

**Burden of oral symptoms and its associations with nutrition, well-being, and survival among nursing home residents**

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1 **Abstract**

2

3 **Objectives:** To explore how oral problems: chewing problems, dry mouth, and swallowing  
4 difficulties cluster and whether their burden is associated with nutritional status, eating habits,  
5 gastrointestinal symptoms, psychological well-being, and mortality among institutionalized  
6 residents.

7 **Design:** Cross-sectional study with 1-year mortality.

8 **Setting and participants:** 3123 residents living in assisted facilities and nursing homes in  
9 Helsinki, Finland.

10 **Measures:** Trained nurses assessed residents in all nursing homes and assisted living  
11 facilities in Helsinki in 2011. A personal interview, the Mini Nutritional Assessment (MNA),  
12 oral symptoms, questions about eating habits, and psychological well-being were used to  
13 assess each resident. We divided the subjects first according to the number of oral symptoms  
14 into four groups: No oral symptoms (G0), one oral symptom (G1), two oral symptoms (G2),  
15 and all three symptoms (G3) and second according to the symptoms: dry mouth, chewing  
16 problems and swallowing difficulties. The diagnoses and medications were retrieved from  
17 medical records and mortality data were obtained from central registers.

18 **Results:** In all, 26% of the subjects had one oral problem (G1), 11% had two oral problems  
19 (G2), and 4% had all three oral problems (G3),  
20 whereas 60% (n=1870) had no oral symptoms. Thus, the oral symptoms moderately  
21 overlapped. The burden of oral symptoms was linearly associated with malnutrition, higher  
22 numbers of comorbidities, dependency in physical functioning, gastrointestinal symptoms,  
23 eating less and more often alone. The higher the burden of oral symptoms, the lower the self-

24 rated health and psychological well-being. Mortality increased along with the higher oral  
25 symptoms burden. Of residents, having one or more symptoms 26% had chewing problems,  
26 18% swallowing difficulties and 15% dry mouth.

27 **Conclusions/Implications:** The burden of oral health problems was associated in a stepwise  
28 fashion with poor health and psychological well-being, malnutrition, and mortality.  
29 Clinicians should routinely assess older institutionalized residents' oral health status to  
30 improve residents' well-being.

31 **Keywords:** Dry mouth, chewing problems, swallowing difficulty, psychological wellbeing,  
32 mortality, oral health

33

## 34 **Introduction**

35 Oral symptoms such as dry mouth,<sup>1-3</sup> chewing problems,<sup>3-5</sup> and swallowing difficulties<sup>6-8</sup>  
36 are common among vulnerable older people. Individual symptoms are associated with  
37 malnutrition, disabilities, and comorbidities, especially among institutionalized older  
38 people.<sup>1-5,7,9,10</sup>

39 Dry mouth is defined as a subjective sensation of dryness in the mouth that is often referred  
40 to as xerostomia.<sup>2</sup> The prevalence of xerostomia in community-dwelling older people has  
41 ranged from 17% to 62%.<sup>1,11</sup> In the institutionalized elderly, the prevalence has ranged from  
42 20% to 78%.<sup>1</sup> The prevalence was more than 55%<sup>1</sup> particularly among older people living  
43 with systemic diseases, such as diabetes, Parkinson disease, and cancer. Medications may  
44 work synergistically impairing function of salivary glands, decreasing discharge of saliva.<sup>1</sup>  
45 Dry mouth may have negative impacts on oral health, such as caries and fungal infection.<sup>1</sup>  
46 Decreased saliva secretion alters food taste and may negatively impact the enjoyment of  
47 eating.<sup>12</sup>

48 The number and distribution of teeth influence eating abilities.<sup>13</sup> The proportion of  
49 edentulous subjects varies between 23% and 74% in institutional settings.<sup>14</sup> The processing of  
50 food for digestion starts in the mouth and is dependent on the ability to chew and masticatory  
51 functions that are influenced by tooth loss, various diseases, muscle strength, disabilities, and  
52 medications.<sup>15</sup> Moreover, saliva secretion is needed to form comminuted food into a  
53 lubricated concise bolus that is easier to swallow.<sup>1,2,15</sup> Previous studies have shown that  
54 chewing problems are associated with older age, malnutrition, poor eating, and disabilities,  
55 and may predict mortality.<sup>9,13</sup>

56 The prevalence of swallowing difficulties in long-term care establishments has varied  
57 between 12% and 60%, depending on the setting and assessment method.<sup>7,10,16</sup> Swallowing

58 problems are associated with malnutrition, disabilities, and comorbidities and may also  
59 predict mortality.<sup>7,8,16</sup>

60 Although individual oral problems have been increasingly studied among vulnerable older  
61 people, including residents in long-term care establishments, few studies have explored how  
62 oral health problems overlap and how their burden<sup>3</sup> is associated with nutritional factors,  
63 well-being, symptoms and diseases. The aim of this study is to assess how oral health  
64 problems (dry mouth, chewing problems and swallowing difficulties) cluster with each other  
65 and how the burden of as well as various oral symptoms separately are associated with  
66 nutritional status, eating habits, health factors, gastrointestinal (GI) symptoms, psychological  
67 well-being, and mortality among residents living in institutional care establishments in  
68 Helsinki, Finland.

## 69 **Methods**

70 The study population comprised all residents dwelling in assisted living facilities and nursing  
71 homes in Helsinki in 2011. The original study was designed to assess residents' nutritional  
72 status and nutritional care in these settings. In Finland assisted-living facilities are very  
73 similar to traditional nursing homes with respect to resident characteristics and in having 24-  
74 hour nursing assistance,<sup>17</sup> but they are more homelike. They also include group homes for  
75 people with dementia. The response rate of the study was 72% (N=3188). Those not  
76 responding either refused or suffered from moderate to severe dementia and did not have a  
77 proxy to give an informed consent (n=1261). In addition, we excluded those residents not  
78 having the data concerning oral symptoms (n=65). This study includes all residents having  
79 information on three oral symptoms (dry mouth, chewing problems, swallowing difficulties)  
80 and mortality (N=3123). The data of this cross-sectional study were collected in 2011 by  
81 registered nurses who were close caregivers to the residents. They were trained in a one full

82 day hands-on training to complete questionnaires by assessing each resident. All items in the  
83 questionnaire were discussed in this training sessions. Nurses were also guided to inquire  
84 residents about several items such as psychological well-being. The structured questionnaire  
85 was used in two previous nutrition studies in nursing homes and assisted living facilities in  
86 Finland.<sup>18,19</sup>

87 The questionnaire included socio-demographic variables (age, sex, education) and medical  
88 records, used to retrieve current medical diagnoses and use of medications. Comorbidity was  
89 calculated for each participant, using Charlson's comorbidity index.<sup>20</sup> One-year mortality was  
90 retrieved from central registers. Anticholinergic drugs were defined according to the  
91 Anticholinergic Risk Scale.<sup>21</sup>

92 Chewing and swallowing problems, and oral symptoms concerning dry mouth were referred  
93 to by the yes/no questions: "Does the resident suffer from chewing problems?", "Does the  
94 resident have a dry mouth?", and "Does the resident suffer from swallowing difficulties?"  
95 The nurses' evaluations were based on bedside assessment, and observation of the residents  
96 while eating and swallowing. The nurses were trained to assess each resident's mouth  
97 problems (dental status, dryness of mouth). They were also trained to recognize swallowing  
98 disorder. Specific tests were not used for swallowing or secretion of saliva. The dentition  
99 status of residents was categorized, according to the type of dentition, in five groups: 1)  
100 edentulous without dentures, 2) edentulous with complete dentures in the upper and lower  
101 jaws, 3) edentulous, upper or lower complete denture, 4) natural teeth with one or more  
102 dentures (mixed dentition) or 5) natural teeth only.

103 The resident's nutritional status was assessed with the Mini Nutritional Assessment (MNA).<sup>22</sup>  
104 Each subject was categorised as having good nutrition (24–30 points), being at risk of  
105 malnutrition (17–23.5) or being malnourished (<17).<sup>22</sup> Feeding was assessed in three

106 categories: eats independently, eats with some assistance and unable to eat without assistance.

107 GI symptoms ( constipation, diarrhoea, and vomiting) were charted with yes/no options.

108 The consistency of the food offered was divided into two groups: normal or soft and pureed,

109 or liquid food. The average proportion of food consumed by residents was assessed with the

110 question: How much on average does the resident eat of the main meal? The nurses were

111 instructed to compare this proportion with model portions, for which images were available.

112 The average amount of a meal consumed was dichotomized as eating adequately (eats very

113 much, quite much, and normally) and eating little (quite little or little). The use of protein- or

114 energy-rich meals, and oral protein-energy supplements was inquired with yes/no questions.

115 The subjects' cognitive and physical functioning were assessed with well-validated questions

116 retrieved from the Clinical Dementia Rating (CDR) scale.<sup>23</sup> The subject's stage of cognition

117 was evaluated according to the stage 'at least moderate cognitive decline': CDR 'memory'

118 item  $\geq 2$ . The subject's physical functioning was considered dependent if the CDR 'personal

119 care' item was  $\geq 2$ .

120 The psychological well-being was assessed, using six questions about (1) life satisfaction

121 (yes/no), (2) feeling needed (yes/no), (3) having plans for the future (yes/no), (4) having zest

122 for life (yes/no), (5) feeling depressed (seldom or never/sometimes/often or always), (6)

123 suffering for loneliness (seldom or never/ sometimes/often or always). The psychological

124 well-being score<sup>24</sup> was created from questions in which each question represented 0 points

125 (no in questions 1–4, often or always' in questions 5 or 6), 0.5 points (sometimes in questions

126 5 or 6), or 1 point (yes in questions 1–4, seldom or never in questions 5 or 6). The total

127 amount of points was then divided by the number of questions the residents were able to

128 answer. Thus, a score of 1 represented the best well-being and 0 the poorest. These questions

129 have been used in a number of studies,<sup>24–26</sup> and the validity<sup>25</sup> and reliability<sup>26</sup> of the scale

130 have been evaluated. Residents' self-rated health was inquired by a question 'How do you  
131 rate your current health status?' (1 = healthy, 2 = quite healthy, 3 = unhealthy and 4 = very  
132 unhealthy). Those answering healthy and quite healthy were considered as having good self-  
133 rated health. Those residents unable to answer, due to severe dementia, were not included in  
134 the psychological well-being and self-rated health items.

135 The residents were grouped (G0, G1, G2, G3) as having no, one, two, or three oral symptoms  
136 (symptoms in chewing, swallowing, dry mouth). A Venn diagram was created to illustrate the  
137 clustering and burden of oral symptoms. In addition, residents were grouped according to  
138 their symptoms: dry mouth, chewing problems and swallowing difficulties. The categorical  
139 variables were described as percentages (%), the continuous variables as means and standard  
140 deviations (SDs). The demographic and clinical characteristics of the participants in the  
141 groups were compared. Statistical significance for the hypotheses of linearity was evaluated,  
142 using analysis of variance (ANOVA), the Cochran-Armitage test, or logistic models. In the  
143 case of violation of the assumptions (e.g. non-normality), a bootstrap-type test was used.  
144 Difference between oral symptoms groups were evaluated using generalized estimating  
145 equations (GEE) with appropriate distribution and link function. To determine characteristics  
146 associated with burden of oral symptoms, multivariate forward stepwise ordered logistic  
147 regression analysis were applied. Mortality analyses were performed with the Log-rank test  
148 and Cox regression models. The normality of the variables was tested, using the Shapiro-  
149 Wilk W-test. All analyses were performed using STATA software version 14.0 (StataCorp  
150 LP, College Station, TX, USA).

151 All the study procedures have been performed according to Helsinki Declaration. The Ethics  
152 Committee of Helsinki Central Hospital and City of Helsinki (Ethical committee of medicine)  
153 approved this study. The participation in this study was voluntary. Each participant or his/her  
154 closest proxy gave written consent to participate before the commenced the study procedure.



## 155 **Results**

156 Of all participants, 40% (n=1253) had at least one oral symptoms, 15% (n=462) with dry  
157 mouth, 26% (n=817) with problems in chewing, or 18% (n=548) with difficulties in  
158 swallowing. The oral symptoms moderately overlapped. Of these subjects, 26% had one oral  
159 problem (G1), 11% had two oral problems (G2), and 4% had all three oral problems (G3),  
160 whereas 60% (n=1870) had no oral symptoms (Figure 1). Of all participants 15% had dry  
161 mouth, 26% had chewing problems and 18% swallowing difficulties.

162 Table 1 presents the demographic and health characteristics of the study population, divided  
163 into groups according to the burden of oral symptoms and the table 2 in groups divided  
164 according to oral symptoms. The mean age of the study participants was 84 years, 77% being  
165 females. The burden of oral symptoms was associated with more advanced age, higher  
166 numbers of comorbidities, and poorer self-rated health. Nursing home residents had higher  
167 burden of oral symptoms than those living in assisted living facilities. There was also a linear  
168 relationship between the higher number of oral symptoms and stroke and Parkinson disease.  
169 In addition, a linear relationship was not observed between the higher number of medications,  
170 use of anticholinergic drugs, and lower number of oral symptoms. The more the participants  
171 had oral symptoms, the more often they were dependent on their physical functioning and  
172 unable to walk independently inside. In addition, there was a linear relationship between the  
173 number of oral symptoms and poorer psychological well-being (see Table 1).

174 Those having various oral symptoms were older and lived more often in nursing homes than  
175 those not having any oral symptoms. The participants having oral symptoms had lower self-  
176 rated health and poorer psychological well-being that those not having oral symptoms. In  
177 addition, mortality was higher in the oral symptom groups compared to that of those not  
178 having oral symptoms (see Table 2).

179 The associations between dentition status, nutritional factors, GI symptoms and eating habits  
180 with burden of oral symptoms are shown in table 3 and with the various oral symptoms are  
181 shown in Table 4. Malnutrition according to the MNA was significantly associated with the  
182 burden of oral symptoms as well as with various oral symptom.

183 Residents with oral symptoms needed more help in eating than those not having oral  
184 symptoms. They also ate more often alone during the main meal. The more the participants  
185 had oral symptoms, the larger the proportion who ate little or very little and more often food  
186 with a pureed or liquid consistency. The use of protein supplements and energy-/protein-rich  
187 meals was associated in a step-wise fashion with the burden of oral symptoms. Dental status  
188 was also associated with the burden of oral symptoms: the prevalence of natural teeth only  
189 was highest among those with no oral symptoms, whereas the prevalence of edentulousness  
190 without dentures was highest among those with three oral symptoms. The more the  
191 participants had oral symptoms, the more often they had, vomiting, constipation, and  
192 diarrhoea. There were similar difference concerning various oral symptoms compared to  
193 those having no oral symptoms (see Table 4).

194 We performed a fully adjusted multivariate model to explore which characteristics and  
195 variables were associated with the burden of oral symptoms. **Several gastrointestinal**  
196 **symptoms, nutritional status, and nutritional care factors were associated with burden of oral**  
197 **symptoms whereas age, sex, dependence in physical functioning or comorbidities were not**  
198 **(see Table 5).**

199 Mortality was associated with the burden of oral symptoms even when adjusted for age and  
200 sex. In the Cox regression model adjusted for age, sex, having one oral symptom (Group 1)  
201 predicted mortality HR 1.19 (95% CI 1.07–1.32; p=0.001), having two oral symptoms (group

202 2) HR 1.62 (95% CI 1.41-1.85,  $p<0.001$ ) and having three oral symptoms HR 1.70 (95% CI  
203 1.37-2.12;  $p<0.001$ ).

## 204 **Discussion**

205 Our study shows the magnitude of oral symptoms in institutional settings, and how they are both  
206 separately and their burden is linearly associated with poor well-being and mortality. Of the residents  
207 (N=3123) living in long-term care settings, 40% showed at least one oral symptom and the three  
208 symptoms examined (dry mouth, chewing problems, and swallowing difficulties) clustered in 4% of  
209 participants. The more the participants had oral problems, the larger the proportions of subjects that  
210 were malnourished, ate less and more often alone. The participants with higher burdens of oral  
211 symptoms had poorer dental status and more frequent GI symptoms. Higher burden of oral  
212 symptoms was linearly associated with poorer psychological well-being and self-rated health  
213 and with higher mortality even adjusted for age and sex.

214 To our knowledge, this is the first study to explore clustering of oral symptoms and the  
215 associations of their burden with various outcomes. The strengths of the study include a large  
216 and representative sample of all residents of long-term care establishments in Helsinki. Each  
217 nurse familiar with the resident was trained thoroughly in performing the assessments and  
218 interviews, and the information was collected with the structured questionnaire, validated and  
219 used in previous nutrition studies of nursing homes and assisted living facilities in Finland.  
220 We used validated MNA,<sup>22</sup> which is widely used to indicate malnutrition in older people.

221 One limiting factor was that the oral symptoms were recorded only with single yes/no  
222 questions. No formal measurements of dry mouth or tests in difficulties of chewing or  
223 swallowing were used, and the assessment was thus based only on the nurses' evaluation,  
224 which still may have underestimated the prevalence of oral symptoms. Thus, probably the  
225 severe cases were identified thus reinforcing the associations between oral symptoms and

226 various characteristics. Due to the cross-sectional nature of the baseline data, it is impossible  
227 to draw any conclusions on the causal relationships between the burden of oral symptoms and  
228 its associations. The response rate was fairly good. However, those not responding represent  
229 probably the frailest part of this population (moderate-severe dementia, not having a proxy)  
230 and may underestimate the true prevalence of oral symptoms. Thus, generalizing these  
231 findings should be done with caution.

232 The proportion of residents with chewing problems (26%), swallowing difficulties (18%), or  
233 dry mouth (15%) were similar to or lower compared to those in previous studies concerning  
234 long-term care establishments.<sup>1,9,11,27</sup> Our evaluation methods may explain the differences  
235 between the prevalences. The nurses' clinical assessment may not have been as sensitive in  
236 identifying these problems as the detailed tests for dry mouth or swallowing.

237 The novel finding in this study was that the burden of oral symptoms was so strongly and in a  
238 stepwise manner associated with malnutrition, eating habits, and GI symptoms. Two in three  
239 of those with three oral symptoms were malnourished, nearly one in three ate alone, and four  
240 in ten ate little or very little. Malnutrition was very common in this population, especially  
241 among those with two or three oral symptoms. The proportions of malnutrition among those  
242 residents having increased burdens of oral symptoms were even higher than Cereda and co-  
243 workers found in their large meta-analysis (2016) of long-term care settings.<sup>28</sup> The burden of  
244 oral symptoms may lead to poor diet quality among older adults, which may lead to nutrient  
245 deficiencies,<sup>29,30</sup> discomfort when eating, or shame when eating in front of other people.<sup>31</sup>  
246 The burden of oral symptoms was linearly associated with all types of GI symptoms, both  
247 constipation and diarrhoea, suggesting that oral symptoms are intertwined with the quality of  
248 the diet, poor mobility, and poor drinking. Residents with oral symptom burden also showed  
249 poor dentition status, which further contributed to these problems.

250 Unexpectedly, some variables such as education, severity of cognitive decline, diabetes,  
251 chronic infections, chronic intestinal diseases or psychiatric diseases were not associated with  
252 burden of oral symptoms. Low education and cognitive decline have in previous studies been  
253 associated with edentulousness.<sup>29</sup>

254 Malnutrition, poor self-rated health and lower psychological well-being were in a stepwise  
255 fashion associated with burden of oral symptoms, which is in line with previous studies.

256 Several studies have shown that a poor oral health-related quality of life (OHRQoL) rating  
257 was associated with risk of malnutrition.<sup>31,32</sup> A recent review stated that decreased health-  
258 related quality of life (HRQoL) and severity of dysphagia have an inverse bidirectional  
259 relationship.<sup>33</sup> Furthermore, xerostomia had a significant and negative impact on self-rated  
260 health and quality of life.<sup>34</sup>

261 In line with prior studies the burden of oral symptoms was also significantly associated with  
262 mortality.<sup>7,29</sup> Those with higher burden of oral symptoms also had higher numbers of  
263 comorbidities and increased problems in mobility and daily functioning. Indeed, the burden  
264 of oral symptoms predicted higher mortality. Several studies have suggested that focusing on  
265 oral health problems may benefit institutionalized residents' health outcomes and quality of  
266 life.<sup>35,36</sup>

## 267 **Conclusions/Implications**

268 The burden of oral health problems is a serious problem in institutional settings. It is  
269 associated in a stepwise fashion with malnutrition, gastrointestinal symptoms, psychological  
270 well-being, and mortality. It is also associated with higher need for nutritional care.

271 **Clinicians should routinely assess older institutionalized residents' oral health status to**  
272 **improve their well-being.**

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361 Legends to figure:

362 Figure 1. Venn diagram showing clustering of oral symptoms (dry mouth, chewing problems,  
363 swallowing difficulties) among institutionalized residents in Helsinki, Finland.

Table 1.

Table 1. Characteristics of residents in assisted living facilities and nursing homes in Helsinki divided into groups according to their number of oral symptoms (dry mouth, chewing problems, swallowing problems): no oral symptoms (G0), having one oral symptom (G1), having two oral symptoms (G2), having three symptoms (G3).

Characteristic	G0: No oral problems N=1870	G1: One oral problem N=789	G2: Two oral problems N=354	G3: Three oral problems N=110	P <sup>a</sup>	P <sup>b</sup>
Age, mean (SD)	84 (8)	84 (8)	85 (8)	85 (7)	0.005	n.a.
Female %	76	78	78	77	0.23	n.a
Education <8years, %	48	51	53	47	0.22	0.28
Living in %					0.004	0.004
Nursing home	49	55	56	55		
Assisted living facility	51	45	44	45		
Self-rated health good, % (n responders <sup>c</sup> )	78 (n=1320)	69 (n=497)	59 (n=184)	33 (n=49)	<0.001	<0.001
Charlson index, mean (SD)	2.3 (1.5)	2.4 (1.4)	2.5 (1.5)	2.6 (1.8)	0.013	0.009
Mean number of medications (SD)	8.2 (3.6)	7.8 (3.7)	7.5 (3.9)	8.0 (4.7)	0.002	0.002
Drug with anticholinergic property, %*	49	48	43	43	0.020	0.049
Stroke, %	25	29	30	36	<0.001	<0.001
Dementia, %	73	71	73	63	0.11	0.049
Psychiatric disease, %	11	12	12	9	0.72	0.45
Parkinson disease, %	5	6	7	10	0.007	0.005
Diabetes, %	7	5	8	9	0.53	0.58
Chronic intestinal disease, %	4	5	4	7	0.59	0.86
Chronic infection, %	5	5	6	8	0.067	0.098
At least moderate cognitive decline: CDR “memory” item $\geq 2$ , %	72	70	77	75	0.092	0.17
Able to walk independently indoors (with or without device), %	56	40	27	21	<0.001	<0.001
Dependent in physical functioning: CDR “personal care” item $\geq 2$ , %	85	88	94	93	<0.001	<0.001
Psychological wellbeing, mean (SD) (n responders <sup>c</sup> )	0.72 (0.24) (n=1430)	0.69 (0.26) (n=553)	0.63 (0.29) (n=209)	0.52 (0.25) (n=55)	<0.001	<0.001
Mortality, % (95% CI)	60 (58 to 62)	67 (63 to 70)	76 (71 to 80)	80 (72 to 87)	<0.001	<0.001

SD: standard deviation, Charlson comorbidity index (Charlson et al. 1987), CDR: Clinical Rating scale (Hughes et al. 1982). Psychological wellbeing (Routasalo et al. 2009). <sup>a</sup> p for linearity. <sup>b</sup> P-values adjusted with age and gender. <sup>c</sup> Those with severe dementia excluded

Table 2.

Table 2. Characteristics of residents in assisted living facilities and nursing homes in Helsinki divided into groups according to their oral symptoms (dry mouth, chewing problems, swallowing problems).

Characteristic	No oral problems (N=1870)	Dry mouth (N=462)	Chewing problems (N=817)	Swallowing difficulties (N=548)	P <sup>a</sup>	P <sup>b</sup>
Age, mean (SD)	84 (8)	85 (7)	85 (8)	84 (8)	<0.001	n.a.
Female %	76	81	79	74	0.020	n.a.
Education <8years, %	48	53	55	57	0.19	0.30
Living in %					<0.001	<0.001
Nursing home (n=1509)	49	53	56	61		
Assisted living facility (n=1614)	51	47	44	39		
Self-rated health good, % (n responders <sup>c</sup> )	78 (n=1320)	60 (n=327)	65 (n=426)	52 (n=259)	<0.001	<0.001
Charlson index, mean (SD)	2.3 (1.5)	2.4 (1.5)	2.4 (1.5)	2.6 (1.5)	<0.006	<0.005
Mean number of medications (SD)	8.2 (3.6)	8.9 (4.2)	7.4 (3.8)	7.3 (3.8)	<0.001	<0.001
Drug with anticholinergic property, %*	49	47	45	43	0.055	0.072
Stroke, %	25	27	29	37	<0.001	<0.001
Dementia, %	73	60	74	74	<0.001	<0.001
Psychiatric disease, %	11	13	12	10	0.38	0.10
Parkinson disease, %	5	8	5	9	<0.001	<0.001
Diabetes, %	7	21	16	16	<0.001	<0.001
Chronic intestinal disease, %	4	6	3	4	0.17	0.20
Chronic infection, %	5	7	6	6	0.17	0.19
At least moderate cognitive decline: CDR “memory” item $\geq 2$ , %	72	61	78	80	<0.001	<0.001
Able to walk independently indoors (with or without device), %	56	44	32	21	<0.001	<0.001
Dependent in physical functioning: CDR “personal care” item $\geq 2$ , %	85	82	93	95	<0.001	<0.001
Psychological wellbeing, mean (SD) (n responders <sup>c</sup> )	0.72 (0.24) (n=1430)	0.61 (0.28) (n=336)	0.66 (0.27) (n=475)	0.65 (0.26) (n=294)	<0.001	<0.001
Mortality, % (95% CI)	60 (58 to 62)	71 (66 to 75)	72 (69 to 75)	76 (72 to 79)	<0.001	<0.001

SD: standard deviation, Charlson comorbidity index (Charlson et al. 1987), CDR: Clinical Rating scale (Hughes et al. 1982). Psychological wellbeing (Routasalo et al. 2009). <sup>a</sup> Difference between oral symptoms groups were evaluated using generalized estimating equations (GEE) with appropriate distribution and link function. <sup>b</sup> P-values adjusted with age and gender. <sup>c</sup> Those with severe dementia excluded. n.a.=not applicable.

Table 3.

Table 3. Nutritional status, nutritional care and oral status and gastrointestinal symptoms of residents in assisted living facilities and nursing homes in Helsinki divided into groups according to their number of oral symptoms (dry mouth, chewing problems, swallowing problems): no oral symptoms (G0), having one oral symptom (G1), having two oral symptoms (G2), having three symptoms (G3).

Nutrition	G0: No oral problems N=1870	G1: One oral problem N=789	G2: Two oral problems N=354	G3: Three oral problems N=110	P-value <sup>a</sup>	P*-value <sup>b</sup>
<i>Nutritional status</i>						
MNA, %					<0.001	<0.001
< 17p, malnourished	17	27	47	64		
17-23p, at risk for malnutrition	65	65	49	32		
>23.5, well-nourished	18	9	4	5		
<i>Nutritional care</i>						
Feeding					<0.001	<0.001
Eats independently	57	35	19	19		
Eats with some assistance	29	33	31	19		
Unable to eat without assistance	18	31	50	62		
Eats alone	14	17	19	29	<0.001	<0.001
Consistency of food: liquid or pureed, %	7	28	47	60	<0.001	<0.001
Eats little or very little on the main meals, %	20	29	37	40	<0.001	<0.001
Eats protein energy supplements, %	8	12	23	30	<0.001	<0.001
Energy or protein rich meal, %	5	9	16	22	<0.001	<0.001
<i>Oral status and gastrointestinal symptoms</i>						
Dentition status, %					<0.001 <sup>c</sup>	n.a.
Edentulous without dentures	7	17	23	29		
Edentulous, complete dentures in upper and lower jaw	26	19	17	18		
Edentulous, upper or lower complete dentures	6	8	8	12		
Natural teeth with one or more dentures	15	17	14	8		
Natural teeth only	45	39	38	33		
Constipation	31	40	51	59	<0.001	<0.001
Diarrhoea	10	12	12	21	<0.001	<0.001
Vomiting	3	5	8	12	<0.001	<0.001

<sup>a</sup> p for linearity; <sup>b</sup> Variables tested adjusted with age and gender; <sup>c</sup> Differences between groups were tested using the chi-square test. n.a. =not applicable. MNA Mini Nutritional Assessment (Guigoz et al.1997)

Table 4.

Table 4. Nutritional status, nutritional care and oral status and gastrointestinal symptoms of residents in assisted living facilities and nursing homes in Helsinki divided into groups according to their number of oral symptoms (dry mouth, chewing problems, swallowing problems): no oral symptoms (G0), having one oral symptom (G1), having two oral symptoms (G2), having three symptoms (G3).

Nutrition	No oral problems (N=1870)	Dry mouth (N=462)	Chewing problems (N=817)	Swallowing difficulties (N=548)	P-value <sup>a</sup>	P*-value <sup>b</sup>
<i>Nutritional status</i>						
MNA, %					<0.001	<0.001
< 17p, malnourished	17	35	39	50		
17-23p, at risk for malnutrition	65	56	55	46		
>23.5, well-nourished	18	9	6	4		
<i>Nutritional care</i>						
Feeding					<0.001	<0.001
Eats independently	57	41	24	16		
Eats with some assistance	29	29	32	27		
Unable to eat without assistance	14	30	43	58		
Eats alone	14	23	19	19	<0.001	<0.001
Consistency of food: liquid or pureed, %	7	26	43	51	<0.001	<0.001
Eats little or very little on the main meals, %	20	36	33	35	<0.001	<0.001
Eats protein energy supplements, %	8	18	17	24	<0.001	<0.001
Energy or protein rich meal, %	5	12	12	18	<0.001	<0.001
<i>Oral status and gastrointestinal symptoms</i>						
Dentition status, %					<0.001	<0.001
Edentulous without dentures	7	15	26	22		
Edentulous, complete dentures in upper and lower jaw	26	24	16	16		
Edentulous, upper or lower complete dentures	6	9	9	8		
Natural teeth with one or more dentures	15	18	14	11		
Natural teeth only	45	34	34	44		
Constipation	31	50	46	49	<0.001	<0.001
Diarrhoea	10	17	13	13	<0.001	<0.001
Vomiting	3	7	7	9	<0.001	<0.001

<sup>a</sup> Difference between oral symptoms groups were evaluated using generalized estimating equations (GEE) with appropriate distribution and link function.; <sup>b</sup> Variables tested adjusted with age and gender; <sup>c</sup> Differences between groups were tested using the chi-square test. n.a. =not applicable. MNA Mini Nutritional Assessment (Guigoz et al.1997)

Table 5. Characteristics and variables associated with burden of oral symptoms in multivariate forward stepwise ordered logistic regression analysis. Care site (nursing home s. assisted living facility), comorbidities (Charlson comorbidity index) or dependence in physical functioning were included in the model but were not associated with burden of oral symptoms.

	OR	95% CI	p value
Age	1.00	0.99 to 1.01	0.54
Sex	1.08	0.90 to 1.29	0.40
MNA, malnourished	1.00		
MNA, at risk for malnutrition	0.50	0.41 to 0.59	<0.001
MNA, well-nourished	0.27	0.20 to 0.36	<0.001
Constipation	1.63	1.41 to 1.90	<0.001
Vomiting	2.42	1.72 to 3.41	<0.001
Energy or protein rich meal	1.65	1.25 to 2.18	<0.001
Protein energy supplement	1.30	1.00 to 1.63	0.047
Eats little or very little	1.37	1.15 to 1.63	<0.001
Eats alone	1.26	1.04 to 1.53	0.020
Number of drugs	0.98	0.96 to 1.00	0.071

Figure 1.

N = 3123

