Table 2: Cohort and case-control studies: Is poor oral health a risk factor for developing dementia (including cognitive decline)?

<table>
<thead>
<tr>
<th>Author and year</th>
<th>Study type</th>
<th>Population</th>
<th>Results</th>
<th>Authors’ conclusions</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gil-Montoya et al 2015 16</td>
<td>Case-control</td>
<td>Cases: Patients treated in a behavioural and cognitive neurology department, with a firm diagnosis of AD, dementia, or MCI</td>
<td>Controls: Patients being seen in primary healthcare, for problems other than dental or neurological problems. Excluded schizophrenic, depressive, personality disorder, diseases not under treatment, drug abuse, and previous periodontal treatment in the last 6 months</td>
<td>Average plaque and bleeding scores were significantly higher in the patients with a diagnosis of AD, dementia or MCI</td>
<td>High</td>
</tr>
</tbody>
</table>

**A. Dementia impact on plaque, gingival bleeding and gingivitis**

1. **OR of cognitive impairment in relation to oral hygiene habits**
   - Reference group: those who brushed twice or more a day
   i. Mouthwash only OR=11.37 CI(5.46 - 23.68) p<0.001
   ii. No brushing OR=7.21 CI(3.48 - 14.96)
   iii. Brushing once a day OR=3.34 CI(2.03 - 5.49)

2. **OR of cognitive impairment in relation to dental variables**
   - Reference group: 0.00 - 1.00
   i. Plaque index
      1.01 to 2.00; OR=1.92 CI(0.94 - 3.90)
      2.01 to 2.50; OR=6.33 CI(3.15 - 12.72)
      2.51 to 3.00; OR=15.70 CI(7.72 - 31.92)
   ii. Bleeding index (reference group was 0-25% BOP)
      50.1 to 90% BOP OR=2.67 CI(1.47 - 4.85)
      90.1 to 100% BOP OR=3.53 CI(1.88 - 6.63)

3. **Association between dental variables and levels of cognitive impairment**
   - Mean Plaque Index
      MCI: 2.26 (SD=0.49)
      Mild dementia: 2.27 (SD=0.76)
      Moderate dementia: 2.4 (SD 0.57)
      Severe dementia: 2.5 (SD=0.62)
      p=0.18
   - Mean Bleeding Index
      MCI: 45.4 (SD=20.9)
      Mild dementia: 62 (SD=29.5)
      Moderate dementia: 61.5 (SD=34.2)
      Severe dementia: 77.6 (SD: 27.3)
      p=0.001
   - Oral hygiene habits
      a. Brushed twice or more a day
         MCI: 33.3% (n=7)
         Mild dementia: 25.8% (n=16)
         Moderate dementia: 13.1% (n=8)
         Severe dementia: 5.6% (n=2)
      b. Brushed once a day
         MCI: 52.4% (n=11)
         Mild dementia: 46.8% (n=29)
         Moderate dementia: 37.7% (n=23)
         Severe dementia: 36.1% (n=13)
      c. Used only mouthwash
         MCI: 14.3% (n=3)

There is evidence of increased bleeding score with cognitive decline; however, there was not significantly more plaque present with cognitive decline. The present results evidence a significant worsening of oral hygiene habits (reduction or cessation of toothbrushing) with more advanced cognitive disease. The direction of the association is yet to be established.
<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Participants</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stewart et al 2013</td>
<td>5-year prospective cohort study</td>
<td>1053 participants from the Health ABC study; well-functioning black and white men and women aged 70 to 79</td>
<td>Although worse scores on almost all oral health measures were associated with cognitive impairment, previous education and race substantially accounted for these associations Most oral health measures were not associated with later cognitive decline. One exception was gingival inflammation, which was the factor most strongly associated with impairment and the only factor predicting cognitive decline - an association that was robust to adjustment for a large number of potential confounding factors</td>
</tr>
</tbody>
</table>

**Findings:**

1. Unadjusted OR for cognitive impairment in relation to quartile increase in oral health variable, measured in year 2
   - Mean gingival index score OR=2.10 CI(1.66–2.87)
   - Mean plaque score OR=2.07 CI(1.67–2.57)
   - Number of sites with bleeding on probing OR=1.09 CI(0.87–1.38)

2. Adjusted OR for cognitive impairment in relation to quartile increase in oral health variable
   - Mean gingival index score OR=1.55 CI(1.17–2.06)
   - Mean plaque score OR=1.34 CI(1.05–1.72)

3. Unadjusted OR for cognitive decline in relation to quartile increase in oral health variable
   - Mean gingival index score OR=1.17 CI(0.99–1.38)
   - Mean plaque score OR=1.06 CI(0.92–1.22)
   - Number of sites with bleeding on probing OR=0.99 CI(0.84–1.17)

4. Adjusted OR for cognitive decline (between years 3-5) in relation to gingival bleeding
   - OR=1.57 CI(1.01–2.45)

5. Adjusted OR for cognitive decline (between years 1-5) in relation to gingival bleeding
   - OR=2.54 CI(1.75–3.70)

In additional secondary analyses, further individual adjustment for baseline systolic and diastolic blood pressures and fasting blood glucose resulted in stronger rather than weaker association.
<table>
<thead>
<tr>
<th>Study</th>
<th>Duration</th>
<th>Study Design</th>
<th>Countries</th>
<th>Participants</th>
<th>Key Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Batty et al 2013</td>
<td>5-year prospective cohort study</td>
<td>Countries: Australia, Canada, China, Czech Republic, Estonia, France, Germany, Hungary, India, Ireland, Italy, Lithuania, Malaysia, Netherlands, New Zealand, Philippines, Poland, Russia, Slovakia, United Kingdom</td>
<td>11140 men and women aged 55–88 years with type 2 diabetes and a history of major micro or macro vascular disease, or at least one other cardiovascular risk factor, from the ADVANCE trial</td>
<td>HR for development of dementia in relation to days of bleeding gums per year at baseline (c.f. no days of bleeding gums)</td>
<td>Days of bleeding gums was unrelated to either increased risk of developing dementia and cognitive decline</td>
</tr>
<tr>
<td>Paganini-Hill et al 2012</td>
<td>18-year longitudinal cohort study</td>
<td>Country: United States of America</td>
<td>5,468 Residents of a California retirement community from the Leisure World Cohort Study</td>
<td>Adjusted HR for dementia in relation to Dental Health Behaviours</td>
<td>For dentate individuals, those who reported not brushing their teeth daily had a 22% (males) to 85% (females) greater risk of dementia than those who brushed three times daily—in the morning, during the day, and at night. The risk was statistically significant only in women. Using dental floss, mouthwash, or a toothpick had little effect on risk.</td>
</tr>
<tr>
<td>Study</td>
<td>Design</td>
<td>Number of participants</td>
<td>Country</td>
<td>Summary</td>
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<td>--------------------------------------------</td>
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<td>-------------------------------------------------------------------------</td>
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</tbody>
</table>
| Yamamoto et al 2012                        | 4-year prospective cohort study | 4425                  | Japan             | 1. Univariate HR of dementia onset in relation to self-reporting care of dental health (c.f. to those who self-reported taking care of their dental health)  
   i. Not taking care: HR=2.91 CI(1.62-5.20) p<0.001  
   ii. Not certain: HR=1.89 CI(1.21-2.94) p=0.005  
  2. Adjusted HR of dementia onset in relation to self-reporting care of dental health (c.f. to those who self-reported taking care of their dental health)  
   i. Not taking care: HR=1.76 CI(0.96-3.20) p=0.07  
   ii. Not certain: HR=1.46 CI(0.93-2.28) p=0.10  
  3. Adjusted HR of dementia onset in relation to self-reporting care of dental health after excluding participants with dementia onset within 1 year after baseline (c.f. to those who self-reported taking care of their dental health)  
   Not taking care: HR=1.85 CI(0.96-3.57) |
|                                            |                   |                        |                   | The association between taking care of dental health and dementia was explained by the socio-demographics, health behaviours, and forgetfulness as an early symptom of mild cognitive impairment. Self-reported dental health, detectable by these variables, may contribute to early detection of dementia in the long-term care insurance system |
| Hatipoglu et al 2011                       | Prospective case-control | 31                    | Turkey            | 1. Oral hygiene status of cases c.f. control patients  
   Good: 1 (3.2%) c.f. 9 (19.1%); p>0.510  
   Fair: 9 (29.0%) c.f. 15 (31.9%); p>0.510  
   Poor: 21 (67.7%) c.f. 23 (48.9%); p>0.510  
  2. Correlation between clinical and oral findings  
   MMSE scores were significantly correlated with oral hygiene status p=0.015 |
|                                            |                   |                        |                   | The results of this study indicate that oral hygiene status is closely related with cognitive functions of the patients with AD |
## B. Periodontitis impact on dementia

<table>
<thead>
<tr>
<th>Author and year</th>
<th>Study type</th>
<th>Population</th>
<th>Results</th>
<th>Authors’ conclusions</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Okamoto et al 2015</td>
<td>5-year prospective cohort study</td>
<td>Country: Japan 2335 cognitively intact or mild memory impaired independent elderly residents of Nara Prefecture aged 65 years or over and able to walk unassisted</td>
<td>OR for MMI development in relation to CPI score at baseline (reference group CPI 0-3) Code 4 OR=1.04 CI (0.74–1.47) p=0.828</td>
<td>A significant association was not found between the CPI code and MMI</td>
<td>Medium</td>
</tr>
<tr>
<td>Gil-Montoya et al 2015</td>
<td>Case-control</td>
<td>Country: Spain</td>
<td>OR of cognitive impairment in relation to dental variables (Periodontitis: % of sites with AL &gt;3mm where moderate 33-66%; severe 67-100%) (reference group absent/mild periodontitis)</td>
<td>Periodontitis appears to be associated with cognitive impairment after controlling for age, sex, education level and oral hygiene habits</td>
<td>High</td>
</tr>
<tr>
<td>Gil-Montoya et al 2015</td>
<td>Case-control</td>
<td>Country: Spain</td>
<td>1. OR of cognitive impairment in relation to dental variables</td>
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<td>Moderate: OR=2.58 (1.31 - 5.09) Severe: OR=3.04 (1.89 - 5.46) p&lt;0.001 Adjusted for age, sex, present teeth, OH habits, hyperlipidaemia, studies: Moderate: OR=2.64 (1.18-5.92) Severe: OR=2.31 (1.15-4.66) p=0.04</td>
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<td>2. Association between dental variables and levels of cognitive impairment</td>
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<tr>
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<td>i. Mean Pocket Depth</td>
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<td>MCI: 2.8 (S.D=0.5) Mild Dementia: 3.0 (S.D=0.6) Moderate Dementia: 3.1 (S.D=0.6) Severe Dementia: 2.0 (S.D=0.9) p=0.47</td>
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<td>ii. Mean Attachment loss (mm)</td>
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<td>MCI: 4.6 (SD=1.0) Mild Dementia: 4.8 (SD=1.4) Moderate Dementia: 5.1 (SD=2.0) Severe Dementia: 4.7 (SD=1.3) p=0.42</td>
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<td>iii. Attachment loss (percentage &gt;3mm)</td>
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<td>MCI: 75.2 (SD=19.8) Mild Dementia: 76.6 (SD=27.4) Moderate Dementia: 73.3 (SD=33.8) Severe Dementia: 75.0 (SD=27.1) p=0.94</td>
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<td>iv. Severe periodontitis (% with 67-100% AL &gt;3mm)</td>
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<td>MCI: 66.7% Mild Dementia: 67.7% Moderate Dementia: 70.5% Severe Dementia: 66.7% p=0.98</td>
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<td>3. Adjusted OR of cognitive impairment in relation to periodontitis</td>
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<td>Periodontitis severity; reference group absent/mild periodontitis;</td>
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<td></td>
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<td></td>
<td>i. Moderate periodontitis OR=2.64 CI(1.18 - 5.92),</td>
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<td>ii. Severe periodontitis OR=2.31 CI(1.15 - 4.66) p=0.04</td>
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</tr>
</tbody>
</table>

**Cases:** Patients treated in a behavioural and cognitive neurology department, with a firm diagnosis of AD, dementia, or MCI

**Controls:** Patients being seen in primary healthcare, for problems other than dental or neurological problems. Excluded schizophrenic, depressive, personality disorder, diseases not under treatment, drug abuse, and previous periodontal treatment in the last 6 months

Average plaque and bleeding scores were significantly higher in the patients with a diagnosis of AD, dementia or MCI

Risk of cognitive impairment was more than three-fold higher in patients with severe periodontitis compared with those with no or mild periodontitis

There is evidence of increased bleeding score with cognitive decline; however, there was not significantly more plaque present with cognitive decline

The present results provide evidence of significant worsening of oral hygiene habits (reduction or cessation of toothbrushing) with more advanced cognitive disease; however, the direction of the association is yet to be established
<table>
<thead>
<tr>
<th>Reference</th>
<th>Duration</th>
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<th>Country</th>
<th>Sample Size</th>
<th>Methodology</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stewart et al 2013</td>
<td>5-year prospective cohort study</td>
<td>1053 participants from the Health ABC study; well-functioning black and white men and women aged 70 to 79. White Medicare beneficiaries and all black community residents living in designated areas around Memphis and Pittsburgh.</td>
<td>United States of America</td>
<td>1053</td>
<td>Univariate HR of dementia onset in relation to self-reported care of dental health (c.f. to those who self-reported taking care of their dental health)</td>
<td>Not taking care: HR = 2.91 CI (1.62-5.20) p &lt; 0.001 Not certain: HR = 1.89 CI (1.21-2.94) p = 0.005 The study did not show any global relationship between the oral condition and occurrence of dementia. The association between taking care of dental health and dementia was explained by the socio-demographics, health behaviours and forgetfulness as an early symptom of mild cognitive impairment. Self-reported dental health care, detectable by these variables, may contribute to early detection of dementia in the long-term care insurance system.</td>
</tr>
<tr>
<td>Arrivé et al 2012</td>
<td>15-year cohort study</td>
<td>405 individuals aged 66–80 years followed-up prospectively for screening of dementia over 15 years in Gironde, France.</td>
<td>France</td>
<td>405</td>
<td>Adjusted Hazard Ratio of Dementia in relation to Periodontal Status (reference group sound periodontal status) Presence of &gt;4mm pockets adjusted for gender, BMI, diabetes, depression, hypertension and ischaemic cardiopathy/history of brain stroke Higher school level: HR = 0.42 CI (0.15–1.15) Lower school level: HR = 0.97 CI (0.29–3.19)</td>
<td>The periodontal condition was not associated with the risk of dementia. The study did not show any global relationship between the oral condition and occurrence of dementia.</td>
</tr>
<tr>
<td>Yamamoto et al 2012</td>
<td>4-year prospective cohort study</td>
<td>4425 participants of the Aichi Gerontological Evaluation Study, Japanese who did not have a physical or cognitive disability at baseline (defined by not receiving public long-term care insurance benefits)</td>
<td>Japan</td>
<td>4425</td>
<td>1. Unadjusted OR for cognitive impairment in relation to relation to quartile increase in oral health variable, measured in year 2 Mean probing depth OR = 1.50 CI (1.17–1.92) Proportion with probing depth 3 mm or more OR = 1.42 CI (1.12–1.82) Mean loss of attachment OR = 1.35 CI (1.06–1.72) Proportion with loss of attachment OR = 1.30 CI (1.02–1.65)</td>
<td>Periodontitis may be a risk factor for cognitive decline. Note, this conclusion relates to gingivitis – see Table 1A above.</td>
</tr>
<tr>
<td>Kaye et al 2010</td>
<td>32-year longitudinal cohort study</td>
<td>597 Community-dwelling dentate men enrolled in the Veterans Affairs Dental Longitudinal Study aged 28 to 70 at study baseline.</td>
<td>United States of America</td>
<td>597</td>
<td>1. Dental characteristics at baseline (1966-1973) in relation to MMSE (measured between 1993 and 2001) i. Mean number of teeth with probing pocket depth ≥ 4 mm Low MMSE: 4.0 (SD=3.0) Normal MMSE: 3.7 (SD=4.3) ii. Mean number of teeth with alveolar bone loss ≥ 40%</td>
<td>Risk of cognitive decline over a decade increased 2-5% for each tooth that had progression of alveolar bone loss or probing pocket depth.</td>
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<td>America</td>
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</table>
| **Low MMSE**: 0.7 (SD=1.4)  
**Normal MMSE**: 0.6 (SD=1.7) |

2. **Dental characteristics at first cognitive test (1993–2001) in relation to MMSE**
   i. **Mean number of teeth with probing pocket depth progression**
   Low MMSE: 15.8 (SD=6.6)  
   Normal MMSE: 15.1 (SD=6.0)
   ii. **Mean Number of teeth with alveolar bone loss progression**
   Low MMSE: 11.8 (SD=7.7)  
   Normal MMSE: 10.9 (SD=9.0)

3. **Adjusted HR of Low Mini-Mental State Examination (MMSE) scores in relation to periodontal disease progression**
   i. **Risk per tooth with alveolar bone loss progression per decade**
   All participants: HR=1.03 CI(1.00–1.07)  
   Aged 45.5 years or younger: HR=1.00 CI(0.94–1.07)  
   Aged 45.5 years or older: HR=1.05 CI(1.01–1.09)
   ii. **Risk per tooth with pocket depth progression per decade**
   All participants: HR=1.04 CI(1.01–1.09)  
   Aged 45.5 years or younger: HR=1.02 CI(0.95–1.10)  
   Aged 45.5 years or older: HR=1.05 CI(1.01–1.10)

**Risks of a lower MMSE score were consistently higher in the older than the younger men**

**Rates of tooth loss and periodontal disease progression during adulthood independently predict performance on the MMSE cognitive test**

**Rates of tooth loss and periodontal disease progression predicted subsequent decline in cognitive function**
## C. Caries impact on dementia

<table>
<thead>
<tr>
<th>Author and year</th>
<th>Study type</th>
<th>Population</th>
<th>Results</th>
<th>Authors’ conclusions</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaye et al 2010</td>
<td>32-year longitudinal cohort study</td>
<td>597 Community-dwelling dentate men enrolled in the Veterans Affairs Dental Longitudinal Study aged 28 to 70 at study baseline</td>
<td>1. Dental characteristics at baseline (1966-1973) in relation to MMSE (measured between 1993 and 2001) Mean number of teeth with 1 decayed or filled surfaces Low MMSE: 15.1 (SD=5.3) Normal MMSE: 15.3 (SD=5.1) 2. Dental characteristics at first cognitive test (1993–2001) in relation to MMSE Mean number of teeth with new caries or restorations Low MMSE: 13.2 (SD=5.1) Normal MMSE: 11.7 (SD=5.6) 3. HR of Low Mini-Mental State Examination (MMSE) Scores in relation to caries incidence HR per tooth with new caries or restorations per decade All participants: 1.02 CI(0.97–1.08) Aged 45.5 years or younger: 1.01 CI(0.94–1.09) Aged 45.5 years or older: 1.06 CI(0.96–1.16)</td>
<td>Development of caries appeared to increase the risk of poor performance in cognitive tests. The greater risks were most consistent in men who were older than 45.5 at the dental baseline</td>
<td>Medium</td>
</tr>
</tbody>
</table>
## D. Tooth loss/tooth number impact on dementia

<table>
<thead>
<tr>
<th>Author and year</th>
<th>Study type</th>
<th>Population</th>
<th>Results</th>
<th>Authors' conclusions</th>
<th>Quality</th>
</tr>
</thead>
</table>
| Stewart et al 2015 | 37-year retrospective longitudinal cohort | Country: Sweden 697 women from the prospective population study of women in Gothenburg (539 with no dementia, 158 with incident dementia) | 1. OR for dementia diagnosis in 2000-2005 with relation historic tooth count (reference group 25 or more teeth) 1968 tooth count:  
  i. 21-24 teeth OR=1.24 CI(0.74 - 2.09)  
  ii. 9-20 teeth OR=1.25 CI(0.72 - 2.17)  
  iii. <9 teeth OR=1.81 CI(1.03-3.19)  
1980 tooth count  
  i 21-24 teeth OR=1.51 CI(0.79 - 2.89)  
  ii. 9-20 teeth OR=1.30 CI(0.68 - 2.47)  
  iii. <9 teeth OR=2.25 CI(1.18-4.32)  
2. Adjusted OR of dementia diagnosis in 2000-2005 and historically lower tooth count (reference group more than 25 teeth c.f. less than 9 teeth)  
  i. 1968 OR=1.62 CI(0.84 - 3.11)  
  ii. 1980 OR=2.61 CI(1.22 - 5.60)  
  iii. 1992 OR=1.81 CI(0.77 - 4.25)  
For all three previous examinations, later dementia was two to three times as common in those with fewer than nine teeth as in those with 25 or more teeth, with broadly comparable age-adjusted ORs (1968, OR=1.81; 1980, OR=2.25; 1992, OR=1.99) | Dementia was associated with fewer teeth measured approximately 32, 20, and 8 years before its clinical onset. The first two of these three associations remained significant after adjustment for age; neither was significant after adjustment for age and education, although the association between lower 1980–81 tooth count and dementia in 2000–05 regained statistical significance after further adjustment for vascular risk factors. In most of the analyses, lower tooth count was not associated with dementia, although a significant association was found for one of the three examinations | Medium |
| Tsakos et al 2015 | 10-year prospective longitudinal cohort | Country: England 3166 individuals drawn from ELSA (English Longitudinal Study of Aging), community dwelling population aged 60 and over | 1. Adjusted OR of poor memory in relation to dental status at baseline (reference group those with natural teeth)  
  No natural teeth OR=1.07 CI(0.92 - 1.25)  
2. Adjusted OR of change to poor memory at any follow up (t+1) in relation to dental status at baseline (reference group those with natural teeth)  
No natural teeth | Total tooth loss was independently associated with physical and cognitive decline in older adults in England; Tooth loss is a potential early marker of decline in older age | High |
| Gil-Montoya et al 2015 | Case-control | Country: Spain  
Cases: Patients treated in a behavioural and cognitive neurology department, with a firm diagnosis of AD, Dementia, or MCI (n=180)  
Controls: Patients being seen in primary healthcare, for problems other than dental or neurological problems (n=229). Excluded schizophrenic, depressive, personality disorder, diseases not under treatment, drug abuse, and previous periodontal  | 1. OR of cognitive impairment in relation to number of teeth (reference group 20-32 teeth)  
  i. 10-19 teeth OR=0.95 CI(0.61 - 1.50)  
  ii. 1-9 teeth OR=1.76 CI(1.05 - 2.95)  
p=0.04  
2. Association between mean number of teeth present number and levels of cognitive impairment  
  i. MCI: 17.2 (S.D=7.8)  
  ii. Mild Dementia: 15. 5 (SD=8)  
  iii. Moderate Dementia: 15.1 (S.D=8.1)  
  iv. Severe Dementia: 14 (SD=7.9)  
p=0.53  
3. Adjusted OR of number of teeth present on cognitive decline (reference group 20-32 teeth)  
  i. 10-19 teeth OR=0.76 CI(0.44 - 1.32)  
  ii. 1-9 teeth OR=1.25 CI(0.67 - 2.36)  
p=0.27 | No significant association was found between the number of teeth present and cognitive impairment | High |
<table>
<thead>
<tr>
<th>Study</th>
<th>Study Type</th>
<th>Country</th>
<th>Participants</th>
<th>Treatment</th>
<th>Effect</th>
<th>Strength</th>
</tr>
</thead>
</table>
| Okamoto et al 2015 | 5-year prospective cohort study | Japan | 2335 cognitively intact or mild memory impaired independent elderly residents of Nara Prefecture aged 65 years or over and able to walk unassisted | Treatment in the last 6 months | 1. Age and gender adjusted 5 year cumulative incidence of MMI according to remaining teeth at baseline (reference group 25-32 teeth)  
   i. 25-32 teeth 7.4%  
   ii. 17-24 teeth 11.5%  
   iii. 9-16 teeth 8.9% NS  
   iv. 1-8 teeth 9% NS  
   v. Edentulous 14.6%  
   2. Adjusted OR for development of MMI per 1 tooth loss OR=1.02 CI(1.00-1.03); p=0.039  
   3. Adjusted OR for development of MMI in relation to tooth number at baseline (reference group 25-32 teeth at baseline)  
   i. 17–24 teeth OR=1.58 CI(1.12–2.25); p=0.010  
   ii. 9–16 teeth OR=1.17 CI(0.73–1.88); p=0.527  
   iii. 1–8 teeth OR=1.08 CI(0.64–1.80); p=0.781  
   iv. Edentulous OR=2.39 CI(1.48–3.86); p<0.001  
   4. Adjusted OR of development of MMI in relation to the decrease in number of teeth  
   i. 25–32 group at baseline decreasing to the 17–24 group at follow up OR=0.98 CI(0.48–1.97); p=0.946  
   ii. 17–24 group at baseline decrease to the 9–16 group or 1–8 group at follow up OR=0.92 CI(0.50–1.70); p=0.788  
   iii. 9–16 group at baseline decrease to the 1–8 group or edentulous group at follow up OR=0.87 CI(0.35–2.17); p=0.759  
   iv. 1–8 group at baseline decrease to the edentulous group at follow up OR=4.68 CI(1.50–14.58); p=0.008 | Medium |
| Stewart et al 2013 | 5-year prospective cohort study | United States of America | 1053 participants from the Health ABC study; well-functioning black and white men and women aged 70 to 79  
   White Medicare beneficiaries and all black community residents living in designated ZIP code areas around Memphis and Pittsburgh |  | 1. Unadjusted OR for cognitive impairment in relation to quartile increase in oral health variable, measured in year 2 (number of teeth measured per quartile decrease)  
   i. Number of teeth OR=0.56 CI(0.48–0.67)  
   ii. Number of occluding pairs OR=0.58 CI(0.49–0.70)  
   2. Adjusted OR for cognitive impairment in relation quartile increase in oral health variable, measured in year 2 (number of teeth measured per quartile decrease)  
   Number of teeth OR=1.18 CI(0.95–1.45)  
   3. Unadjusted OR for cognitive decline in relation to number of teeth (quartile increase in oral health variable)  
   Number of teeth OR=0.88 CI(0.77–1.00) | High |
| Paganini-Hill et al 2012 | 18-year longitudinal cohort study | United States of America | 5,468 residents of a California retirement community from the Leisure World Cohort Study | No link between number of teeth and dementia | Adjusted HR for dementia in relation to number of natural teeth (reference group 25–32 teeth)  
   i. 16–25 teeth: male HR=1.17 CI(0.86–1.58) female HR=0.94 CI(0.80–1.10)  
   ii. 1–15 teeth: male HR=1.21 CI(0.84–1.73) female HR=0.96 CI(0.79–1.19) | Medium |
<table>
<thead>
<tr>
<th>Authors</th>
<th>Study Details</th>
<th>Sample Characteristics</th>
<th>Outcome Measures</th>
<th>Country</th>
<th>Risk Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arrivé et al 2012</td>
<td>15-year cohort study</td>
<td>405 individuals aged 66–80 years followed-up prospectively for screening of dementia over 15 years in Gironde, France</td>
<td>Adjusted HR of Dementia in relation to number of missing teeth (reference group &lt;11 teeth missing) &gt;11 missing Higher school level: HR=1.07 CI(0.57–2.02) Lower school level: HR=0.30 CI(0.11–0.79)</td>
<td>France</td>
<td>Medium</td>
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<tr>
<td>Yamamoto et al 2012</td>
<td>4-year prospective cohort study</td>
<td>4425 participants of the Aichi Gerontological Evaluation Study Japanese who did not have a physical or cognitive disability at baseline (defined by not receiving public long-term care insurance benefits)</td>
<td>1. Univariate HR of dementia onset in relation to tooth number (reference group; 20 or more teeth at baseline) Less than 19 teeth with/without dentures HR=1.45 CI(0.97-2.16) p=0.07 2. Adjusted HR of dementia onset in relation to tooth number (reference group 20 or more teeth) i. Less than 19 teeth with/without dentures HR =1.01 CI(0.67-1.51) p=0.98 ii. Few teeth with dentures HR=1.09 CI(0.73-1.64) p=0.68 iii. Few teeth without dentures HR=1.85 CI(1.04-3.31) p=0.04 3. Adjusted HR of dementia onset in relation to tooth number, after excluding participants with dementia onset within 1 year after baseline (reference group 20 or more teeth) Few teeth without dentures HR=1.89 CI(0.97-3.69)</td>
<td>Japan</td>
<td>Low</td>
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<tr>
<td>Batty et al 2013</td>
<td>5-year prospective cohort study</td>
<td>11140 men and women aged 55–88 years with type 2 diabetes and a history of major micro or macro vascular disease, or at least one other cardiovascular risk factor, from the ADVANCE trial</td>
<td>1. HR for development of dementia in relation to number of teeth at baseline (reference group 22 or more teeth) i. 1-21 teeth HR=1.24 CI(1.05, 1.46) ii. 0 teeth HR= 1.48 CI(1.24, 1.78) p=0.001 2. HR for cognitive decline in relation to number of teeth at baseline (reference group 22 or more teeth) i. 1-21 teeth HR=1.23 CI(1.10, 1.38) ii. 0 teeth HR=1.39 CI(1.21, 1.59) p=0.001</td>
<td>Australia, Canada, China, Czech Republic, Estonia, France, Germany, Hungary, India, Ireland, Italy, Lithuania, Malaysia, Netherlands, New Zealand, Philippines, Poland, Russia, Slovakia, United Kingdom</td>
<td>Low</td>
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<td>i. Percentage with any tooth loss</td>
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<td>Low MSME: 86%</td>
<td>Normal MMSE: 74%</td>
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<td>ii. Mean number of teeth lost</td>
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<td>Low MMSE: 5.7 (SD=6.0)</td>
<td>Normal MMSE: 3.8 (SD=4.8)</td>
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3. Adjusted HR of Low Mini-Mental State Examination (MMSE) scores in relation to prospective tooth loss (per additional tooth lost per decade)

All participants HR=1.09 CI(1.01–1.18)
Aged 45.5 years or younger: HR=1.08 CI(0.92–1.26)
Aged 45.5 years or older: HR=1.10 CI(1.01–1.21)
## E. Denture impact on dementia

<table>
<thead>
<tr>
<th>Author and year</th>
<th>Study type</th>
<th>Population</th>
<th>Results</th>
<th>Authors’ conclusions</th>
<th>Quality</th>
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</thead>
<tbody>
<tr>
<td>Yamamoto et al 2012</td>
<td>4-year prospective cohort study</td>
<td>4425 participants of the Aichi Gerontological Evaluation Study: Japanese who did not have a physical or cognitive disability at baseline (defined by not receiving public long-term care insurance benefits)</td>
<td>1. Univariate HR of dementia onset in relation to tooth number (reference group 20 or more teeth at baseline) More than 19 teeth with/without dentures HR=1.45 CI(0.97-2.16) p=0.07 Few teeth with dentures HR=2.70 CI (1.84-3.94) p&lt;0.001 Few teeth without dentures HR=4.57 CI(2.63-7.94) p&lt;0.001</td>
<td>This 4-year prospective cohort study of older Japanese adults showed that few teeth without dentures increased risk of dementia onset after adjusting for possible confounders, including age, adjusted household income, BMI, present illness, alcohol consumption</td>
<td>Low</td>
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<td>2. Adjusted HR of dementia onset in relation to tooth number (reference group, 20 or more teeth) Less than 19 teeth with/without dentures HR =1.01 CI(0.67-1.51) p=0.98 Few teeth with dentures HR=1.09 CI(0.73-1.64) p=0.68 Few teeth without dentures HR=1.85 CI(1.04-3.31) p=0.04</td>
<td>Although people with few teeth and no dentures were found to be at risk for dementia, no significant difference in dementia risk was observed between participants having few teeth and using dentures and participants having 20 teeth or more</td>
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<td>3. Adjusted HR of dementia onset in relation to tooth loss after excluding participants with dementia onset within 1 year after baseline (reference group 20 or more teeth) Few teeth without dentures HR=1.89 CI(0.97-3.69)</td>
<td>Additional intervention studies are required to clarify the effects of dentures for prevention of dementia in people with few teeth and to confirm the mechanism of nutrient deficiency</td>
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<td>4. Adjusted HR of dementia onset in relation to those who could not chew well after excluding participants with dementia onset within 1 year after baseline (reference group those who can chew anything) Those who could not chew very well HR=1.32 CI(0.81-2.15)</td>
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<tr>
<td>Paganini-Hill et al 2012</td>
<td>18-year longitudinal cohort study</td>
<td>5,468 residents of a California retirement community from the Leisure World Cohort Study</td>
<td>1. HR of Dementia in relation to denture status (reference group no dentures) Partial or partial plus one jaw full: male HR=0.96 CI(0.73–1.26) female HR=0.97 CI(0.83–1.13) Full upper and lower: male HR=1.06 CI(0.68–1.64) female HR=1.08 CI(0.84–1.39) Unknown: male HR=1.48 CI(0.82–2.69) female HR=1.07 CI(0.85–1.34)</td>
<td>For denture wearers, cleaning dentures was not significantly related to dementia</td>
<td>Medium</td>
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<td>2. HR of dementia in relation to denture cleaning (reference group clean dentures every day) Sometimes: male HR=0.69 CI(0.33–1.45) female HR=1.25 CI(0.77–2.02) Never: male HR=1.29 CI(0.77–2.14) female HR=0.93 CI(0.69–1.26)</td>
<td>Lower risk of dementia associated with adequate masticatory function and adequate toothbrushing</td>
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<td>3. Masticatory function and dementia Although 90% of participants with inadequate masticatory function wore some dentures, those that did not had higher risk of incident dementia than those with adequate natural masticatory function (≥10 upper teeth and ≥6 lower teeth): Males: HR=1.91 95% CI(1.13-3.21) Females: HR=1.22 95% CI(0.86-1.73)</td>
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