teeth Interview 4-day dietary record Blood test	Edentate subjects had lower intakes of fibre, intrinsic and milk sugars, protein, calcium, riboflavin, niacin, pantothenic acid, vitamin C, non-heme iron, thiamine and vitamin E than dentate subjects. 20% higher value of mean plasma ascorbate level for dentate than for edentate subjects.	Representative sample of people aged 65+ years. Part of nationwide British Diet and Nutrition Survey.
Marshall et al. 2002	N = 220 Mean age 86 y 68% female	Clinical oral examination: number of teeth, dentition status Nutrient intake (3-day dietary records)	Intakes of protein, vitamin C, calcium, phosphorus and zinc were associated with the number of teeth. No association between dentition status and nutrient intakes.	Rural Iowans aged 79 years or older, USA
Sahyoun et al. 2003	N = 5958, Mean age 64 y males, 65 y females 51% female	Clinical oral examination. Nutrient intake (24-hour dietary recall), Healthy Eating Index (HEI), serum values	Those with impaired dentition had more unhealthy diets. They consumed less fruit, had lower serum concentrations of beta carotene and vitamin C than those with ≥ 5 posterior occluding pairs (POP). Those with impaired dentition had lower dietary intake levels of vitamin A, carotene, folic acid and vitamin C than those with ≥ 5 posterior occluding pairs (POP).	Large, representative sample the US adult population.
de Andrade et al. 2009	N = 816; Mean age 71 y, 67% female	Clinical oral examination; Nutrient intake (24-hour dietary recall). Interview	45% edentulous, 79% 0 POP. Intakes of all nutrients (incl. protein), except for vitamin C and dietary fibre were lower in those with 0 POP than those with 1–4 or 5–8 POP	Most subjects with poor dental condition. In Brazil
Ervin et al. 2009	N = 2560 60+ y 50% female	Dentition status: edentulous, 1–20 teeth, ≥ 21 teeth (functional dentition) Nutrient intake (24-hour dietary recall), HEI; BMI	Males with ≥ 21 teeth consumed more fruit and their intakes of α - and β -carotene were higher than in edentulous males. Females with any natural teeth had significantly higher vitamin C intakes than edentulous females. No association between dentate status and protein intake.	US population
Ervin et al. 2012	N = 4462 60+ y 50% female	Clinical oral examination. Interview Nutrient intake (24-hour dietary recall)	Significant associations between dental status and nutrient intakes for calories and vitamin C for men and β -carotene for women in adjusted model. Demographic and behavioural variables explained many of the differences seen in nutrient intakes	Nationally representative sample of the US population
Cousson et al. 2012	N = 97 Mean age 70 y 57% female	Clinical oral examination: edentulous with full dentures/fully dentate 3-day dietary record.	In general, insufficient energy intakes and deficit in vitamins and micronutrients. Edentulous subjects had lower intakes of fibre, magnesium, phosphorus, calcium, iron, folic acid, thiamine, riboflavin and pantothenic acid than dentate subjects: Average protein intakes were comparable in both groups.	Patients in a dental hospital in France. Small samples: 50 dentate and 47 dentures.

2.4.3 Oral health and nutritional status

Table 4 provides an overview of the findings of previous studies concerning oral health and the nutritional status among older people. A Finnish study using the MNA to assess the nutritional status found that those home care patients with chewing and swallowing problems had lower MNA scores than the others (Soini 2004). In a Japanese study among home care patients, no significant association was found between the oral health status and nutritional status according to the MNA (Furuta et al. 2013). However, direct associations between the oral health status and swallowing function, and between swallowing function and the nutritional status were found. This suggested that oral health may indirectly influence the nutritional status. Having even a few natural teeth has found to be protective against the risk of malnutrition (De Marchi et al. 2008).

Oral health and its association with the nutritional status have received little attention in institutionalized older people, but some evidence indicates an independent association between the oral health status and malnutrition in this population (Van Lancker et al. 2012). Edentulousness without dentures or with only one complete denture was associated with lower MNA scores and increased difficulty in eating hard foods, increased mashed food consumption and decreased eating pleasure (Lamy et al. 1999). A similar association between a compromised dentition status and lower MNA score was found by Soini and colleagues (2006). Those subjects who were edentulous without dentures tended to have the worst nutritional status. In the study by Griep et al. (2000) using multivariate analyses, the number of natural teeth was not found to be associated with being malnourished. Dion et al. (2007) found that the probability of malnutrition increased consistently as the chewing capacity decreased.

Similar associations were reported from study by Nordenram and coworkers (2001) between the chewing capacity and protein-energy malnutrition measured by the Nutrition Score (NuSC). The number of oral health problems (such as chewing problems, dry mouth, pain in the mouth and swallowing difficulties) has been shown to be associated with malnutrition measured by involuntary weight loss and the nutritional status (Sullivan et al. 1993, Soini et al. 2006). Caregiver-assessed oral health problems (problems with the voice, lips, mucous membranes, tongue, gums, teeth/dentures, saliva, swallowing) were more common among malnourished compared with well-nourished patients measured by Subjective Global Assessment (SGA) (Andersson et al. 2002). Problems with swallowing had the strongest association with the nutritional status.

Table 4. Overview of findings of studies exploring the oral health and nutritional status of older people

Study	Participants	Methods	Findings	Context, comments
Studies using MNA among community-dwelling older people				
Soini et al. 2003	Home care patients N = 51; mean age 84 y; 78% female	Clinical oral examination Questionnaire: eating problems, Mini Nutritional Assessment (MNA)	67% edentulous; 0% malnourished, 47% at risk of malnutrition and 52% well nourished. Dentist estimation of dry mouth was associated with lower MNA scores. Oral status was not associated with MNA scores.	Small sample of frail home care patients in the municipality of Loppi, Finland.
Soini et al. 2004	Home care patients N = 178; mean age 84 y	Questionnaire: chewing and swallowing problems. MNA	36% chewing and swallowing problems, 3% malnourished, 48% at risk of malnutrition. Those with chewing and swallowing problems had a lower MNA score than the others.	Home-care patients in three rural municipalities in southern Finland.
De Marchi et al. 2008	N = 471, mean age 69 y 59 % female	Clinical oral examination: number of teeth and use of dental prosthesis Questionnaire MNA	44% edentulous, 1% malnourished, 19% at risk of malnutrition. Participants with a worse oral status and dissatisfaction with their gingival health had a higher risk of malnutrition. Having even a few natural teeth (1–8) was protective against the risk of malnutrition.	Random sample of Brazilians.
Cousson et al. 2012	N = 97; 57% females. Mean age 70 y	Oral quality of life: General Oral Health Assessment Index (GOHAI-Add) MNA	The dentate group had a better oral quality of life than denture wearers. More subjects in the edentulous group (21%) at risk of malnutrition than in the dentate group (0%).	Patients in a dental hospital. Small samples: 50 dentate and 47 dentures. In France.
Furuta et al. 2013	Home care patients N = 286. Mean age 85 y; 74% female	Oral health status: number of, wearing dentures, Swallowing function, ADL, Cognitive ability, MNA - short form	40.6% edentulous; 14% malnourished. No association between oral health status and nutritional status. A direct association between swallowing function and oral health status. Nutritional status related to swallowing function. Oral health status may influence nutritional status and ADL.	Home care patients in two mid-sized municipalities in Japan.
Studies using MNA among institutionalized older people				
Griep et al. 2000	Retirement homes N = 81, mean age 83 y, 80% female	Clinical oral examination: number of teeth and type of dentures MNA	2% malnourished, 37% at risk of malnutrition. Association between MNA score and the number of natural teeth. In a multivariate model, the number of natural teeth and the MNA score were not associated.	Participants with mental deterioration and dementia were excluded. Belgium
Soini et al. 2006	Nursing homes, N = 2036, mean age 83 y, 81% fem. Long-term care facilities, N = 1052, mean age 81 y, 75% female	Nurses' assessment of oral status MNA	Chewing problems 24% (NH)–34% (LT), swallowing difficulties 14% (NH)–30% (LT), xerostomia 11% (NH)–15% (LT). NH: 29% malnourished, 60% at risk of malnutrition, LT: 57% malnourished, 40% at risk for malnutrition. Association between nutritional status and the number of oral health problems and dentition status.	All residents in all nursing homes (NH) and long-term care wards (LT) in Helsinki, Finland.
Dion et al 2007	Nursing homes, N = 1094, mean age 80 y, 74% females	Oral examination: Masticatory percentage MNA	38% edentulous. Mean masticatory percentage 45%. 18% malnourished. A constant increase in the probability of malnutrition as the masticatory percentage decreased (OR 1.15 95% CI 1.06–1.25).	Random sample of nursing homes (N = 100) and residents (N=1094) in France.

Continues		Methods		Findings		Context, comments	
Study	Participants	Methods		Findings		Context, comments	
Studies using Nutrition Score or SGA among institutionalized older people							
Nordenram et al. 2001	Nursing home N = 192, mean age 84 y, 80% female	Oral health: Chewing capacity Nutrition Score (NuSc),		50 % at risk of protein energy malnutrition (PEM), 25% had PEM. Subjects with ≥ 4 occlusal contacts had better NuSc than those not able to chew.		One nursing home in Stockholm, Sweden.	
Andersson et al. 2002	Geriatric rehabilitation ward; N = 223; 65+ years female 56%	Oral assessment by Revised Oral Assessment Guide (ROAG) Nutritional status (SGA)		Oral health problems were associated with dependency. 34% were at risk of malnutrition or malnourished. Oral health problems were more common among malnourished patients than among those adequately nourished.		On a hospital ward in Sweden.	
Studies using involuntary weight loss, BMI or serum albumin concentrations among institutionalized older people							
Sullivan et al. 1993	N = 109 Mean age 77 y, 1 % female	Oral problems Involuntary weight loss		The number of oral health problems was associated with involuntary weight loss		A Geriatric Rehabilitation Unit of a Veterans Administration hospital, USA.	
Rauen et al. 2006	N = 187, Mean age 81 y 80% female	Clinical oral examination: Dentition groups BMI < 18,5 thin		59% edentulous, 48% a highly compromised dentition, 14% thin Thinness was associated with the oral condition of highly compromised dentition.		All institutionalized older people, 10 geriatric institutions in Florianopolis, Brazil.	
Sadamori et al 2008	N = 94 demented women, mean age 90 y	Oral status: 1. occlusal support provided by natural molar teeth; 2. occlusal support provided by dentures; 3. no occlusal support Serum albumin levels, BMI.		Significant differences in serum albumin, but no significant differences in BMI between denture wearers and non-denture wearers.		One nursing home in Okayama, Japan.	

An association between a compromised dentition status and low BMI has also been reported (Mojon et al. 1999, Chai et al. 2006, Rauen et al. 2006). Sadamouri et al. (2008) found no significant differences in BMI between denture wearers and non-denture wearers (Sadamori et al. 2008). Furthermore, an association between the number of teeth and underweight (BMI < 20) has been observed (Srisilapanan et al. 2002).

2.4.4 Oral symptoms and nutrition

Oral symptoms such as chewing problems, swallowing difficulties, pain in the mouth (Sullivan et al. 1993, Andersson et al. 2002, Bailey et al. 2004, Suominen et al. 2005, Jung & Shin 2008) and dry mouth (Dormenval et al. 1999, Andersson et al. 2004) have been identified as indicators of nutritional risk and are linked to each other (Poisson et al. 2014). Bailey et al. (2004) found that self-reported oral health problems were associated with impaired nutrition and nutrient intake. Caregiver-reported swallowing difficulties have also been reported to associate with the nutritional status (Andersson et al. 2002). In Finland, Soini and colleagues found that 24% of nursing home residents had chewing problems, 14% had swallowing difficulties, 11% dry mouth and 6% pain in the mouth (Soini et al. 2006). These oral symptoms were associated with a poor nutritional status measured by the MNA. Oral symptoms, eating and chewing difficulties and dry mouth appeared to be most prevalent for individuals who use dentures (Henriksen et al. 2004), and they also have a negative impact on the oral health-related quality of life (Nitschke & Muller 2004, Peltola et al. 2005, Jung & Shin 2008, Kim et al. 2009, Willumsen et al. 2010) and psychological well-being (Soini et al. 2008).

2.5 Nutrition, oral health and mortality

Recent studies have suggested an association between malnutrition and mortality (Gazzotti et al. 2000, Van Nes et al. 2001, Persson et al. 2002, Donini et al. 2003, Saletti et al. 2005). Furthermore, the MNA has been confirmed to have a good ability to predict mortality in older populations in different settings (Donini et al. 2003). Gazzotti and colleagues (2000) reported higher mortality rates among malnourished patients than well-nourished patients during the hospital stay. Persson et al. (2002) observed that one-fourth (26%) of newly admitted geriatric patients were malnourished

according to the MNA, and mortality was higher in those patients classified as malnourished. Similarly, Donini and coworkers (2003) found in a sample of older subjects admitted to long-term care that the MNA scores were significantly lower in those patients who died during the follow-up period. Saletti et al. (2005) reported that the three-year mortality was 50% for malnourished subjects and 28% for well-nourished subjects, and that low MNA scores independently predicted mortality among older people receiving home care.

In addition, some cohort studies have suggested an association between the dentition status and mortality (Hamalainen et al. 2003, Abnet et al. 2005, Holm-Pedersen et al. 2008, Osterberg et al. 2008). In a Finnish study by Hämäläinen et al. (2003), the lower the number of teeth the subject had, the higher was the risk of death. Dental variables proved to be significant predictors of mortality, even after controlling for the general health status. Abnet et al. (2005) found in an Asian population-based cohort that tooth loss significantly increased the risk of death. Furthermore, Österberg et al. (2008) showed that the number of teeth was still an important predictor of mortality after adjusting for the most important covariates. They concluded that each remaining tooth at the age of 70 decreased the mortality risk by 4%. A recent study by Holm-Pedersen et al. (2008) found that individuals who were edentulous at the age of 70 were at higher risk of mortality during a 21-year follow-up period. In institutionalized older people, similar findings have also been observed. Shimazaki et al. (2001) found that the six-year mortality rate among edentulous subjects without dentures was significantly higher than that among subjects with 20 or more teeth (Shimazaki et al. 2001). In nursing home residents, the risk of mortality was almost two times higher among edentulous subjects without dentures than those with adequate dentition with natural teeth only or natural teeth with partial dentures (Ohruu et al. 2006).

In Japanese and Taiwanese older populations, self-assessed unsatisfactory chewing ability did not independently predict mortality (Nakanishi et al. 2005). However, swallowing difficulties appeared to be an independent predictor of mortality among hospitalized patients (Guyomard et al. 2009).

2.6 Summary of the literature

Good oral health is an important part of well-being in older people. In Finland, the prevalence of edentulousness has decreased during recent decades, but it is still common in the oldest age groups. Although oral diseases such as caries, periodontal disease and mucosal lesions such as stomatitis are

highly preventable, they are highly prevalent among older populations. The proportion of dentate older people is increasing and they have a higher number of teeth. This positive change may lead to an increase in treatment needs in the health care system.

Older people with functional and cognitive decline have challenges in independently maintaining effective oral hygiene. Among dependent older people, the state of oral hygiene still appears to be poor, and they have a number of oral health needs. However, oral health care has a low priority in nursing care due to the lack of education and training on how to provide oral hygiene activities for dependent older people. Several educational interventions for nursing staff have been implemented to improve the oral hygiene of institutionalized older people. In addition to dental hygiene, regular attendance of dental care services is important to maintain oral health in later life. Older people use dental services at a lower rate than younger people, and especially among institutionalized dependent individuals, regular visits to a dentist appear to be rare. Nurses and older people themselves recognize the need for oral health treatment.

Although a number of studies have described the oral status, oral hygiene and use of dental services among older people, less is known of how these factors are associated with the functioning, health, nutritional status or mortality of older people. The mouth is part of the human digestive system, so oral health problems such as tooth loss, a deterioration in chewing function, salivary flow, swallowing difficulties and pain in the mouth may also be risk factors for malnutrition.

Good nutrition plays a crucial role in healthy ageing. Due to several reasons, nutritional problems increase with ageing and are very common among institutionalized older people. Malnutrition has many harmful effects on individuals and results in additional costs to society. Functional decline, dependency and the need for assistance increase the risk of malnutrition. The same factors are also risk factors for oral diseases. There is still a paucity of studies exploring the associations between dentition, oral symptoms, malnutrition, nutrient intakes and mortality.

3. THE AIMS OF THIS STUDY

The aim of this study was to investigate the dentition, oral hygiene habits, oral symptoms, use of oral health services and nutrition of residents in assisted living facilities.

The following research questions were addressed:

1. What are the tooth brushing and denture cleaning activities among residents in assisted living facilities and their associated factors? (I)
2. What are the dentition status and the prevalence of oral symptoms among residents in assisted living facilities and their associated factors? (II–IV)
3. Are the dentition status and oral symptoms associated with the nutritional status and the energy, protein and nutrient intakes among residents in assisted living facilities? (II–V)
4. Do the dentition status, chewing problems and swallowing difficulties predict mortality among residents in assisted living facilities? (II–IV)

4. SUBJECTS AND METHODS

4.1 Study populations

This study was carried out in the cities of Helsinki and Espoo in Finland as a part of a project aimed at developing nutritional care in long-term care facilities. The study population comprised all residents aged 65 years or over in all assisted living facilities in these two cities (N = 2188) in 2007. Assisted living facilities intended are for persons who cannot cope with everyday life in their own homes, even with home-care services. Residents mainly live in their own flats or in their own rooms in group homes, which are intended for people with dementia. Residents may eat their meals in a common dining room or have their food delivered to their own rooms. Nursing care is provided around the clock, while medical services are mainly provided by primary care physicians.

Altogether, 1475 (67%) residents participated in the study. The rest either refused to participate (28%) or were individuals who had only resided in the assisted living facility for a short time period (5%). Tooth brushing/denture cleaning data were available for 1447 subjects, dentition status and mortality data for 1369 subjects, chewing problems and mortality data for 1383 subjects, and swallowing difficulties and mortality data for 1466 subjects. In addition, 345 volunteer residents in Helsinki provided one-day food diaries. A flow chart of the study population is presented in Figure 2.

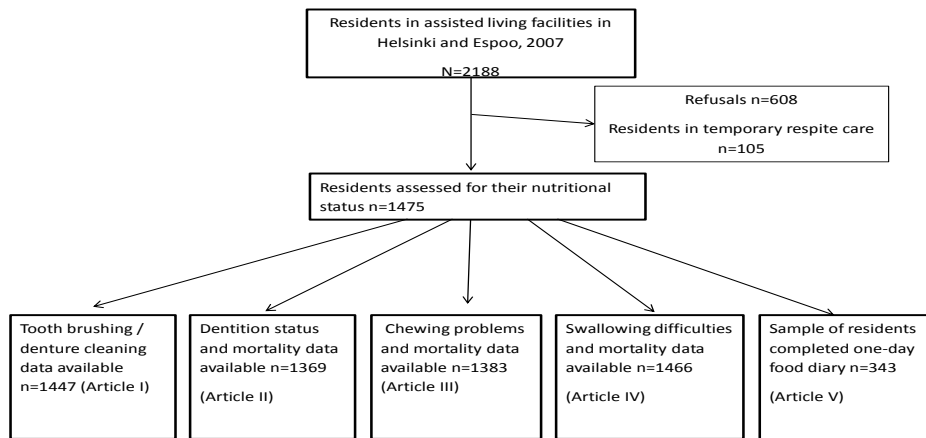


Figure 2. Flow chart of the study population

4.2 Methods

4.2.1 Data collection

The data were collected in March 2007 by using structured questionnaires, the Mini Nutritional Assessment (MNA) and one-day food diaries. Registered nurses who were familiar with the residents interviewed, observed and assessed each resident and completed the questionnaires and food diaries. The structured questionnaire (appendix 1) included information on demographic characteristics (age, gender, marital status and education), dentition status, oral symptoms and tooth brushing/denture cleaning habits, the use of dental services, the functional and cognitive status, diets and subjective health. The nurses received detailed one-day education prior to performing the assessments and completing the food diaries. They also received a detailed written guide. Furthermore, a nutritionist guided the nurses in completing the food diaries as needed. All active medical diagnoses for the residents were retrieved from their medical records and three-year mortality data were retrieved from national statistics on the causes of death obtained from Statistics Finland on 6 July 2010.

Oral hygiene, dentition status and oral symptoms

As a measure of oral hygiene habits, the frequency of teeth/denture cleaning was assessed with the following question: “Does the resident clean or has he/she cleaned his/her teeth/dentures daily?” (yes/no). In study I, the dentition status of residents was classified according to the type of dentition and included the following four categories: edentulous without dentures, edentulous with complete dentures in both jaws, only one complete denture with or without natural teeth (mixed dentition) or natural teeth only. In studies II and V, the dentition status was classified into three groups: edentulous without dentures, edentulous with some removable dentures in one or both jaws (complete or partial), all or some natural teeth left with or without removable dentures in one or both jaws.

Nurses assessed and observed oral symptoms such as chewing problems, dry mouth, pain in the mouth and swallowing difficulties, which were charted with yes/no options. The use of oral care services was assessed with the question: “When was the most recent oral examination performed by a dentist or dental hygienist?” Responses were categorised as follows: 1 = less than one year ago, 2 = one to three years ago and 3 = more than three years ago.

Nutritional status, nutrient intake and diets

The nutritional status of residents was established using the Mini Nutritional Assessment (MNA), which is a widely used, simple, quick and validated tool for estimating the nutritional status of aged individuals living in various settings (Guigoz 2006, Vellas et al. 2006). The full MNA comprises 18 items grouped as anthropometric measurements (body mass index, mid-arm and calf circumferences, and weight loss over the previous 3 months; items B, F, Q and R), general assessment (lifestyle, mobility, medication use, presence of acute stress, and presence of dementia or depression; items C, D, E, G, H and I), dietary assessment (number of meals per day, protein consumption, fluid consumption per day, autonomy of feeding; items A, J, K, L, M and N) and a subjective assessment (self-perception of health and nutrition; items O and P). The maximum score in the MNA is 30. Aged individuals with scores <17 are classified as malnourished and those with scores from 17 to 23.5 are classified as at risk of malnutrition. People at risk of malnutrition have not started to lose weight and do not show low albumin levels, but have lower protein-calorie intakes than recommended (Vellas et al. 2006). For them, early nutritional interventions are needed. Subjects with scores >23.5 are considered well nourished.

Nurses measured the height and weight of the residents. Body mass index (BMI) was calculated by dividing their weight in kilograms by the square of their height in metres. If it was not possible to measure a resident in the standing position, height was estimated from the knee height, as recommended for older people, who often have difficulties standing straight (Hurley 1997). Regular weight monitoring was charted with the options: never, once a year or less frequently, 2–6 times a year, and over 6 times a year.

The consistency of offered food was divided into four groups: normal food, soft food and pureed or liquid food. The average proportion of offered food eaten by residents was assessed with the question: How much on average does the resident eat of the main meal? The nurses compared the average portions of meals consumed with model portions, for which images were available. The average amount of a meal consumed was dichotomized as eating adequately (eats very much, eats quite much and eats normally) and eating little (quite little or little). The use of oral nutritional supplements, vitamin D and calcium supplements and snacks between meals was inquired with yes/no questions.

Energy, protein and nutrient intakes of 343 volunteer residents were calculated from one-day food diaries, which were completed by nurses. A nutritionist guided and checked the nurses in completing the food diaries when needed. These food diaries were analysed using the program Aivo (www.aivo.fi). The nutritionist entered the food items into the program. As a measure of dietary adequacy, the daily energy and nutrient intakes were compared with the recommendations of the Finnish National Nutrition Council (Valtion ravitsemusneuvottelukunta 2005). The recommendations were as follows: energy 2070 kcal for males, 1700 for females; fibre 25–35 g/d; vitamin C 75 mg/d; vitamin E 10 mg/d for males, 8 mg/d for females; vitamin A 900 mg/d for males, 700 mg/d for females; folate 300 µg/d; calcium 800 mg/d; vitamin D 10 µg/d. A cut-off point of 60 g/d was used to define an adequate protein intake.

Morbidity, cognitive and physical functioning and subjective health

Medical records were used in retrieving the medical diagnoses of the residents. For each subject, we calculated comorbidity using Charlson's comorbidity index (Charlson et al. 1987), which is a weighted index that takes into account the number and seriousness of comorbid diseases.

We used validated questions retrieved from the Clinical Dementia Rating Scale (CDR) to evaluate the cognitive and physical functioning of the subjects (Hughes et al. 1982). The state of cognition

was evaluated according to the 'Memory' score in the CDR (0 = no memory problems, 0.5 = possible memory problems, 1 = mild problems, 2 = moderate problems, or 3 = severe problems) and divided into two groups: those with $CDR < 1$ and those with $CDR \geq 1$ (cognitive impairment). The dependence of the residents in activities of daily living (ADL) was assessed according to the CDR "personal care" item. $CDR \geq 2$ was defined as dependence in ADL (requiring assistance in dressing, hygiene, managing personal effects, or requiring significant help with personal care, often involving incontinence). Information on the mobility of the residents was obtained with the question: "Can the resident walk indoors?" (yes/no). Their subjective health was enquired and categorized as follows: good (healthy, quite healthy) or poor (unhealthy, very unhealthy). The eyesight of the residents was assessed with the question "Is the resident's eyesight good enough for reading regular print" (yes/no) (with or without glasses).

4.2.2 Statistics

Groups were compared using the chi-squared test or Fischer's exact test for categorical variables and the Mann-Whitney U-test or the Kruskal-Wallis test for continuous variables when appropriate. Logistic regression models were used to evaluate the independent prognostic value of chewing problems and swallowing difficulties for mortality. Logistic regression models were also used to evaluate whether the dentition status had independent value in predicting low protein use. Cox regression analysis was used to explore the prognostic value of dentition status for mortality. The results were considered as statistically significant at the level $p < 0.05$.

4.2.3 Ethical questions

The local ethics committee of Helsinki University Hospital and City of Helsinki (Ethical committee of medicine) approved this study. Residents and their proxies were informed both orally and in writing about the study. Participation in this study was voluntary, and we made clear to participants and their proxies that they could refuse to participate or discontinue their participation at any time. Written informed consent was obtained from the residents, or in case of poor cognitive capability or judgment (about 55%), informed consent was obtained from the participant's closest proxies. We analysed all data anonymously.

5. RESULTS

5.1 Basic characteristics of the residents

Table 5 presents the demographic characteristics of the study population of residents in assisted living facilities. The mean age was 82.7 years (SD 7.8; range 65–99), and females were older than males. Most of the residents were females (78%), widowed (59%) and had a low educational level; more than half of the residents (56%) had a primary school education or less. The residents had lived in their present assisted living facility for a mean of 2.9 years. Of the residents, 55% had cognitive impairment ($CDR \geq 1$). They were highly dependent in their ADL, with 84% requiring at least prompting or assistance in dressing, hygiene and the keeping of personal effects, or requiring considerable help with personal care, often involving incontinence. One-third of the participants were able to walk inside without help and most of residents (83%) had such good eyesight that they were able to read. Of the study population, 44% died during the three-year follow-up.

Over a half of the residents (52%) were edentulous (Table 6): 7% were edentulous and did not use any dentures, while 38% had complete dentures in both jaws. About 29% had only natural teeth and 20% had natural teeth and some dentures. Most of the residents (83%) reported daily tooth brushing or denture cleaning, females (85%) significantly more often than male participants (73%) ($p < 0.001$). Various oral symptoms were common among the residents, being more common among females than males: 21% had chewing problems, 21% dry mouth, 12% swallowing difficulties and 7% pain in the mouth. Of the residents, 41% had at least one oral symptom and 15% had 2–4 oral symptoms. The latest oral examination performed by a dentist or dental hygienist was less than one year ago for 36%, 1–3 years ago for 35% and over 3 years ago for 29% of the residents.

Table 5. The demographic characteristics, health, and cognitive and functional status of the residents in assisted living facilities.

Demographic characteristics	Total (n = 1475)	Females (n = 1146)	Males (n = 329)	p-value¹
Mean age, years (SD²)	82.7 (7.8)	83.7 (7.4)	79.2 (7.9)	<0.001
Marital status, %				<0.001
Single	16.4	15.3	20.2	
Widowed	58.6	64.6	37.2	
Divorced	14.2	13.3	17.4	
Married	10.8	6.8	25.2	
Education, %				0.086
Primary school or less	55.6	55.0	57.4	
Secondary school	37.0	38.2	32.8	
Academic education	7.4	6.8	9.8	
Mean length of stay, months (SD²)	34.6 (34.5)	34.9 (34.9)	33.5 (32.6)	0.50
Memory (CDR³), %				0.012
0 = no memory loss or slight inconsistent forgetfulness	27.0	25.8	31.2	
0.5 = mild consistent forgetfulness; partial recollection of events; 'benign' forgetfulness	17.9	17.7	18.3	
1 = moderate memory loss, more marked for recent events; defect interferes with everyday activities	17.4	16.9	19.3	
2 = severe memory loss; only highly learned material retained; new material rapidly lost	21.9	22.1	21.5	
3 = severe memory loss; only fragments remain	15.7	17.5	9.6	
Dependence in activities of daily living, ADLs (CDR³), %				0.053
0 = independent	15.5	16.5	12.1	
1 = needs prompting	16.1	15.3	18.8	
2 = requires assistance in dressing, hygiene and keeping of personal effects	39.4	38.3	43.1	
4 = requires considerable help with personal care; often involving incontinence	29.0	29.9	25.9	
The resident can walk inside without trouble, %				0.013
Yes	33.9	32.1	40.1	
No, needs stick or walker	43.1	43.7	41.1	
No, needs help from another person	12.5	13.7	8.3	
No, cannot walk	10.5	10.5	10.5	
The resident is able to read (eyesight), %	82.5	81.6	85.6	0.059
Charlson comorbidity index, mean (SD²)	3.1 (1.3)	3.1 (1.3)	2.8 (1.2)	0.023
Dementia, %	59.3	61.2	52.6	0.005
Prior stroke, %	25.9	23.9	32.9	0.001

¹Differences between the gender groups were tested using the chi-squared test for categorical variables and the Mann-Whitney U-test for non-normally distributed continuous variables. ²SD = standard deviation. ³ CDR = Clinical Dementia Rating scale.

Table 6. Dentition, tooth brushing/denture cleaning frequency, use of dental services and oral symptoms of the residents in assisted living facilities.

Oral health	Total (n=1466)	Female (n=1143)	Male (n=323)	p- value¹
Dentition, %				<0.001
Edentulous without dentures	7.0	5.3	12.9	
Edentulous, complete dentures in upper and lower jaw	38.0	39.4	33.0	
Edentulous, upper or lower complete dentures	6.9	7.2	5.7	
Natural teeth with one or more dentures	19.7	19.8	19.5	
Natural teeth only	28.5	28.3	28.9	
Daily tooth brushing/denture cleaning, %	82.6	85.3	73.1	<0.001
Latest oral examination performed by a dentist/dental hygienist, %				0.043
Less than 1 year ago	36.0	37.3	31.3	
1–3 years ago	35.4	33.8	41.3	
More than 3 years ago	28.6	28.9	27.3	
Chewing problems, %	21.1	21.4	19.8	0.29
Dry mouth, %	21.3	22.7	16.1	0.005
Pain in the mouth, %	7.0	7.6	4.6	0.038
Swallowing difficulties, %	11.8	12.9	8.0	0.010
Number of oral symptoms, %				0.020
0 symptoms	58.8	57.4	63.8	
1 symptom	26.4	26.3	26.7	
2 symptoms	10.8	11.9	7.3	
3 symptoms	3.1	3.3	2.1	
4 symptoms	0.9	1.1	0.0	

¹Differences between the gender groups were tested using the chi-squared test for categorical variables.

Table 7 shows the nutritional status and eating habits of the residents, 22% of whom were well nourished, 65% at risk of malnutrition and 13% malnourished. Male residents had a better nutritional status than female residents. The mean BMI was 25.5. About 70% of the participants were independent in eating without any problems and 88% ate normal food. Half of the residents (48%) took vitamin D supplements. The respective figure for calcium supplements was 49%. Female residents took these supplements more commonly than male subjects. Of the residents, 22% had their weight monitored over six times a year.

Table 7. Nutritional status and eating habits of the residents in assisted living facilities

Nutrition	Total (n = 1457)	Females (n = 1137)	Males (n = 320)	p-value¹
MNA², %				0.003
<17	13.4	13.6	12.5	
17–23.5	64.6	66.3	58.7	
>23.5	22.0	20.1	28.9	
BMI³, mean (SD⁴)	25.5 (5.2)	25.4 (5.3)	25.7 (4.6)	0.16
Fluid consumption per day, %				0.039
<3 cups	1.9	2.1	1.2	
3–5 cups	35.7	37.2	30.5	
>5 cups	62.4	60.8	68.3	
Mode of feeding, %				0.003
Unable to eat without assistance	6.7	7.7	3.1	
Self-fed with some difficulty	23.7	24.5	20.9	
Self-fed without any problem	69.6	67.8	76.0	
Consistency of food, %				0.27
Liquid	0.1	0.1	0.0	
Pureed	6.6	7.1	4.7	
Soft	5.5	5.8	4.4	
Any food/normal food	87.9	87.0	90.9	
The amount of food the resident eats on average from the main meals, %				<0.001
Little	6.5	6.9	5.0	
Quite little	18.1	20.2	10.9	
Normal amount	66.7	66.5	67.6	
Quite much	8.0	5.8	15.9	
Much	0.7	0.7	0.6	
Eats snacks, %	58.9	58.9	59.1	0.51
Takes oral nutritional supplements, %	3.2	3.4	2.2	0.17
Takes vitamin D supplements, %	48.4	52.3	34.6	<0.001
Takes calcium supplements, %	49.5	54.3	32.7	<0.001
Weight monitoring frequency, %				0.12
Never	6.7	6.6	7.2	
≤1 time a year	21.2	20.0	25.7	
2–6 times a year	49.8	50.4	47.6	
>6 times a year	22.2	23.0	19.4	

¹Differences between the groups were tested using the chi-squared test for categorical variables and the Mann-Whitney U-test for non-normally distributed continuous variables. ²MNA = Mini Nutritional Assessment. ³BMI = Body Mass Index. ⁴SD = standard deviation.

5.2 Tooth brushing and denture cleaning (Article I)

Of the residents, 17% (n = 252) had not cleaned or had not received assistance in cleaning their teeth and/or dentures daily. Dependency in daily living (p < 0.001), cognitive impairment

$p < 0.001$) and impaired eyesight ($p < 0.001$) were associated with less frequent tooth brushing/denture cleaning. A low level of education tended to be associated with less frequent tooth brushing/denture cleaning ($p = 0.052$).

Oral hygiene activities varied according to the dentition. Of the edentulous residents without dentures, 19% had daily mouth cleaning. Of those subjects who wore some dentures, 89% cleaned their dentures or had them cleaned daily. Of the dentate residents, 85% brushed their teeth or cleaned their dentures daily. Oral symptoms (chewing problems, $p < 0.001$; dry mouth, $p = 0.011$; pain in the mouth, $p = 0.02$; and swallowing difficulties; $p < 0.001$) were more common among the residents who did not undertake daily oral hygiene activities than among those with better oral hygiene habits.

Figure 3 illustrates the proportion of residents who did not undergo daily tooth brushing/denture cleaning according to the nutritional status of the participants. Of the malnourished residents, 29% did not attend to daily oral hygiene activities. The respective figure for well-nourished residents was 11%. The mean BMI was not significantly associated with oral hygiene habits.

Less frequent tooth brushing/denture cleaning was also associated with poorer subjective health among residents. Of those participants without daily oral hygiene activities, 32% felt themselves unhealthy or very unhealthy. The respective figure among those with better oral hygiene habits was 23% ($p = 0.017$). Of the participants, about 59% had a diagnosis of dementia. A dementia diagnosis was associated with less frequent tooth brushing/denture cleaning. Those residents with daily tooth brushing/denture cleaning had more comorbidities according to the Charlson's comorbidity index.

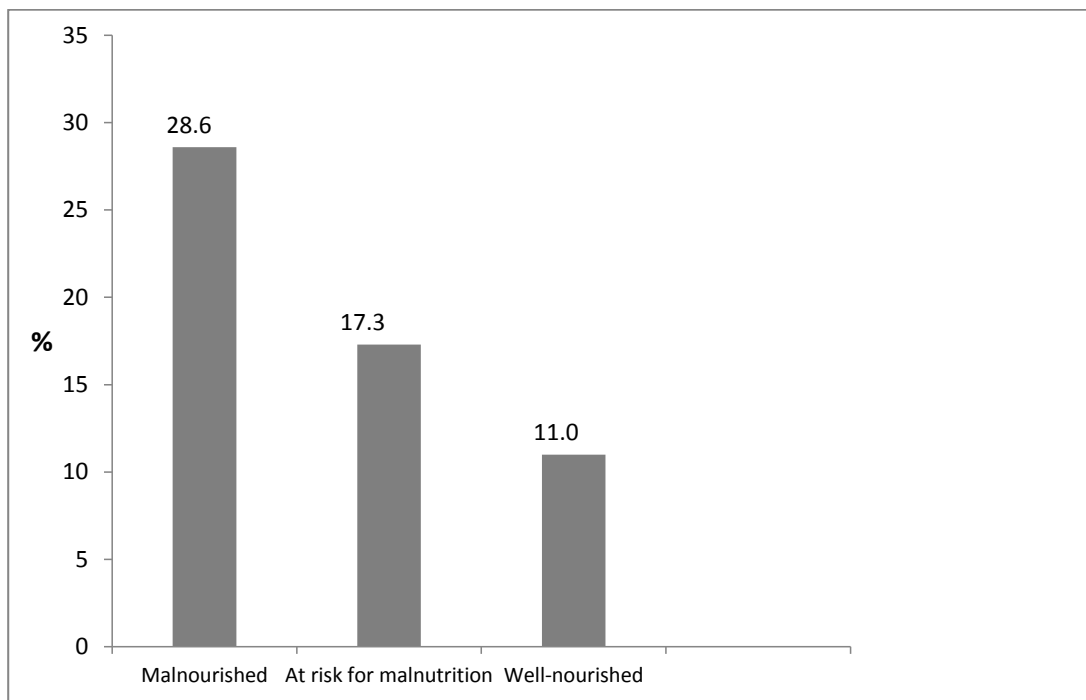


Figure 3. The proportion of residents who did not undergo daily tooth brushing/denture cleaning according to the nutritional status of the participants in assisted living facilities.

5.3 Dentition, malnutrition and mortality (Article II)

The study population was divided into three groups according to the type of dentition: Group 1, edentulous participants without dentures (n = 94); Group 2, edentulous participants with some removable dentures in one or both jaws (n = 614); Group 3, dentulous participants all or some natural teeth and with or without removable dentures in one or both jaws (n = 661). In Group 2, having complete dentures in both jaws was the most common situation (n = 520). Education was significantly associated with dentition, with edentulous residents having the lowest educational level. In Group 1, 84% of edentulous subjects did not manage their activities of daily living and required assistance. The respective figures in other two groups were 67% and 68%. Subjects in Group 1 were also more often unable to walk inside. Cognitive function did not differ between the groups, with over half of all residents having cognitive impairment according to the CDR.

Morbidity according to Charlson's comorbidity index did not differ between the three dentition groups, but a prior hip fracture and diabetes diagnosis were least common among residents with some natural teeth left in Group 3. In Group 1, edentulous subjects more often had chewing problems and swallowing difficulties, but they had undergone less frequent oral examinations than those in Groups 2 and 3.

Of the edentulous residents without dentures (Group 1), 23% were malnourished (MNA < 17). The respective figures in other two groups were 12% in each. The proportions of subjects at risk of malnutrition were 63% in Group 1, 64% in Group 2 and 66% in group 3. The respective figures for well-nourished subjects were 14%, 24% and 22%. The nutritional status of participants was significantly associated with dentition ($p = 0.014$). Almost half of the edentulous subjects (47%) in Group 1 ate pureed or soft food. According to nurse evaluations, 76% of the residents ate a normal amount of their food at meals. Edentulous participants in Group 1 more often ate adequately from the main meals than those in Groups 2 and 3.

The mortality rate differed between the dentition categories. Of the edentulous residents in Group 1, 52% died during the three-year follow-up, while the respective figures in Groups 2 and 3 were 48% and 40% ($p = 0.004$). In multivariate model (Cox regression) adjusted for age, gender, comorbidities and the MNA score, the dentition status no longer predicted mortality in Group 1 (hazard ratio (HR) 1.19, 95% CI 0.87 to 1.63) or Group 2 (HR 1.15, 95% CI 0.97 to 1.37) when group 3 was used as the reference group (HR 1.0). The multivariate analysis was repeated without the MNA score, but the findings were essentially the same (Group 1: HR 1.29, 95% CI 0.95 to 1.77; Group 2: HR 1.13, 95% CI 0.96 to 1.34).

5.4 Chewing problems, swallowing difficulties, nutrition and mortality (Articles III and IV)

One-fifth of residents had chewing problems. They were older, had more comorbidities and were more likely to have poor subjective health and be dependent in ADL than those without chewing problems. Of the participants who suffered from chewing problems, 23% were malnourished. The respective figure for the residents without chewing problems was 11% ($p < 0.001$). There was no significant difference between groups in the proportion of their food they ate at the main meals. Over half of the residents (55%) with chewing problems and 41% of the residents without chewing

problems died during the 3-year follow-up ($p < 0.001$). In the logistic regression model using age, gender, MNA class and comorbidities as covariates, chewing problems still independently predicted mortality (OR = 1.46, 95 % CI = 1.10–1.93).

About 12% of the residents suffered from swallowing difficulties. They more often had a diagnosis of Parkinson's disease, COPD and chronic infections than those residents without swallowing difficulties. Swallowing difficulties were significantly associated with cognitive impairment, poorer abilities of daily living and malnutrition ($p < 0.001$). Of the subjects with swallowing difficulties, 31% suffered from malnutrition. The respective figure in the residents without swallowing difficulties was 11%. Of those participants with swallowing difficulties, 55% died during the three-year follow-up period, whereas the respective figure for those without swallowing difficulties was 41%. In adjusted (age, gender, comorbidities, and MNA as covariates) logistic regression analysis, swallowing difficulties predicted mortality (OR = 1.49, 95% CI = 1.04–2.12).

5.5 Latest visit to a dentist or dental hygienist (unpublished results)

Of the participants, 36% had visited a dentist or dental hygienist during the previous 12 months (Table 6). This was associated with female gender, a higher educational level, cognition, natural teeth, daily tooth brushing/denture cleaning and the number of oral symptoms (Table 8). More frequent use of dental services was not associated with nutrition, comorbidities or subjective health.

Table 8. Latest visit to dentist or dental hygienist among residents in assisted living facilities.

Characteristics	Latest visit to dentist or dental hygienist			
	< 1 year ago (n = 500)	1–3 years ago (n =486)	>3 years ago (n = 397)	p -value ¹
Mean age (SD) ²	82.5 (7.2)	82.1 (8.1)	83.2 (8.0)	0.075
Females, %	81.2	74.8	79.4	0.043
Education, primary school or less, %	45.0	56.9	67.9	<0.001
Cognition, CDR \geq 1 ³ , %	50.5	61.3	48.7	<0.001
ADL ⁴ , CDR \geq 1, %	82.3	87.8	81.1	0.082
Edentulous, %	34.6	53.7	69.2	<0.001
Daily tooth brushing/denture cleaning, %	86.6	83.2	77.1	<0.001
At least one oral symptom (chewing problem, pain in the mouth, dry mouth, swallowing difficulties), %	47.5	40.0	38.5	0.011
MNA ⁵ < 17 points (malnutrition), %	13.2	13.6	12.8	0.94
Good subjective health, %	75.3	75.0	75.6	0.98
Mean Charlson’s comorbidity index (SD) ²	3.1 (1.4)	3.1 (1.3)	3.1 (1.3)	0.78

¹Differences between the groups were tested using the chi-square test for categorical variables and the Kruskal-Wallis--test for non-normally distributed continuous variables. ²SD=standard deviation; ³CDR=Clinical Dementia Rating Scale; ADL= Activities of Daily Living according to CDR, ⁵MNA=Mini Nutritional Assessment. ³BMI= Body Mass Index.

5.6 Dentition and energy, protein and nutrient intakes (article V)

Of the residents, 343 provided one-day food diaries. The mean age of the study group was 83 years (SD 7.3), 82% were female and 56% had a low level of education, being primary school or less. Of the subjects, 82% had impaired cognition according to the CDR memory score (CDR \geq 1) and 82% were dependent in ADL (CDR \geq 2). Cognitive decline (p = 0.022) and dependency (p = 0.026) were significantly associated with the dentition status. All edentulous subjects without dentures in Group 1 had cognitive decline and were dependent in ADL. Chewing problems and swallowing difficulties were most common among edentulous residents without dentures in Group 1. Malnutrition was most common in edentulous subjects without dentures, 32% being malnourished. The corresponding figure in other two groups was 26% and 17%, respectively. No significant difference existed between dentition groups for BMI, the mean value for subjects being 25.4.

Among females, the mean intake of energy was 1657 kcal (recommendation 1700 kcal). The respective figure among male residents was 1881 kcal (recommendation 2070 kcal). Almost half of the subjects received less energy than recommended, the proportions being 49% among males and 34% among females. Dentition was not associated with the mean intake of energy or proportion of individuals receiving an inadequate amount of energy.

Inadequate dietary intakes of the studied micronutrients were common in all dentition groups. Of all residents, the percentages receiving less than the recommended amounts of nutrients were as follows (Figure 4): fibre 97%, vitamin C 42%, vitamin E 85%, vitamin A 73%, folate 100%, iron 48%, selenium 53% and zinc 28%. Furthermore, 44% of residents received less than the recommended amount of vitamin D, when including vitamin D supplements in the dietary intake. The respective figure for the total calcium intake was 13%.

Half of the residents (49%) received less than 60 g/day of protein. In Group 1, the proportion receiving less than 60 g/day of protein was 64%. The corresponding figures in Groups 2 and 3 were 56% and 49%. Intakes of protein ($p = 0.009$) and vitamin C ($p = 0.031$) differed according to dentition status. In the logistic regression model including age, gender and Charlson's comorbidity index as covariates, Group 1 and Group 2 predicted a poor protein intake (<60 g/day; OR 2.4 (95% CI 1.0–5.7; $p = 0.042$) and OR 1.6 (95% CI 1.0–2.6; $p = 0.045$) compared with the reference Group 3 (OR = 1).

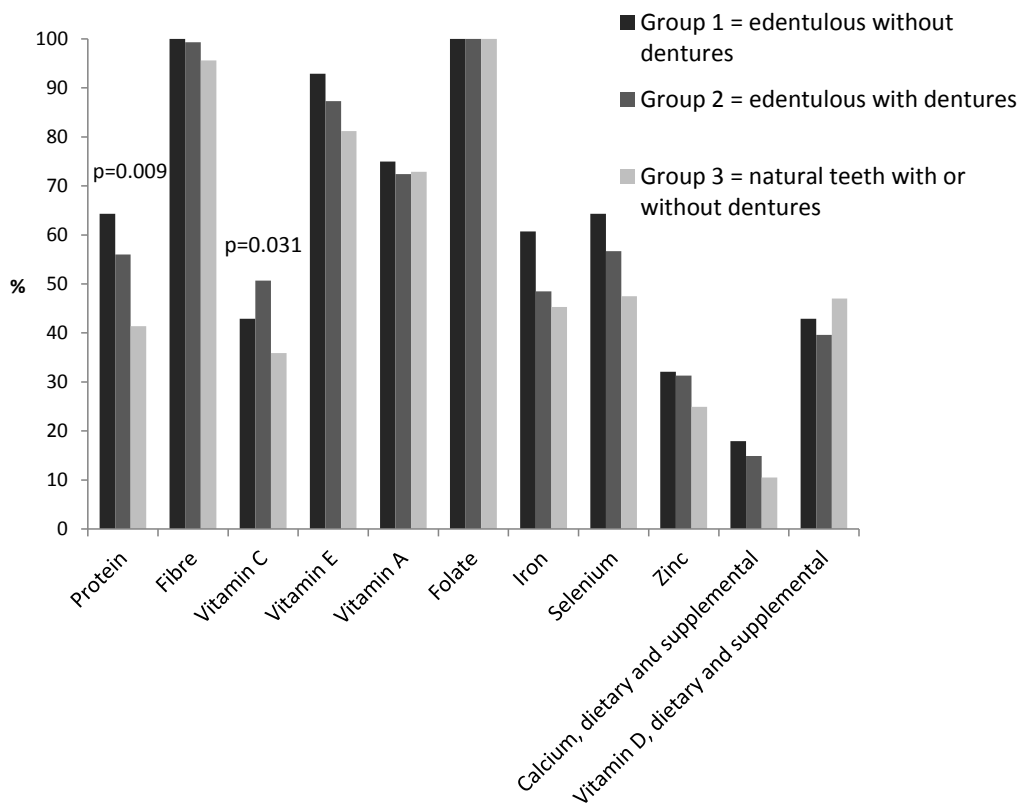


Figure 4. Proportions of participants who received less than 60 g/day of protein and other nutrients below the recommended levels of the Finnish National Nutrition Council according to dentition status (Group 1: edentulous residents without dentures; Group 2: edentulous residents with some removable dentures; Group 3: Dentulous residents with or without removable dentures).

6. DISCUSSION

This study investigated the dentition, tooth brushing/denture cleaning, oral symptoms and nutrition of the residents in all assisted living facilities in Helsinki and Espoo. The participants were old and frail, the mean age being 83 years, and 60% suffered from dementia and 83% from ADL impairment.

Edentulousness was common in this dependent old study population, since over half of these institutionalized residents had lost all their teeth. Oral symptoms such as chewing problems, swallowing difficulties, pain in the mouth or dry mouth were very common among the residents, and they were associated with tooth brushing/denture cleaning less frequently than once a day, and often with the dentition status. Most residents attended to daily oral hygiene activities, but one in six of the residents did not brush their teeth or clean their dentures daily. Poor oral hygiene was associated with male gender, ADL dependency, cognitive decline, malnourishment and less frequent visits to a dentist or dental hygienist. Similarly, edentulousness was associated with male gender, a lower educational level and ADL dependency. Chewing problems were associated with a higher age, poor nutrition, poor subjective health, comorbidities, ADL dependency and mortality. Swallowing problems were associated with female gender, ADL dependency, cognitive decline, malnutrition and the use of oral supplements.

Malnutrition was common: 13% of residents were malnourished and 65% at risk of malnutrition. Malnutrition was associated with edentulousness, chewing problems and swallowing difficulties. A large proportion of participants received inadequate amounts of nutrients. Edentulousness was associated with a poor protein intake. Chewing problems and swallowing difficulties independently predicted 3-year mortality.

6.1 Discussion of methodology

Strengths

All assisted living facilities in Helsinki and Espoo were included in this study. The study population was large (n = 1475) and included 67% of eligible residents (N = 2188) in assisted living facilities.

The participation rate was at an acceptable level and the study population was fairly representative of the older residents in assisted living facilities in the Helsinki Metropolitan Area of Finland.

The data were collected by trained registered nurses familiar with the residents. The nurses also collected other study information, including data on demographic factors, the functional and cognitive status, dentition and other oral factors. These nurses received one-day thorough education on the use of the questionnaire, and how to complete the Mini Nutritional Assessment food diaries. They also received written instructions on how to perform the assessments. The registered nurse who was most familiar with the residents and had assisted them over a long period of time assessed their tooth brushing and eating habits.

The structured questionnaire contained questions retrieved from well-validated measures (e.g. the Clinical Dementia Rating Scale, CDR, Mini Nutritional Assessment, MNA). The questionnaire has been validated in earlier nutritional studies in nursing homes and long-term care wards in Helsinki (Suominen et al. 2005, Soini et al. 2011). Information on medical diagnoses was directly retrieved from medical records, which also supported the validity of the data.

The nutritional status of the residents was assessed by the MNA, which has been specifically developed and validated in populations of older people (Guigoz 2006, Vellas et al. 2006, Bauer et al. 2008). The MNA is easy to perform and has been used in many countries and different settings such as community dwelling, home care, service housing, nursing homes and hospitals (Guigoz et al. 2002). Studies have also confirmed the predictive value of the MNA for mortality and other adverse outcomes among older people (Gazzotti et al. 2000, Van Nes et al. 2001, Persson et al. 2002, Donini et al. 2003, Bauer et al. 2008).

Actual nutrient intakes were assessed using detailed one-day food diaries of 343 volunteer residents. The sample size was large enough to explore the detailed nutrient intake prospectively among institutionalized older people. Prospective record methods such as food records or food diaries, which assess current intake at the time of food consumption, have not been applied before in this kind of context. To my knowledge, this is the first study exploring the oral status and its association with energy and nutrient intakes based on food diaries among institutionalized older individuals. A nutritionist guided the nurses in completing the diaries and entered the food items into the Aivo program with the supervision of the principal investigator of nutrition (Merja Suominen). All data were checked and cross-checked by the nutritionist and principal investigator in charge of the data set.

Limitations

The present study had a cross-sectional design, thus making it impossible to draw conclusions on causal associations from the findings. The data on oral factors were collected using a structured questionnaire, and no clinical oral examination was performed. The number of natural teeth was not counted, so all residents with any natural teeth left were categorized as dentate. Therefore, this dentate group may have included subjects with only a few natural teeth with or without dentures, as well as those with full dentition. Moreover, the fit of dentures was not assessed. Thus, the differences between our dentate groups are conservative estimates of the true differences.

A limitation of this study is that only a single question on daily tooth brushing or denture cleaning was used in this study in order to measure oral hygiene habits. Furthermore, this study did not inquire how large a proportion brushed their teeth twice daily, which is the recommendation. In addition, the tooth brushing or denture cleaning frequency tells little about the efficacy of oral and denture hygiene habits. The cleanliness of teeth/dentures was not measured, which is a limitation of this study. However, an earlier study suggested that the frequency of tooth brushing and denture cleaning is associated with the cleanliness of the teeth and dentures (Vysniauskaite & Vehkalahti 2009). Other types of oral health behaviour (interdental cleaning, use of fluoride, density of sugar use, smoking) than tooth brushing/denture cleaning and use of oral health services were not investigated.

Different oral symptoms (chewing problems, swallowing difficulties, pain in the mouth and dry mouth) were charted with single yes/no questions. No tests of chewing ability, swallowing or salivary flow were used. This may underestimate the true prevalence of these oral symptoms. A one-day food diary cannot measure day-to-day variations in energy and nutrient intakes. However, even though eating habits and food consumption may differ over longer time periods, residents in assisted living facilities have fairly similar daily eating habits from day to day.

6.2 Discussion of the findings

Tooth brushing/denture cleaning

Most of the residents (83%) reported daily oral hygiene activities, but quite a large proportion of them (17%) failed to have their teeth brushed or their dentures cleaned daily. The proportion of residents with daily oral hygiene activities was markedly higher than in a Danish population study

(age 65+, 48%) (Christensen et al. 2003) or a Japanese study on older people in home care (52%) (Morishita et al. 2001). However, in the Helsinki Ageing Study, home-dwelling older people did clean their dentures more frequently (96–98%) (Nevalainen et al. 1997). A comparison of the results with earlier findings is difficult due to the different research methods used.

In line with previous studies, associations were found in present study between tooth brushing/denture cleaning frequencies and gender, cognitive decline and dependence in activities of daily living. Daily oral hygiene activities took place more often among female than among male residents (Christensen et al. 2003, Vysniauskaite & Vehkalahti 2009, de Oliveira et al. 2010). The residents in this study were highly dependent and they needed assistance with their daily hygiene, including oral hygiene. Our findings showed that those residents who were dependent were less likely to attend to daily oral hygiene activities (Morishita et al. 2001, Catovic et al. 2003, Montal et al. 2006). This suggests that those dependent residents unable to perform daily oral hygiene activities independently and in need of assistance did not receive regular assistance from nursing personnel (Frenkel et al. 2000, Simons et al. 2001, Montal et al. 2006, Morishita et al. 2001). Similarly, cognitive decline and a dementia diagnosis were associated with less frequent oral hygiene activities. Syrjälä and coworkers (2012) found in their recent study that older persons with dementia had poorer oral hygiene than individuals without dementia (Syrjala et al. 2012). Cognitive decline may have resulted in residents forgetting to carry out daily oral hygiene activities, even though they were able to perform them. Daily tooth brushing and denture cleaning should be part of the daily nursing care of dependent residents in assisted living facilities.

Studies have suggested that there are many nursing personnel-, management- and resident-related barriers to performing adequate oral hygiene activities among dependent individuals in institutional care (Wardh et al. 2012, Willumsen et al. 2012). More information is needed on these barriers in Finnish assisted living facilities to tackle this problem. Poor oral hygiene places older residents at great risk of oral health problems (Vysniauskaite & Vehkalahti 2009, Zenthofer et al. 2014). In our study, oral symptoms such as chewing problems, pain in the mouth and swallowing difficulties were associated with tooth brushing or denture cleaning less than once a day. Nonetheless, the residents without daily oral hygiene activities had fewer visits to a dentist or dental hygienist.

Edentulousness

Even though oral health has improved in the last decade, the dentition status among residents in assisted living facilities was still poor. Altogether, 52% were edentulous, and of these edentulous residents, 13% did not wear any dentures, 73% had complete dentures and 13% had only one complete denture. According to earlier studies, the prevalence of edentulism among institutionalized older people has been 23–74% (Table 3-4). The proportion of edentulous subjects in our study was even higher than in earlier Finnish studies, since 42–45% of subjects among hospitalized older patients were found to be edentulous (Pirilä 2002, Peltola et al. 2004). In line with earlier studies, we observed that edentulousness was associated with a higher age, lower level of education, disability, oral symptoms and less frequent dental care attendance (Hildebrandt et al. 1997, Macek et al. 2004, Suominen-Taipale 2004, Holm-Pedersen et al. 2008, Arcury et al. 2012).

Oral symptoms

Various oral symptoms were common in our study population. Of the participants, 41% had at least one oral symptom and 15% had 2–4 oral symptoms. One-fifth of the participants (21%) had chewing problems or a dry mouth, 7% had pain in the mouth and 12% had swallowing difficulties. These proportions are slightly lower than those previously recorded by Soini and coworkers in nursing homes and long-term care wards in Helsinki (Soini et al. 2006). A possible explanation for this difference is that the participants in this study were less frail and dependent than those of Soini and colleagues. In a study by Simons et al. (2001), 19% of dentate nursing home residents reported chewing difficulties. Furthermore, Montal et al. (2006) observed that over a half of their hospitalized subjects had a chewing disorder. Chewing problems were associated with dependency in activities of daily living. In a study by Lee et al. (2010), a self-reported unsatisfactory chewing ability was found among 37% of home-dwelling adults aged 65 years or older. In this study, chewing problems were evaluated by nurses, which may explain these differences. Similarly, swallowing difficulties were assessed by caregivers without any validated swallowing test, which may underestimate the true prevalence of these difficulties. In previous studies, the prevalence of swallowing difficulties in long-term care facilities has been estimated to be up to 60% (Easterling & Robbins 2008, Rofes et al. 2011). Chewing problems and swallowing difficulties were associated with the dentition status. As expected, those edentulous participants without dentures more frequently reported these problems than participants who were edentulous with dentures or dentate.

Oral symptoms and nutritional status

According to the MNA, 78% of the residents in assisted living facilities had nutritional deficits, being either at risk of malnutrition or malnourished. This is in line with the findings from Swedish studies among service flat residents (Saletti et al. 2000, Odlund Olin et al. 2005). However, in the Swedish studies, the proportion of malnourished residents (21–30%) was higher than in the present study (13%). We found that malnutrition was more common among those residents without daily oral hygiene activities than those with daily tooth brushing/denture cleaning. To my knowledge, the association of nutritional status and tooth brushing/denture cleaning has not previously been examined. These results suggest that malnutrition may also lead to poorer oral hygiene and subsequent oral health problems, due to the decline in functional capacity. Malnourished residents also need support and assistance with their oral hygiene. On the other hand, poor oral hygiene may lead to oral health problems and eating difficulties and subsequent nutritional problems.

We found a significant association between dentition status and nutrition. Those edentulous residents who did not use dentures had the poorest nutritional status. Our finding is in line with previous studies applying the MNA among institutionalized older people. In a study by Lamy and coworkers (1999), edentulous residents without dentures or with only one complete denture had significantly lower MNA scores than those wearing two complete dentures. Griep et al. (2000) reported that the mean MNA score in a group of complete denture wearers was significantly lower than in a group of partial denture wearers, but they found no association between complete denture wearers and those with only natural dentition. Soini and colleagues (2006) recorded similar findings in their study among older residents in nursing homes and long-term care facilities in Finland. There have also been studies reporting similar results in community-dwelling populations that were younger than our study population (Daly et al. 2003, De Marchi et al. 2008, Cousson et al. 2012). De Marchi and colleagues concluded that having even a few natural teeth was protective against malnutrition.

Although most of subjects in this study were able to eat normal food, the consumption of pureed or soft food was most common among edentulous residents without dentures. Almost half of them ate pureed or soft food. Lamy et al. (1999) found similar results and also reported that those nursing home residents who consumed mashed food had lower MNA scores than subjects with normal diets. They concluded that mashed food consumption did not nutritionally compensate for the compromised dentition status and was not sufficient to maintain a good nutritional status.

Approximately one-fifth of the residents had chewing problems and 12% suffered from swallowing difficulties. These eating-related problems were most common in the group of edentulous residents without dentures, and they were associated with the poor nutritional status of the residents. This finding is in line with previous Finnish studies reporting that those with chewing and swallowing problems had a significantly lower MNA score than others (Soini et al. 2004, Soini et al. 2006). Lamy and coworkers used the masticatory test to measure the chewing function of nursing home residents. They found that over half of the subjects could not perform the masticatory test, and these individuals had lower MNA scores than those who were able to perform the test. Furthermore, Dion and colleagues (2007) estimated the masticatory percentages of nursing home residents and reported a constant increase in the probability of malnutrition (MNA < 17) as the masticatory percentage decreased. They also found that swallowing disorder was the strongest factor that augmented the probability of malnutrition. Similarly, Suominen and coworkers found that swallowing difficulties were one of the best predictors of malnutrition among nursing home residents (Suominen et al. 2005). Furthermore, Poisson et al. (2014) reported that subjects with dysphagia were more likely to be classified as undernourished according to the MNA, and they also had the lowest dietary intakes. Andersson and coworkers (2002) used the SGA to assess the nutritional status of patients in a geriatric rehabilitation ward, and they found that oral health problems were more common among undernourished patients than among those who were well nourished. Furthermore, they reported that swallowing difficulties were associated with the nutritional status in an adjusted model.

Oral factors and nutrient intake

Studies investigating the nutrient intakes of older people have been scarce, especially among residents in institutional care. In this study, residents in assisted living facilities received lower amounts of energy and various nutrients than recommended. Although the mean energy intakes of both female and male residents were quite acceptable, 49% of males and 34% of females received less energy than recommended. However, we did not find an association between dentition status and the dietary intake of energy. This is in line with findings of Sheiham et al. (2001), who reported no significant difference in energy intake between dentate and edentate independently living older individuals. However, among dentate participants, those with more teeth had greater mean intakes of energy. In a recent study, Cousson and coworkers (2012) reported that complete denture wearers had lower energy intakes than fully dentate individuals among community-dwelling participants. Suzuki et al. (2005) observed an association between the number of teeth and energy intake among residents in Japanese assisted living facilities.

Although the mean intakes of protein were fairly good, a large percentage of residents (47%) received less than 60 g/day of protein, the amount that was used as the cut-point for an adequate protein intake (Vellas et al. 1997, Morley et al. 2010). This cut-off point is quite moderate, because the current recommendation is 1.2–1.4 g protein per kilogram of body weight for people aged 65 years or older (Valtion ravitsemusneuvottelukunta 2014). Older adults with diseases may need even more dietary protein (up to 1.5 g/kg BW/d), and people with a severe illness or injury or with marked malnutrition may need much as 2.0 g/kg BW/d day (Bauer et al. 2013). Suominen et al. (2004) reported a mean protein intake of 59 g/d for female residents in dementia care units (Suominen et al. 2004). Even lower mean intakes were found in study by Leslie and coworkers among older residential care home residents (47 g/d for females and 50 g/d for males) (Leslie et al. 2006). These findings from earlier studies among institutionalized older people have been based on very low sample sizes. There have been very few studies using food diaries to explore the actual nutrient intakes. The findings of this study demonstrated that an inadequate protein intake was most common among edentulous subjects without dentures. This is in line with earlier observations among community-dwelling older people (Griep et al. 1996, Krall et al. 1998, Marshall et al. 2002, Marcenes et al. 2003). Edentulousness also predicted a poor protein intake in this study. An adequate oral condition may contribute to the functional capacity, because an adequate protein intake is important for older people to maintain and retain muscle mass and functionality (Covinsky et al. 1999, Janssen et al. 2002). A protein deficit may lead to the loss of independence and increased morbidity and mortality (Morley & Silver 1995, Lesourd 2006, Rolland et al. 2008, Landi et al. 2013), and thus also to increased health-care costs (Van Nes et al. 2001, Janssen et al. 2004, Freijer et al. 2013). Therefore, it is important to ensure an adequate protein intake in older residents of assisted living facilities. Special attention should be paid to those older residents with a compromised dentition status.

The use of vitamin D supplements was inadequate. Only a half of the resident took vitamin D supplements and 44% of residents received less than the recommended amount of vitamin D when vitamin D supplements were included in the dietary intake.

Dentition, oral symptoms and mortality

Follow-up studies investigating associations between oral health and mortality are scarce. This study had follow-up of 3 years, which is a strength (Gordon et al. 1995). Dentition did not predict mortality in adjusted models, but its consequences, such as chewing problems and swallowing

difficulties, had an independent predictive value for mortality. This finding is in line earlier studies (Smithard et al. 1996, Ansai et al. 2007, Onder et al. 2007).

7. CONCLUSIONS

Many older residents in assisted living facilities attended to inadequate oral hygiene activities. Less frequent tooth brushing/denture cleaning was associated with dependency, cognitive decline, other oral health problems and malnutrition. The most vulnerable frail older people are at high risk of oral diseases.

Edentulousness is still prevalent among older people, since over half of this study population had lost all their natural teeth. Some of the edentulous participants did not use removable dentures at all, which is significant in terms of nutrition. Edentulousness was associated with dependency in activities of daily living, poor subjective health, comorbidity and malnutrition.

Chewing problems and swallowing difficulties are prevalent among residents in assisted living facilities. Almost half of the study population died during the three-year follow-up. Edentulousness did not predict mortality in an adjusted model, whereas chewing problems and swallowing difficulties did. Edentulousness is intertwined with chewing problems and swallowing difficulties.

Most residents in assisted living facilities were malnourished or at risk of malnutrition. A poor nutritional status was associated with edentulousness, infrequent tooth brushing/denture cleaning, chewing problems and swallowing difficulties.

Inadequate dietary intakes of energy and micronutrients were common in all dentition groups. Inadequate protein and vitamin C intakes were associated with dentition status among older people in assisted living facilities

8. RECOMMENDATIONS

On the basis of the findings of this thesis and the previous scientific literature, the following recommendations can be made:

Malnutrition is a common and complex problem among institutionalized older people, and oral health has a role in maintaining good nutrition. Multi-professional co-operation is essential to tackle these nutritional problems. We need nurses, geriatricians, nutritionists and dental care professionals to work together to improve the nutrition status and nutritional care of dependent older people.

Nutritional assessment and clinical oral examination should be a part of comprehensive geriatric assessment. Assessment of the nutritional status should be performed on admission and on a regular basis in assisted living facilities using the MNA. It is essential to identify those residents who are malnourished or at risk of malnutrition. The causes of this condition should be determined and early interventions to treat them should be performed. Assessment of the dentition status, chewing problems and swallowing difficulties and other oral health problems should be considered as an integral part of the nutritional assessment of older residents. There appears to be a need for training among nurses to recognize these nutritional and oral health problems.

Entry to an assisted living facility is a good time point for older people to also undergo an assessment of their oral health and risks of oral diseases. This should lead to an individual care plan, including both preventive care and necessary dental treatments. This care plan should be part of comprehensive service and care plans of residents. Regular oral examinations and necessary treatments must be arranged for dependent older people, who do not always recognize themselves the need for oral care and treatment. It is also essential that nurses are aware of how to orally examine and treat their patients.

Daily oral hygiene activities should be performed routinely. Nurses should support the residents' own capability to perform oral hygiene procedures and provide appropriate daily oral hygiene measures for dependent residents.

Nurses should be aware of the importance of good oral health to general health, nutrition, well-being and the prevention of diseases such as aspiration pneumonia in older people. Nurses and other

caregivers need structured training to assist or carry out daily oral hygiene for older people. Dental hygienists should provide this training to nursing staff in assisted living facilities.

We need more information on the barriers to dental care among assisted living residents. Moreover, we must develop interventions to minimize these barriers and to improve oral health. This must be done in conjunction with dental care professionals, nursing staff, doctors, nutritionists and social care workers. Dental care services will need to invest in preventive oral health care for older people. A visit to a dental clinic may be impossible for dependent older people, necessitating some form of domiciliary dental care. Mobile dental units provide an opportunity to export comprehensive dental care to the dependent groups of older people.

To promote healthy ageing, good oral health should be achieved before older people become frail and dependent. Oral health care services should be available for all older people when needed.

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PALVELUTALO**ASUKKAAN RAVITSEMUSTILAN ARVIOINTI (MNA)**

Asukkaan sukunimi, etunimi _____

Sotu _____

Palvelutalo: _____

Asuuko asukas ryhmäkodissa: Kyllä ___ Ei ___

Ryhmäkodin nimi: _____

Päivämäärä: _____

Asukkaan pituus _____ cm (katso ohje MNA-testin käyttöoppaasta kysymys 6.)

Paino nyt _____ kg paino syksyllä 2006 _____ kg

Milloin hoitojakso on alkanut? PVM _____ Kesto: vuotta ___ kuukautta ___ päivää _____

Seuraavissa kysymyksissä ympyröi yksi vastausvaihtoehdoista ja kirjaa ympyröimäsi numero kysymyksen oikealla puolella olevaan ruutuun.

SEULONTA

A. Onko ravinnonsaanti vähentynyt viimeisen kolmen kuukauden aikana ruokahaluttomuuden, ruoansulatusongelmien, puremis- tai nielemisvaikeuksien takia?

0 = Kyllä, ravinnonsaanti on vähentynyt huomattavasti

1 = Kyllä, ravinnonsaanti on vähentynyt hieman

2 = Ei muutoksia

B. Painonpudotus kolmen viime kuukauden aikana?

0 = Painonpudotus yli 3 kg

1 = Ei tiedä

2 = Painonpudotus 1-3 kg

3 = Ei painonpudotusta

C. Liikkuminen?

0 = Vuode- tai pyörätuolipotilas

1 = Pääsee ylös sängystä, mutta ei käy ulkona

2 = Liikkuu ulkona

D. Onko viimeisen kolmen kuukauden aikana ollut psyykkistä stressiä tai akuutti sairaus?

0 = Kyllä

2 = Ei

E. Neuropsykologiset ongelmat?

0 = Dementia, depressio tai neuropsykologinen ongelma

1 = Lievä dementia, depressio tai neuropsykologinen ongelma

2 = Ei ongelmia

F. Painoindeksi eli BMI (=paino / (pituus)² kg/m²)

0 = BMI on alle 19

1 = BMI on 19 tai yli, mutta alle 21

2 = BMI on 21 tai yli, mutta alle 23

3 = BMI on 23 tai enemmän **Pisteet yhteensä (1. sivu)**

ARVIOINTI

G. Asuuko haastateltava kotona?

0 = Ei

1 = Kyllä

H. Onko päivittäisessä käytössä enemmän kuin 3 reseptilääkettä?

0 = Kyllä

1 = Ei

I. Painehaavaumia tai muita haavoja iholla?

0 = Kyllä

1 = Ei

J. Päivittäiset lämpimät ateriat (sisältää puurot ja vellit)?

0 = 1 ateria

1 = 2 ateriaa

2 = 3 ateriaa

K. Sisältääkö ruokavalio vähintään

EiKyllä

- Yhden annoksen maitovalmisteita (maito, juusto, piimä, viili)
- Kaksi annosta tai enemmän kananmunia viikossa (myös ruuissa, esim. laatikot)
- Lihaa, kalaa tai linnun lihaa joka päivä

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0 = Jos 0 tai 1 kyllä -vastausta

0.5 = Jos 2 kyllä -vastausta

1 = Jos 3 kyllä -vastausta

L. Kuuluuko päivittäiseen ruokavalioon kaksi tai useampia annoksia hedelmiä tai kasviksia?

0 = Ei

1 = Kyllä

M. Päivittäinen nesteen juonti?

0 = Alle 3 lasillista

0.5 = 3-5 lasillista

1 = Enemmän kuin 5 lasillista

N. Ruokailu

0 = Tarvitsee paljon apua tai on syötettävä

1 = Syö itse, mutta tarvitsee hieman apua

2 = Syö itse ongelmitta

O. Oma näkemys ravitsemustilasta

0 = Vaikea virhe- tai aliravitsemus

1 = Ei tiedä tai lievä virhe- tai aliravitsemus

2 = Ei ravitsemuksellisia ongelmia

P. Oma näkemys terveydentilasta verrattuna muihin samanikäisiin

0 = Ei yhtä hyvä

0.5 = Ei tiedä

1 = Yhtä hyvä

2 = Parempi

Q. Olkavarren keskikohdan ympärysmitta (OVY cm)

0 = OVY on alle 21 cm

0.5 = OVY on 21-22 cm

1.0 = OVY on yli 22 cm

R. Pohkeen ympärysmitta (PYM cm)

0 = PYM on alle 31 cm

1 = PYM on 31 cm tai enemmän

Pisteet yhteensä (2+3. sivu)

Pisteet yhteensä 1. sivulla

Kokonaispistemäärä

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ASUKKAAN TAUSTATIEDOT

Kysymyksien vastausvaihtoehdoista ympäröidään sopivin numero (vain yksi).

19. Ikä: _____ vuotta

20. Sukupuoli?

1 = Nainen

2 = Mies

21. Siviilisääty?

1 = Naimaton

2 = Leski

3 = Eronnut

4 = Avio- tai avoliitossa

22. Koulutus?

1 = Kansakoulu tai vähemmän

2 = Keskikoulu, ammattikoulu, lukio, muu ammattitutkinto

3 = Korkeakoulu

23. Syökö asukas yleensä pääateriansa yksin

1 = Ei

2 = Kyllä

24. Missä asukas syö yleensä pääaterian/pääateriat

1 = Palvelutalon ruokasalissa

2 = Ryhmäkodin ruokasalissa

3 = Ruoka viedään palvelutalon keittiöstä asukkaan kotiin

4 = Ruoka tulee kotiateriapalvelusta asukkaan kotiin

5 = Asukas hoitaa itse ateriansa

6 = Muu, mikä _____

25. Jos asukas syö palvelutalon/ryhmäkodin ruokasalissa

1 = Ruoka tulee valmiiksi annosteltuina asukkaalle

2 = Asukas voi itse tai avustettuna annostella ruokansa

3 = Asukas voi valita useasta pääruokalajista ateriansa

26. Millainen on asukkaan ruoan rakenne?

3 = Nestemäinen

4 = Sosemainen

5 = Pehmeä

6 = Kiinteä (normaali)

27. Kuinka paljon asukas syö tavallisesti pääaterioilla?

1 = vähän

2 = melko vähän

3 = normaalisti

4 = melko paljon

5 = paljon

26. Syökö asukas välipaloja?

1 = Ei

2 = Kyllä

27. Käyttääkö asukas täydennysravintovalmisteita (esim. Nutridrink, Addera, Fresubine)?

1 = Ei

2 = Kyllä

28. Käyttääkö asukas kalsiumvalmistetta?
1 = Ei
2 = Kyllä
29. Käyttääkö asukas D-vitamiinivalmistetta
1 = Ei
2 = Kyllä
30. Seurataanko asukkaan painoa säännöllisesti?
1 = Ei koskaan
2 = Kerran vuodessa tai harvemmin
3 = Kahdesti - kuudesti vuodessa
4 = Yli kuusi kertaa vuodessa
31. Onko asukkaalla seuraavia ruokailuun ja suuhun sekä ruoansulatuselimistöön liittyviä ongelmia? (voi valita useita vaihtoehtoja)
- | | <u>Ei</u> | <u>Kyllä</u> |
|--------------------------------|-----------|--------------|
| 1 = Puremisongelmia | 1 | 2 |
| 2 = Kuiva suu | 1 | 2 |
| 3 = Kipua suussa | 1 | 2 |
| 4 = Nielemisongelmia | 1 | 2 |
| 5 = Ummetusta | 1 | 2 |
| 6 = Ripulia | 1 | 2 |
| 7 = Oksentelua | 1 | 2 |
| 8 = Muita ongelmia, mitä _____ | 1 | 2 |
32. Mikä on asukkaan hampaiston tila?
1 = Hampaaton, ei proteesia
2 = Kokoproteesi sekä ylä- että alaleuassa
3 = Hampaaton, mutta joko ylä- tai alaleuan kokoproteesi ja/tai muita osaproteeseja
4 = Omia hampaita ja yksi tai useampia proteeseja
5 = Vain omia hampaita
33. Peseekö asukas hampaansa/pudistaa proteesinsa päivittäin?
1 = Ei
2 = Kyllä
34. Koska hammaslääkäri tai hammashuoltaja on tarkastanut asukkaan hampaat/suun viimeksi?
1 = alle vuosi
2 = yhdestä kolmeen vuoteen
3 = yli kolme vuotta sitten
35. Onko asukkaalla seuraavia sairauksia tai onko hän sairastanut jonkin niistä aikaisemmin?
- | | <u>Ei</u> | <u>Kyllä</u> |
|--|-----------|--------------|
| 1 = Diabetes (sokeritauti) | 1 | 2 |
| 2 = Sepelvaltimotauti | 1 | 2 |
| 3 = Sydänveritulppa eli sydäninfarkti | 1 | 2 |
| 4 = Aivohalvaus tai aivoverenkiertohäiriöitä | 1 | 2 |
| 5 = Dementia | 1 | 2 |
| 6 = Depressio | 1 | 2 |
| 7 = Muu psykiatrinen sairaus | 1 | 2 |
| 8 = Parkinsonin tauti | 1 | 2 |
| 9 = MS, ALS, muu neurologinen sairaus | 1 | 2 |
| 10 = Reuma tai muu nivelsairaus | 1 | 2 |
| 11 = Krooninen keuhkoputkentulehdus (COPD),
astma tai muu keuhkosairaus | 1 | 2 |
| 12 = Maha- tai pohjukais-suolen haavauma | 1 | 2 |
| 13 = Muu krooninen suolistosairaus | 1 | 2 |

• Jos on, mikä _____		
14 =Lonkkamurtuma	1	2
15 =Syöpä	1	2
• Jos on, mikä _____		
16 =Pitkäaikainen tulehdus	1	2
• Jos on, mikä _____		
17 = Jokin muu pitkäaikainen sairaus	1	2
• Jos on, mikä _____		

Kysytään asukkaalta itseltään:

36. Oletteko tyytyväinen elämäänne?
1. en
 2. kyllä
 3. asukas ei pysty vastaamaan
37. Tunnetteko itsenne tarpeelliseksi?
1. en
 2. kyllä
 3. asukas ei pysty vastaamaan
38. Onko Teillä tulevaisuudensuunnitelmia?
1. ei
 2. kyllä
 3. asukas ei pysty vastaamaan
39. Onko Teillä elämänhalua?
1. ei
 2. kyllä
 3. asukas ei pysty vastaamaan.
40. Oletteko masentunut? (jos asukas ei kykene vastaamaan, hoitajan arvio)
- 1 = harvoin tai ei koskaan
 - 2 = toisinaan
 - 3 = usein tai aina
41. Kärsittekö yksinäisyydestä? (jos asukas ei kykene vastaamaan, hoitajan arvio)
- 1 = harvoin tai ei koskaan
 - 2 = toisinaan
 - 3 = usein tai aina
42. Millaiseksi arvioitte oman terveydentilanne tällä hetkellä?
- 1 = Pidän itseäni terveenä
 - 2 = Pidän itseäni melko terveenä
 - 3 = Pidän itseäni sairaana
 - 4 = Pidän itseäni hyvin sairaana

Hoitajan arvio asukkaan tilanteesta:

43. Millainen on asukkaan muisti (kognitiiviset toiminnot)?
 1 = Ei muistin huonontumista tai pientä muistamattomuutta toisinaan
 2 = Lievää jatkuvaa muistamattomuutta, tapahtumien osittaista muistamista, ”hyvänlaatuista” muistamattomuutta
 3 = kohtalaista muistin huonontumista, selvempänä koskien viimeaikaisia tapahtumia, vaikuttaa jokapäiväisiin toimintoihin
 4 = Vaikea muistihäiriö, vain hyvin opittu aines säilynyt, uusi aines unohtuu pian
 5 = Vaikea muistihäiriö, vain pirstaleita säilynyt
44. Miten asukas huolehtii päivittäisistä toiminnoistaan (itsestä huolehtiminen)
 1 = Täysin kykenevä huolehtimaan itsestään
 2 = Tarvitsee kehotuksia ja muistutuksia
 3 = Tarvitsee apua pukeutumisessa, henkilökohtaisessa hygieniassa ja henkilökohtaisten tavaroidensa hoidossa
 4 = Tarvitsee paljon apua itsestään huolehtimisessa, usein inkontinentti (virtsan tai ulosteen pidätyskyvyttömyys)
45. Pystyykö asukas vaivatta liikkumaan sisällä?
 1 = Kyllä
 2 = Ei, hän tarvitsee kepin tai rollaattorin
 3 = Ei, hän tarvitsee toisen henkilön apua
 4 = Ei, hän ei pysty kävelemään
46. Pystyykö asukas vaivatta liikkumaan ulkona?
 1 = Kyllä
 2 = Ei, hän tarvitsee kepin tai rollaattorin
 3 = Ei, hän tarvitsee toisen henkilön apua
 4 = Ei, hän ei pysty kävelemään
47. Näkeekö asukas lukea?
 1 = Ei
 2 = Kyllä
48. Kuuleeko hän tavallista puhetta?
 1 = Ei
 2 = Kyllä
49. Tiedot taustatietolomakkeeseen antoi
 1 = asukas pääosin itse
 2 = hoitaja

Lääkkeet

- 50. Tulosta tai kopioi asukkaan voimassa oleva lääkelista ja niittaa se tähän kyselylomakkeeseen liitteeksi.**

Lomakkeet palautetaan talon henkilökunnalle ___30_/_3___2007 mennessä

