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ORIGINAL ARTICLE

Relationship between cognitive impairment and oral health: results of the Health 2000 Health Examination Survey in Finland

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Abstract

Objective. The aim was to study oral health in relation to cognitive impairment in the general population. ***Material and Methods.*** The study population comprised 2320 persons aged 55 years or older who participated in a nationally representative Health 2000 Health Examination Survey in Finland. The data were collected by interviews and clinical oral examinations. Cognition was assessed using a shortened version of the Mini-Mental State Examination (score 0–16). Poisson regression models were used to estimate the relative risk (RR) for continuous variables and logistic regression models to estimate the odds ratio (OR) for dichotomized variables. ***Results.*** The results show that individuals with cognitive impairment have more carious teeth (MMSE 11-10: RR: 1.3, CI: 0.9–1.7, MMSE 9-0: RR: 1.5 CI: 1.0–2.4) than healthy persons. Furthermore, compared to cognitively healthy subjects, those with MMSE 9–0 more often have no teeth and no dentures (OR: 5.2, CI: 1.0–26.6) and less often good denture hygiene (OR: 0.4, CI: 0.2–0.7). ***Conclusion.*** Cognitively impaired subjects among older adults in Finland have more carious teeth, are more often edentulous without using a denture, and have poorer denture hygiene than cognitively healthy persons.

Key Words: *Cognitive impairment, dental caries, periodontal pockets, removable dentures*

Introduction

Cognitive impairment in elderly people, in parallel with their increase in number, is an increasing problem. It has been estimated that dementia, the main condition causing cognitive impairment among the elderly, occurs in about 1% of Europeans aged between 65 and 69 years, and in about 29% of those aged 90 years or older [1]. In Finland, 7% of individuals 65 years or older are reported to have severe dementia, while prevalence among the 85-year-olds and above is 38% [2,3].

Oral health is important in elderly people because it affects quality of life [4], ability to chew and speak [5], and nutritional status [6]. Earlier studies have shown cognitively impaired patients to have poor oral clinical status. For example, demented patients have more dental plaque [7,8] and a higher debris index [9] than patients without dementia. Patients with dementia also have a poorer periodontal condition [8], higher coronal and root caries increments [10,11], higher DMFT scores [8], more unrestorable teeth, and fewer filled and sound teeth [12] than patients without dementia.

Warren et al. [9] and Akiyama et al. [12] found no significant associations between presence of dementia and number of teeth. Concerning the use of dentures, demented patients less often have dentures than those without dementia [7,13]. Early demented patients have also been found to have dirtier and older dentures compared to controls [14].

Previous studies concerning oral health among cognitively impaired elderly patients have been carried out in restricted populations and so the results of these studies cannot be generalized to the general population. In this national study, it was possible to obtain information at the population level and to give an overview of oral health among cognitively impaired patients. The aim was to

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analyse oral health in relation to cognitive impairment in the general population.

Material and methods

The nationally representative Health 2000 Health Examination Survey was conducted in 2000–2001 by the National Public Health Institute of Finland [15]. The study population comprised home-dwelling, community-dwelling, and institutionalized persons aged 30 years or older living in continental Finland ($n = 8028$). The sampling fraction of those 80 years or older was doubled in order to involve a sufficient number of elderly people in the study. Almost 89% of the sample participated in an interview and 85% in a health examination. The present study is based on the subpopulation of those aged 55 or older ($n = 2320$).

The data for this research were collected by interviews and oral clinical examinations. In the oral clinical examination the World Health Organization directions were applied [16,17]. Informed consent was obtained from the participants or from their guardians.

Interview

The interviews, conducted by Finnish Statistics and performed by trained professional interviewers, were carried out at the participant's home or at a place indicated by the participant; 9% were done in institutions. Guardians of the participants with cognitive impairment were asked to provide supplementary data as needed. The questions asked in the interview are documented in Aromaa & Koskinen [15].

A shortened version of the Mini Mental State Examination (MMSE) [18] (sum score: mean = 13.44, SD = 2.30, min = 0, max = 16) was used to measure cognitive function, and the MMSE questionnaire was filled in during the home interviews of the participants aged 55 years or older.

The following items of the MMSE scale were used: year, month, day, immediate recall of three words, attention (series 7's), delayed recall of three words, reading, and pentagons. The cut-off point for cognitive impairment in the shortened MMSE for this study was 12 (healthy: score 16–12), which corresponds to the conventional cut-off point of 24 for mild dementia in the long version of MMSE [18].

To investigate the impact of the severity of cognitive impairment on oral health, the group with cognitive impairment was divided into subgroups with mild cognitive impairment (score 11–10) and moderate to severe impairment (9–0).

In the interview, the presence of full denture, partial denture with own natural teeth, own natural teeth, and edentulousness without denture was ascertained. Furthermore, the ability to chew was elicited as follows: no problems in chewing hard or chewy food versus problems in chewing. Smoking was categorized as smoking daily, smoking occasionally, and non-smoking.

Level of education was categorized as follows: low level of education, i.e. no formal vocational or senior secondary education, middle level of education, i.e. vocational training and matriculation examination, and high level of education, i.e. education at higher vocational institutions, universities, or polytechnics.

Oral examination

Five dentists carried out the clinical oral examination with the patient in a dental chair. A headlamp, mouth mirror, and periodontal probe were used in line with the WHO instructions. Calibration was done by having five dentists and a reference dentist who recorded the clinical parameters of 42 persons on the same day. Agreement on dental status was 95% (kappa 0.86), on periodontal pockets 82% (kappa 0.32), and on mucosal lesions 88% (kappa 0.34). Number of teeth included the total number of visible and tactile teeth and tooth remnants in the maxilla and mandible.

Dental caries was examined visually by probing on each surface of all teeth after the teeth were blown dry. Dental caries was diagnosed by surface but recorded by tooth as follows: caries in dentin including crown caries, root caries, both crown and root caries, and carious radix.

Periodontal pocket depth on probing was measured on the four surfaces of each tooth, except in the 3rd molars. All teeth with probing depths of 4 mm or more at any site were recorded as teeth with periodontal pockets.

In the clinical examination, ulcer and hyperplasia related to removable denture and denture stomatitis were recorded. The use of upper and lower dentures and the need to repair the denture were also recorded. The hygiene level of removable denture was determined as good versus poor as follows: hygiene was good if there was no visible plaque and calculus.

Statistical analyses

Descriptive statistics included socio-demographic variables, smoking habits, ability to chew food, the score of the short MMSE, and the dental variables of the participants.

We used Poisson's regression model to estimate the relative risk (RR) and 95% confidence intervals (CI) for continuous variables and logistic regression models to estimate the odds ratios (OR) and 95% confidence intervals for dichotomized variables. The models were adjusted for age, sex, education, smoking, and number of teeth. We used the STATA

SURVEY DATA (version 8.0, Stata Corporation, 2003) procedures svytab, svylogit, and svypoisson to take into account the two-stage cluster sampling method.

Results

Altogether 31% of the study subjects were edentulous. The descriptive statistics (Tables I–III) indicate that the subgroup with moderate or severe cognitive impairment included more older and institutionalized persons, more with lower education, and more with poor ability to chew compared to the other participants (Table I). Furthermore, the subjects with the lowest MMSE scores had an average of 12.7 teeth and 1.7 carious teeth, whereas the corresponding values for the cognitively healthy persons were 18.2 and 0.8 (Table II). Five percent of those with the lowest MMSE scores had no teeth and no dentures, 75% had removable dentures, 23% had good hygiene of removable dentures, 21% had removable denture-related ulcers, and 18% had hyperplasia. The corresponding percentages were 0.4, 57, 45, 17, and 12 among the cognitively healthy (Table III).

The results are presented in Tables IV and V. Cognitive impairment was associated with number of carious teeth (Table IV). Among those with mild cognitive impairment, the relative risk was 1.3 (CI: 0.9–1.7, $p=0.13$), while among those with moderate to severe cognitive impairment the relative risk was 1.5 (CI: 1.0–2.4, $p=0.04$) compared to the cognitively healthy subjects. Cognitive impairment had a weak association with number of teeth (Table IV). We did not find consistent associations between cognitive impairment and the number of teeth with periodontal pockets (Table IV).

The results showed that the subjects with moderate to severe cognitive impairment had increased odds of having no teeth and no dentures compared to the healthy persons (OR: 5.2, CI: 1.0–26.6; $p=0.05$) (Table V). They were also less likely to have good denture hygiene (OR: 0.4, CI: 0.2–0.7; $p=0.001$) and more likely to have denture-related ulcers (OR: 1.6, CI: 0.9–2.6; $p=0.08$) and hyperplasia (OR: 1.8, CI: 1.0–3.4; $p=0.06$) compared to the cognitively healthy persons (Table V). We did not find significant associations between the subjects' cognitive level and use of removable dentures, presence of denture stomatitis, or need to repair their dentures.

Discussion

The results of this national Finnish sample show that cognitive impairment is associated with a high number of carious teeth, edentulousness without using dentures, and poor denture hygiene. Moreover, even subjects with mild cognitive impairment have a higher number of carious teeth and more often no teeth and no dentures compared to healthy subjects.

Our results are consistent with those of Chalmers et al. [11], who found cognitive impairment to be associated with a high number of carious teeth. Among the several possible explanations for the high prevalence of caries are: deterioration of abilities, knowledge, and understanding concerning oral health behavior and consequent poor hygiene and inadequate use of health services, but also medication and diet. Dementia is associated with depression, anxiety, delusion, agitation, insomnia, and hallucination that are medicated by anxiolytics, antidepressants, and antipsychotics [19], which have anticholinergic side effects, including

Table I. Socio-demographic variables, smoking habits, ability to chew food, and MMSE score among all participants and the different groups of shortened MMSE

	All participants		MMSE 16–12		MMSE 11–10		MMSE 9–0	
Variable	*n*/total	%	*n*/total	%	*n*/total	%	*n*/total	%
Gender: proportion of males	1334/2320	58	1082/1892	57	174/297	59	78/131	60
Marital status: married	1339/2319	58	1130/1892	60	147/297	49	62/130	48
Place of residence: institution	12/2319	1	5/1891	0.3	1/297	0.3	6/131	5
Education								
Low	1431/2318	62	1094/1891	58	223/297	75	114/130	88
Middle	517/2318	22	446/1891	24	58/297	20	13/ 130	10
High	370/2318	16	351/1891	19	16/297	5	3/130	2
Smoking								
Daily	293/2320	13	241/1892	13	42/297	14	10/131	8
Occasionally	53/2320	2	51/1892	3	2/297	1		0
Non-smoking.	1972/2320	85	1599/1892	85	253/297	85	120/131	92
Ability to chew hard or chewy food	1755/2313	76	1465/1886	78	208/296	70	82/131	63
Age[#] (mean ± SD)	67.5	(9.1)	66.4	(8.5)	71.0	(9.3)	76.3	(10.4)
Sum score for shortened MMSE (mean ± SD)	13.4	(2.3)	14.3	(1.3)	10.6	(0.5)	7.5	(2.1)

[#]Age at 1.7.2000.

Table II. Dental variables among all dentate participants and in the dentate groups with different shortened MMSE scores (mean ± SD)

Variable	All participants	MMSE 16–12	MMSE 11–10	MMSE 9–0
No. of teeth	17.6 (8.5) (n = 1615)	18.2 (8.5) (n = 1378)	14.8 (7.7) (n = 178)	12.7 (8.4) (n = 59)
No. of carious teeth	0.9 (1.9) (n = 1615)	0.8 (1.8) (n = 1378)	1.2 (2.3) (n = 178)	1.7 (2.6) (n = 59)
No. of teeth with periodontal pockets of 4 mm or more	4.5 (5.4) (n = 1531)	4.6 (5.5) (n = 1313)	3.7 (4.7) (n = 165)	3.3 (4.6) (n = 53)
No. of teeth with periodontal pockets of 6 mm or more	1.0 (2.5) (n = 1531)	1.0 (2.5) (n = 1313)	0.7 (2.0) (n = 165)	0.8 (1.8) (n = 53)

hyposalivation. Furthermore, demented patients may refuse oral hygiene, and thus dental plaque will remain. Taste and smell are diminished among medically compromised elders [20], and these dysfunctions may be compensated for by a sweet diet that includes fermentable carbohydrates. The high caries prevalence may also be due to xerostomia and salivary gland hypofunction, the effects of which were not analyzed in this study.

We found cognitive impairment to associate with edentulousness without denture use, which is parallel with the findings of Nordenram et al. [13] and Chalmers et al. [7]. This is important, since poor masticatory function involves a risk for protein malnutrition among nursing home residents [21]. In addition, our results, along with those of Whittle and co-workers [14], show that those with moderate to severe cognitive impairment had the poorest denture hygiene. This is noteworthy, because it has previously been shown that poor denture hygiene relates to incidence of denture stomatitis [22] and possibly to aspiration pneumonia [23].

The need for dental treatment among the elderly will increase in the future as the number of elderly demented people with their own natural teeth will increase. Multiprofessional oral health care will be needed in practice in addition to the regular dental check-ups, treatment, and maintenance care provided by dentists and hygienists. This should also include cooperation between dental personnel and relatives, care-givers, and nurses and efforts made to inform and motivate them to take care of the oral health of demented patients.

In Finland, the dental care of patients in long-term health care is the statutory responsibility of municipal dental health centers. At present, dentists and hygienists working in municipal health centers also visit nursing homes and geriatric hospitals to some extent. The proportion of private dental practitioners caring for patients in nursing homes is small. In the future, there will be a need for hygienists and dentists also to visit the homes of home-cared cognitively impaired patients. Physicians and nurses have the important task of recording oral health among elderly patients and referring them to dental professionals when oral problems occur. Physicians should also emphasize the association between oral health, nutrition status, and aspiration pneumonia when motivating elderly patients and nurses to improve the oral health of elderly patients. The ability of demented persons to practice daily oral self-care may gradually weaken, and our results suggest that those with moderate or severe cognitive impairment need external help to maintain oral heath.

The causal association between the level of cognitive impairment and oral health is not clear. When demographic and socio-economic variables were controlled for, the association between cognitive impairment and the number of teeth, for instance, was attenuated, which means that the association is possibly confounded by factors related to the education and social network of demented patients. Education can have various effects on the oral health of demented patients. For example, it is possible that those with a high level of education have more teeth initially when they develop dementia. Moreover, they may have good oral self-care habits, which are maintained in the early stages of dementia. It is also possible that their relatives and caregivers value oral health and thus take care of the oral hygiene and dental consultations of the demented patient.

Table III. Variables related to removable denture among all participants and in the groups with different shortened MMSE scores (%)

	All participants		MMSE 16–12		MMSE 11–10		MMSE 9–0	
Variable	n/total	%	n/total	%	n/total	%	n/total	%
Removable denture	1384/2317	60	1072/1889	57	214/297	72	98/131	75
No teeth and no denture	18/2317	1	8/1889	0.4	4/297	1	6/131	5
Need to repair removable denture	711/1383	51	542/1071	51	107/214	50	62/98	63
Good hygiene related to removable denture	593/1382	43	485/1071	45	85/213	40	23/98	23
Removable denture-related ulcer	237/1382	17	180/1071	17	36/213	17	21/98	21
Removable denture-related hyperplasia	169/1382	12	130/1071	12	21/213	10	18/98	18
Denture stomatitis	411/1343	31	321/1039	31	57/207	28	33/97	34

Table IV. Poisson regression model relating the shortened MMSE scores to the number of teeth, the number of carious teeth, and the number of teeth with periodontal pockets

Dependent variable Independent variable	RR (95% CI)	*p*
No. of teeth[#]		
MMSE 16–12	1.0	
MMSE 11–10	0.9 (0.8–1.0)	0.03
MMSE 9–0	0.9 (0.7–1.1)	0.17
No. of carious teeth[⋆]		
MMSE 12–16	1.0	
MMSE 11–10	1.3 (0.9–1.7)	0.13
MMSE 9–0	1.5 (1.0–2.4)	0.04
No. of teeth with periodontal pockets of 4 mm or more[⋆]		
MMSE 16–12	1.0	
MMSE 11–10	1.0 (0.8–1.2)	0.76
MMSE 9–0	0.9 (0.6–1.2)	0.40
No. of teeth with periodontal pockets of 6 mm or more[⋆]		
MMSE 16–12	1.0	
MMSE 11–10	0.8 (0.5–1.3)	0.45
MMSE 9-0	1.0 (0.5–1.7)	0.92

[#]Adjusted by age, sex, education, smoking.
[⋆]Adjusted by age, sex, education, smoking, number of teeth.

Table V. Logistic regression model relating the shortened MMSE scores to the variables related to removable denture

Dependent variable Independent variable	OR (95% CI)	*P*
Removable denture[#]		
MMSE 16–12	1.0	
MMSE 10–11	1.2 (0.9–1.7)	0.18
MMSE 0–9	1.0 (0.6–1.6)	0.90
No teeth and no removable denture[⋆]		
MMSE 16–12	1.0	
MMSE 11–10	2.9 (0.9–9.5)	0.08
MMSE 9–0	5.2 (1.0–26.6)	0.05
Need to repair the removable denture#		
MMSE 16–12	1.0	
MMSE 11–10	0.9 (0.7–1.2)	0.67
MMSE 9–0	1.4 (0.9–2.2)	0.16
Good hygiene related to removable denture[#]		
MMSE 16–12	1.0	
MMSE 11–10	0.8 (0.6–1.1)	0.23
MMSE 9–0	0.4 (0.2–0.7)	0.001
Removable denture-related ulcer[#]		
MMSE 16–12	1.0	
MMSE 11–10	1.0 (0.6–1.5)	0.94
MMSE 9–0	1.6 (0.9–2.6)	0.08
Removable denture-related hyperplasia#		
MMSE 16–12	1.0	
MMSE 11–10	0.8 (0.5–1.3)	0.29
MMSE 9–0	1.8 (1.0–3.4)	0.06
Denture stomatitis[#]		
MMSE 16–12	1.0	
MMSE 11–10	0.8 (0.6–1.2)	0.30
MMSE 9–0	1.1 (0.7–1.8)	0.76

[#]Adjusted by age, sex, education and smoking.
[⋆]Adjusted by age, sex and smoking (small *n*).

In order to perform the interviews effectively, the easiest items of MMSE were omitted. This shortened version of MMSE was not validated, which is a shortcoming. However, Magaziner et al. [24] found 7 items correlating with total MMSE sum score among 65+ year-olds. The strength of the study is that it indicates the oral health status of cognitively impaired persons at the population level. Another strength is that the data were based on clinical examination, and the shortened MMSE was conducted by an interviewer at the informant's home. The shortened MMSE scale was filled in for persons aged 55 years or older, which means that the study population also included most of the early forms of cognitive impairment. It is evident that most of the subjects with cognitive impairment were at an early stage of dementia, but there are also other reasons for the low score, e.g. psychiatric problems and aphasia [25].

The results suggest that cognitive impairment associates with poor oral health. Deterioration of the abilities, knowledge, and understanding related to oral health behavior and consequent poor oral self-care and inadequate use of health services, as well as use of many drugs and an improper diet, may be underlying factors. It is important to develop individual and communal strategies in dental care. Multiprofessional oral health care involving dental personnel, nurses, physicians, and relatives is needed if we are to evaluate the need for external help and to improve the oral health of cognitively impaired patients.

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