Dental Health and Cognitive Impairment in an English National Survey Population

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OBJECTIVES: To investigate the association between dental health and cognitive impairment and to examine the extent to which dental status accounts for the association between cognitive impairment and low body mass index (BMI) in a national survey sample.

DESIGN: A secondary analysis of data from the Health Survey for England 2000.

SETTING: A nationally representative cross-sectional population survey.

PARTICIPANTS: Two thousand four hundred sixty-three adults aged 65 and older living in private households and 1,569 adults aged 65 and older living in care homes.

MEASUREMENTS: Data collected by interview (self-reported or by proxy) included age, sex, level of education, disability, BMI, dental status, and cognitive function (Abbreviated Mental Test Score).

RESULTS: Less than half of the community sample (40.4%) and 67.9% of the care home sample were edentulous; lack of teeth was significantly associated with cognitive impairment (odds ratio = 3.59, 95% confidence interval = 2.36–5.47). This association remained strong after adjustment for other covariates only in the community sample. Cognitive impairment was associated with lower BMI in both samples, but dental status did not explain this.

CONCLUSION: Poor dentition is associated with cognitive impairment. Nutritional status in people with cognitive impairment is recognized to be at risk. Although dental health did not account for the association between cognitive impairment and low BMI in this sample, other possible nutritional consequences require further evaluation. **J Am Geriatr Soc 55:1410–1414, 2007.**

Key words: dental health; cognitive impairment; nutritional status; aging; population survey

Interest is growing in the relationships between aging, nutritional status, and cognitive function. Dietary factors potentially have a role in the etiology of cognitive decline and dementia.[1] Cognitive decline itself may also influence nutritional status. Weight loss is detectable several years before the clinical onset of dementia, frequently accompanies dementia.[2] The cause of weight loss in dementia remains unclear. Weight loss in moderate to severe dementia is associated with greater morbidity and mortality,[3] and achieving adequate nutrition in dementia presents important challenges for clinical and social services.

It is recognized that dental health is an important determinant of nutritional status, body mass index (BMI), and general health in older people,[4–6] and it has been suggested that worse dentition is associated with cognitive impairment and dementia.[4,7,8] This association may be complex and bidirectional, with worse dental status both a risk factor for and a consequence of neurodegenerative processes. Alternatively, dental status may be a marker of a common underlying factor such as socioeconomic disadvantage,[9] although little research or evaluation has been done on the association despite the potential effect of comorbid poor dentition and cognitive impairment. A secondary analysis of a national survey of older people living in community and nursing and residential home accommodation was conducted. The objectives were to investigate the association between lack of teeth and cognitive impairment in this sample and to investigate the extent to which edentulism accounted for the association between cognitive impairment and lower BMI. Although the cross-sectional nature of the data set did not allow causal processes to be tested, the hypotheses were that worse dental status as a risk factor for cognitive decline would give rise to an association between edentulism and cognitive impairment and that worse dental status would at least in part account for a presumed causal association between cognitive impairment and low BMI.

METHODS

The Samples

A secondary analysis was conducted on data from the 2000 Health Survey for England. This is the tenth of a series of annual surveys covering the adult and child population living in private households in England and the first to include

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an additional sample of people aged 65 and older living in nursing and residential homes (care homes).

For the survey of community residents, a stratified sample of 360 postcode sectors were selected as primary sampling units, and 19 addresses were selected from each of these, giving a total selected sample of 6,840 addresses, of which 91% contained private households. All people within eligible households were invited to participate, and 7,988 interviews were conducted (response rate 68%: 71% for women, 65% for men). Participants aged 65 and older who had a valid height and weight measurement to allow BMI to be calculated, completed a cognitive function test and answered questions on education status and disability that were included in the analysis. Those who the interviewer considered to have unreliable measurements (e.g., those who had excessive clothing on) were excluded from the analysis.

The care home sample was drawn from a national database of all registered nursing and residential homes but restricted to those accommodating people aged 65 and older as their main or only client group. Local authorities were chosen as the primary sampling unit. Care homes were selected through multilevel stratified sampling, and a random sample of six residents aged 65 and older was randomly selected within each home using a Kish grid. Interviews were conducted in person or using proxies where appropriate. Of the 607 care homes sampled, 544 (90%) took part. Of the 2,493 interviews, 1,220 (49%) were conducted in person and 1,273 (51%) by proxy. Residents interviewed by proxy did not differ significantly in their age profile from those interviewed in person.

Measurements

Information was obtained from participants or proxies. Demographic data included age, sex, and level of education (highest qualification attained). Overall disability was rated according to self- or proxy report according to three groups: no disability, moderate disability, and severe disability. Height and weight measurements (or estimations in the case of proxy interviews) were used to calculate BMI. Dental status was classified as a binary variable according to self- or proxy report. Cognitive function was measured in all participants using the Abbreviated Mental Test Score (AMTS), a widely used brief screening instrument composed of 10 questions primarily covering orientation and memory. Cognitive impairment was defined on the basis of three or more incorrect responses, as previously recommended.[10]

Statistical Analyses

Data were analyzed using STATA software (STATA Corp., College Station, TX) applying appropriate weighting procedures standardized for this survey, taking into account overall selection probabilities. The conceptual bases for the analyses were that poor dental health is a risk factor for cognitive impairment and that cognitive impairment is a cause of lower BMI but that worse dental health, as a causal pathway factor, explains this, at least in part. For the first set of analyses, cognitive impairment was treated as the dependent variable and dental status as the principal independent variable. Age, sex, and education were considered as potential confounding factors (i.e., as factors potentially influencing dental and cognitive status) with BMI, disability, and sampling area (community/care home) further included as exploratory covariates (because these could potentially be consequences rather than causes of exposure and outcome). For most analyses, the community and institutional samples were analyzed separately. Initial descriptive data were generated for the samples and compared in unadjusted analyses according to dental status. The associations between dental status and cognitive impairment within each sample were adjusted for the other covariates using weighted logistic regression with cognitive impairment as the dependent variable. For the second objective and set of analyses, linear regressions were conducted for each sample, with BMI as the dependent variable; cognitive impairment as the principal independent variable; age, sex, and education as potential confounding factors; and dental status as a potential causal pathway (mediating) factor. The effect of adjustment for dental status was assessed as a final procedure for fully adjusted models.

RESULTS

Of the 1,627 participants in the community sample, 677 were edentulous (weighted prevalence 40.4%), and of the 3,028 participants in the care home sample, 2,261 (67.9%) were edentulous. Descriptive data for the two samples are summarized in the first columns of Tables 1 and 2. The care home sample wase older and had a higher female preponderance and higher previous education than the community sample. BMI was lower in the care home sample, and cognitive impairment and physical disability were more common. In both samples, edentulism was associated with older age, female sex, lower education, and worse disability. No significant associations were found with BMI in either sample. Edentulism was significantly associated with cognitive impairment in the community but not in the care home sample. The prevalence of edentulism according to AMTS score in the care home sample was AMTS 10/10 ($n = 329$), 61.4%; AMTS 9/10 ($n = 296$), 68.9%; AMTS 8/10 ($n = 281$), 69.0%; AMTS 7/10 ($n = 163$), 69.3%; AMTS 5–6/10 ($n = 298$), 71.1%; AMTS $<5/10$ ($n = 490$), 84.9%. The prevalence of edentulism according to number of AMTS errors in the community sample was AMTS 10/10 ($n = 1{,}065$), 35.6%; AMTS 9/10 ($n = 415$), 44.6%; AMTS 8/10 ($n = 133$), 51.9%; AMTS $<8/10$ ($n = 77$), 75.3%.

Adjusted associations between dental status and cognitive impairment are summarized in Table 3. In the combined samples, appropriately weighted, the association remained strong and significant after adjustment for other covariates, although this association was significant only in the community sample, and the odds ratio was close to a null value in the care home sample.

In a final analysis, edentulism was investigated as a covariate for the association between cognitive impairment and BMI. In the total sample, cognitive impairment was significantly associated with lower BMI ($\beta = -0.35$, 95% confidence interval (CI) $= -0.61$ to -0.78). This was stronger in the community sample (-0.34, 95% CI $= -0.61$ to -0.06) than the care home sample (-0.16, 95% CI $= -0.55 - 0.24$). After adjustment for

Table 1. Factors Associated with Dental Status in the Care Home Sample

Factor	Total Sample (N = 3,028)	Dental Status: Some Teeth (n = 767)	Dental Status: No Teeth (n = 2,261)	Mean Difference/Odds Ratio (95% Confidence Interval)
Age, mean ± SD	85 ± 7.19	83 ± 7.39	86 ± 6.93	2.78 (1.98–3.57)
Body mass index, kg/m^2, mean ± SD	25.4 ± 4.77	25.7 ± 5.33	25.2 ± 4.49	− 0.43 (− 1.71–0.86)
Female, %	76.6	72.5	78.5	1.39 (1.10–1.75)
Low education (no qualification), %	32.0	30.7	32.6	1.46 (0.51–4.15)
Disability, %				
Absent	12.7	18.3	10.1	1.0 (reference)
Moderate	10.1	11.2	9.6	1.54 (1.03–2.31)
Severe	77.1	70.5	80.3	2.05 (1.53–2.74)
Cognitive impairment, %	28.6	27.3	29.3	1.27 (0.98–1.64)

SD = standard deviation.

age, sex and education, the association in the total sample was − 0.36 (95% CI = − 0.63 to − 0.10), and the associations in the community and care home samples were more similar (− 0.36, 95% CI = − 0.63 to − 0.09 and − 0.38, 95% CI = − 0.71 to − 0.06, respectively). After further adjustment for dental status, there was little change in any association (for total sample: $\beta = -0.39$, 95% CI = − 0.66 to − 0.12; for community sample $\beta = -0.39$, 95% CI = − 0.67 to − 0.11; for care home sample $\beta = -0.38$, 95% CI = − 0.71 to − 0.56).

DISCUSSION

An analysis of a large national survey population drawn from community and care home residents investigated the interrelationship between dental, cognitive, and nutritional status. In summary, worse dental health was significantly associated with cognitive impairment in the community, but not the care home, population. Cognitive impairment was also associated with lower BMI in both samples, but dental health did not explain this, to the extent that this was measured in the survey.

Strengths of the study were that the sample was large and drawn to be nationally representative with appropriate statistical back-weighting. Response rates were also reasonable for a study of this scale. The principal limitation was that the study was cross-sectional in design, which will be discussed further below. A further limitation was that the study was not conducted for the purpose of the analysis described here and measurements of variables of interest were limited in detail and extent. This results in limited power to detect associations because of measurement error, biasing associations to the null. Negative findings should therefore be viewed with caution, although there was a strong and significant association, as hypothesized, between worse dental health and cognitive impairment, despite the fact that dental health assessment was limited to edentulism as a binary variable and cognitive impairment was categorized using a brief screening instrument. There was also a strong association between cognitive impairment and lower BMI.

Although findings from other research have suggested that people with cognitive impairment or dementia have worse dental health,[4,7,8] there has been little systematic research in this area. Several factors may underlie this cross-

Table 2. Factors Associated with Edentulous Status in the Community Sample

Factor	Total Sample (N = 1,697)	Dental Status: Some Teeth (n = 999)	Dental Status: No Teeth (n = 677)	Mean Difference/Odds Ratio (95% Confidence Intervals)
Age, mean ± SD	75 ± 6.50	74 ± 5.90	77 ± 6.86	3.44 (2.78–4.09)
Body mass index, kg/m^2, mean ± SD	27.4 ± 4.41	27.1 ± 4.12	27.7 ± 4.79	0.32 (− 0.18–0.81)
Female, %	55.7	53.7	58.7	1.23 (1.00–1.50)
Low education (no qualification), %	63.9	53.8	78.9	1.81 (0.87–3.76)
Disability, %				
Absent	58.9	65.0	49.9	1.0 (reference)
Moderate	27.9	26.2	30.2	1.51 (1.21–1.89)
Severe	13.2	8.8	19.8	2.92 (2.17–3.95)
Cognitive impairment, %	3.8	1.9	6.6	3.67 (2.12–6.33)

SD = standard deviation.

Table 3. Associations Between Edentulous Status and Cognitive Impairment After Adjustment for Other Covariates

Sequential Adjustments	Combined Sample	Care Home Sample	Community Sample
	Odds Ratio (95% Confidence Interval)		
Unadjusted	3.59 (2.36–5.47)	1.27 (1.03–1.57)	3.67 (2.12–6.33)
Adjusted for age	2.67 (1.73–4.14)	1.23 (0.99–1.53)	3.09 (1.77–5.40)
Plus sex	2.65 (1.71–4.11)	1.22 (0.98–1.52)	3.07 (1.76–5.37)
Plus education	2.60 (1.56–4.37)	0.95 (0.67–1.35)	2.74 (1.52–4.94)
Plus sampling area	2.55 (1.51–4.29)	–	–
Plus disability	2.52 (1.53–4.43)	1.00 (0.71–1.42)	2.71 (1.49–4.92)
Plus body mass index	2.61 (1.49–4.28)	1.02 (0.72–1.45)	2.80 (1.54–5.12)

sectional association. Cognitive impairment may have adverse effects on dental health. People with clinical dementia have been found to have worse or more rapidly deteriorating dental health,[8,11,12] although between-person variability is substantial.[11] A particular problem may be reduced saliva production,[12] which can occur as a side effect of many commonly prescribed medications. Increased dental caries progression in people with dementia has been found to be associated with reduced dental care service attendance, the use of antipsychotic agents with anticholinergic properties, and greater caregiver strain.[8] Dental health may also have an effect on cognitive function, and there seemed to be a dose–response relationship between level of cognitive impairment and the likelihood of edentulism (i.e., not apparently confined to those with the most severe impairment). Periodontal disease is a chronic inflammatory condition associated with raised levels of cytokines,[13,14] which themselves have been implicated as possible risk factors for dementia or dementia progression.[15–17] Loss of functioning teeth is also recognized to be associated with dietary changes and nutritional status, especially with respect to edentulous older people.[18,19] These may also represent causal links with cognitive impairment or dementia due to general or specific nutritional deficiency states. There is also growing evidence of an association between adverse dental health and cardiovascular disease,[20] which is recognized to be an important risk factor for dementia.[21] Finally, dental status may be noncausally associated with other risk factors for cognitive impairment such as smoking, [22] poor functional status,[23] and hypertension.[24]

In this study, the association between edentulism and cognitive impairment was weaker in the care home than in the community sample. This finding should be treated with caution, because it might reflect greater measurement error of dental status in the care home sample. It might also reflect other stronger competing causes of cognitive impairment in the care home population or greater general morbidity in those without cognitive impairment (who will have had some other reason for care home admission), thus obscuring any association with dental status. Furthermore, there may be other differences between care home and community samples that may underlie this. A higher mortality in care home populations might explain a lack of association between cognitive and dental health due to a healthy survivor effect. Care home populations may have different access to dental care, and dental interventions may also differ (e.g., with respect to the likelihood of extractions for a given level of periodontal disease).

The findings from this study suggest that dental status and cognitive impairment are strongly associated in older populations, but because they are drawn from cross-sectional data, the direction of causation cannot be concluded. In a recently reported study of a Korean population, a "dose-response" association between number of teeth and recent onset dementia was found that was independent of multiple potential confounding factors.[25] People with advanced dementia who have lost teeth as a result of the condition do not therefore obviously account for the association between dental health and cognitive function, although further prospective research is required to ascertain the role of earlier cognitive impairment and to establish whether worse dental health is a "risk factor" or a "risk marker." Regardless of the cause and effect relationship, the association is important because of the known effect of both conditions on function and quality of life. In a 6-year prospective study, adverse dental health was found to be a strong predictor of physical and mental decline and greater mortality.[4] A particular objective of the current analysis was to investigate the extent to which poor dental health might explain well-recognized associations between cognitive impairment and lower BMI, because weight loss in dementia is also associated with greater morbidity and mortality.[3] In summary, little evidence was found to support a substantial role. Significant associations were found between cognitive impairment and lower BMI in both samples, as anticipated, which does not suggest that measurement error in BMI was responsible for the lack of association with dental status. However, it should be borne in mind that BMI is only a proxy measure of nutritional status, and further research is indicated to evaluate more-specific nutritional factors, the combined influence of cognitive impairment and dental status on these, and the degree to which this affects functional outcomes.

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