RESEARCH ARTICLE

Oral health status of community dwelling adults aged 50 years and over in Ireland. A cross-sectional analysis of the Wave 3 TILDA cohort. [version 1; peer review: 1 approved, 1 approved with reservations]

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Abstract

Background: Little is known about the current oral health status of adults in Ireland. The aim of this study was to measure the oral health status of community dwelling adults aged 50 years and over in Ireland, and to compare the current status to previous surveys of oral health in adults.

Methods: The Irish Longitudinal Study on Ageing (TILDA) Wave 3 provided an opportunity to assess the oral health of a subset of TILDA participants. Respondents attending for health assessments at the TILDA centre were offered an oral health examination. The World Health Organization examination criteria were used.

Results: Out of the 3111 people who were offered the oral health assessment (OHA), 2525 were examined. Adults below 50 years of age (n=17) and 4 respondents whose oral health data were unavailable at time of analysis were omitted, giving a final sample of 2504 respondents. Among the OHA sample, 9.9% (249) were edentate; 11.5% (159) of females and 8% (90) of males. Of those aged 65 years and older, 15.6% were edentate compared with 40.9% in 2000-02. The mean number of teeth present in those aged 65 years or older was 14.9 for males and 14.2 for females compared with 9.9 and 7.4, respectively, in 2000-02. The mean number of teeth present in those aged 65 years or older was 14.9 for males and 14.2 for females compared with 9.9 and 7.4, respectively, in 2000-02. The mean DMFT of those aged 50 years or more was 18.5 and the Root Caries Index (RCI) was 6.3. For adults aged 65 years and over, the mean DMFT decreased from 25.9 to 20.1 and the Root Caries Index decreased from 11.6 to 9.1, between 2000-02 and 2014-15.

Conclusion: The results suggest an improvement in oral health status...
of community dwelling adults aged 50 years and over in Ireland as compared to the previous Irish survey of 2000-02.

**Keywords**
ageing demographics, cohort studies, oral health, health surveys, public health dentistry

This article is included in the TILDA gateway.

This article is included in the Ageing Populations collection.

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Introduction

The ageing population is one of the great challenges that will confront health services in developed countries in coming years. It is estimated that by 2050, the number of adults aged 60 years and older worldwide will increase from 901 million to 2.1 billion, and the adults called “oldest old” (80 years and over) will more than triple (125 to 434 million), as compared to 2015. In 2011, in Ireland, adults aged 65 years and over comprised 11.4% of the total population and this proportion is predicted to reach 22.4% in 2041. The proportion of adults aged 80 years or older is predicted to be 7.5% of the total population in 2046.

The ageing population faces the challenge of different chronic diseases including physical, mental and oral health related conditions. Oral health directly and indirectly mirrors the health of the entire body and mind, and poor oral health has been called a silent epidemic. It is impossible to be healthy without a healthy mouth because oral health has a bidirectional relationship with systemic physical and mental health. For example, older adults may, as a result of poor oral function, eat a poor quality diet and avoid social interaction and in this way poor oral health may adversely affect health and wellbeing. Similarly, loss of physical and cognitive function, and increasing frailty, often result in less attention to oral health and reduced access to the care that is needed to maintain oral function.

Dental caries and periodontal disease are the most common chronic oral diseases affecting the adult population in Ireland and worldwide, and the loss of natural teeth is considered to be a key indicator of poor oral health in older people. In older adults, understanding the value of oral health conditions such as the presence of natural teeth and their minimum functioning number, periodontal health, dental caries and tooth wear, is very important. The increased retention of natural teeth, and reductions in the levels of total tooth loss either due to dental caries or periodontal disease, are vital for the health and wellbeing of older adults. Although the complete loss of teeth with age has reduced dramatically in recent years, most oral health surveys have reported an age-related deterioration in oral health including an increase in tooth loss, poor periodontal health and increased tooth wear.

In Ireland, the last national survey on the oral health status of adults was undertaken in 2000–02, so up-to-date information reflecting the current oral health status is lacking. This makes it difficult to assess the needs of the population and to design services that maintain the oral health of older adults. The Irish Longitudinal Study on Ageing (TILDA) provided an opportunity to include an oral health assessment in community dwelling adults aged 50 years and over. The aim of this assessment was to provide an up-to-date picture of the oral health of older adults, and to compare the current data with previous data from Irish and international studies.

This oral health assessment (OHA) has not only provided an overview of current oral health status, it can form the basis for understanding oral health in the broader context of the health and social environment of older adults in Ireland. It may also serve as a baseline measurement for the longitudinal study of oral health, thereby increasing our understanding of the factors that specifically affect changes in the oral health of people in Ireland as they age.

Methods

Ethical considerations and consent

Ethical approval for this study was obtained from the Trinity College Faculty of Health Sciences Research Ethics Committee and participants provided written informed consent before the health assessment.

Study design

TILDA is a large-scale, nationally representative, comprehensive cohort study on ageing in Ireland. It was started in 2009 and at the time of writing has completed its fourth wave of data collection. The TILDA cohort consists of randomly selected community-dwelling adults aged 50 years and over, although partners or spouses of any age can also participate. There are three modes of data collection, a computer aided personal interview (CAPI), self-completion questionnaire (SCQ) and health assessments.

In Wave 3 (March 2014 – December 2015), an optional oral health assessment (OHA) was included as part of the health assessment conducted in the TILDA health centre in Trinity College Dublin. As a dentist was not available during the full health centre opening hours, only those participants who completed a health assessment during the dentist hours were invited to participate in the OHA; there were no other exclusion criteria. Periodontal probing was omitted from the assessment of respondents at risk from bacteraemia. The examination criteria used in this study were the same as those used in previous Irish oral health surveys and similar to those recommended by WHO.

The examiners were trained by an experienced examiner (“gold standard”- JMcL) from previous studies. A total of one trainer (“gold standard”) and four assessors (including AN, BOC) completed the data collection. As the OHA was at the end of the health centre assessment (approximately three hours long), a maximum of 10 minutes was allocated for each OHA. Because of the time constraint, it was not possible to perform duplicate examinations during the main data collection. During the pilot phase, a calibration exercise was performed on non-participant volunteers, followed by dual assessment of study participants until any discrepancies between the trainer and assessors were resolved. For the oral health examination, standardised dental equipment consisted of a dental chair with floor mounted Daray LED examination light (Model- XL200 LED examination light, 12–30v/5.8–8.2w), standard plane dental mirror and WHO recommended Community Periodontal Index of Treatment Need (CPITN) probe. Methods and equipment were the same for all examinations. Standard cross infection control measures were followed during examinations.

All respondents attending for a health assessment were invited to participate in the OHA while an examining dentist was present. The data collected for the OHA was; number of natural teeth, use of dentures, CPITN, coronal caries at cavitation level and visual level (WHO and British Association for the Study of Community Dentistry).
coronal tooth wear into dentine\textsuperscript{19} and tooth contacts in the maximum intercuspal position (MIP)\textsuperscript{20,21}. All criteria were based on visual examination and tactile sensing methods using a CPITN probe and no radiographs were taken. Data from the assessment was written on a paper form and then entered on a laptop computer and uploaded to the TILDA database.

For the purpose of the CPITN examination, the mouth was divided into sextants and the highest (worst) score in each sextant was recorded as the sextant score. The scores were; no disease (H), bleeding on examination (B), supra or sub gingival calculus present (C), pocket depth up to 4.5mm (P1), pocket depth >6mm (P2) and if no teeth were present in a sextant/ unable to record (X)\textsuperscript{18}.

Lower tooth contacts in the MIP were recorded to evaluate the functionality of the dentition and the need for replacement of teeth\textsuperscript{11-21}. To achieve MIP, participants were asked to swallow and keep their teeth closed together—the number of mandibular occlusal units in contact was counted. An occlusal unit is considered to be a single anterior tooth or premolar, or half a molar tooth (mesial or distal)\textsuperscript{22}. The percentages of dentate adults with fewer than 10 contacts, and 10 contacts or more, by age group and gender were calculated. Ten tooth contacts indicates approximately 20 teeth in occlusion, which is considered to be a minimal functioning index\textsuperscript{23}.

The prevalence of root caries was calculated using the Root Caries Index (RCI) among the dentate adults\textsuperscript{19}. This index gives the proportion of exposed roots with caries or restorations due to caries (RCI = mean decayed and filled roots/mean exposed roots %). Decayed and filled roots were recorded at tooth level rather than surface level, and so RCI was also calculated at tooth level.

Tooth wear was recorded by visual examination. The Bardsley tooth wear index was used in this study to record coronal tooth wear into dentine\textsuperscript{19}. The mouth was divided in to sextants and each sextant was individually scored. Tooth wear was recorded as; no wear, exposed dentine comprised <1/3 of worst surface of a tooth, exposed dentine comprised >1/3 of worst surface of a tooth, or the sextant was excluded, as no teeth were present in the sextant or unable to record a score. The worst tooth in a sextant was recorded as a sextant score. The highest score of dentine wear per person was recorded as a person’s tooth wear level.

During the statistical analysis, some oral health indicators were calculated for the full OHA sample (denture wear, number of teeth and mean DMFT (decay-missing-filled teeth)) and other oral health indicators (tooth contacts, RCI and periodontal health) were calculated for the dentate sample only, resulting in two bases for results. “Base edentate/dentate” means statistical analysis involved the full OHA sample, including edentate and dentate adults, whereas “Base dentate” means statistical analysis was run only on the dentate sample.

TILDA is subject to the legislation under the Data Protection Act 1988 and the Data Protection (Amendment) Act 2003. All data protection protocols were followed during collection, processing, analysis and reporting on data\textsuperscript{20}. Data analysis followed completion of data cleaning by accessing a TILDA hot desk at the TILDA research centre in Trinity College. STATA software (StataCorp LLC Texas USA) was used for data analysis.

Results

Oral health assessment sample selection

The OHA sample is a sub-sample of the respondents who attended a TILDA health centre assessment at Wave 3. A total of 4309 respondents attended for the health assessment, of whom an opportunistic sample of 3111 (72.2\%) were invited to have the OHA, and of these 2525 (81.1\%) agreed to the assessment. Those aged less than 50 years (n=17) were omitted from this analysis. The full OHA sample consisted of 2508 respondents, however, as the data for 4 of these respondents was not available at the time of the analysis, the results reported here are for 2504 respondents\textsuperscript{18}.

Oral health assessment sample vs TILDA sample (population sample)

The TILDA cohort is a nationally representative sample of adults aged 50 years and over (a population sample). To reduce the bias of a non-random response, weights can be applied to ensure that a sample is representative of the target population, however, as the OHA was completed by a sub-sample of the cohort, it was not possible to apply weights to the OHA sample. Table 1 below reports the two sample proportion test (Z test) for comparisons of the characteristics between the full OHA sample and the Wave 3 TILDA cohort. For the purpose of comparison between the different samples, 10 variables with 23 categories were selected. There was no difference between the samples (OHA and TILDA) in 8 out of the 23 categories.

In summary, the OHA sample was younger, more respondents were married, they were better educated, with good to excellent self-rated general health and more likely to be living in Dublin, as compared with the TILDA (population) sample. As the OHA sample size is large and there are small differences in baseline characteristics between the OHA sample and TILDA cohort, the oral health findings should be representative of the overall sample.

Oral health assessment sample description

For the analysis, the OHA sample was stratified into three age groups as recommended by WHO\textsuperscript{16}; 50–64 years old, 65–74 years old and 75 years and over (see Table 2 for gender breakdown). Almost half of the sample was aged 50–64 years with 14.8\% aged 75 years and over. Overall, the OHA sample consisted of more females than males (55.3\% vs 44.7\%), but this gender difference decreased with increasing age.

Dentate/edentate proportion

Adults with at least one natural tooth present were recorded as dentate. Table 3 shows that overall, 9.9\% of the sample were edentate (no teeth).

The proportion of edentate adults increased with age, and more females were edentate than males in all age groups. Table 3
Table 1. Comparison of the oral health assessment sample with the TILDA sample by a two sample proportion test (Z test). P values less than 0.05 are shown in bold.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Oral Health Assessment Sample (n=2508) n (%)</th>
<th>Population (TILDA sample) (n=6618) n (%)</th>
<th>Hypothesis test of proportions Population (TILDA) vs OHA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50–64 years</td>
<td>1219 (48.6)</td>
<td>3036 (45.9)</td>
<td>0.0196</td>
</tr>
<tr>
<td>65–74 years</td>
<td>918 (36.6)</td>
<td>2110 (31.9)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>≥75 years</td>
<td>371 (14.8)</td>
<td>1472 (22.2)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Female</td>
<td>1386 (55.3)</td>
<td>3679 (55.6)</td>
<td>0.7786</td>
</tr>
<tr>
<td>Education level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary</td>
<td>478 (19.1)</td>
<td>1737 (26.3)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Secondary</td>
<td>1005 (40.1)</td>
<td>2610 (39.4)</td>
<td>0.5805</td>
</tr>
<tr>
<td>Tertiary/higher</td>
<td>1024 (40.8)</td>
<td>2269 (34.3)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Marital status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>1889 (75.3)</td>
<td>4573 (69.1)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Never married</td>
<td>168 (6.7)</td>
<td>562 (8.5)</td>
<td>0.0048</td>
</tr>
<tr>
<td>Separated/divorced</td>
<td>192 (7.7)</td>
<td>469 (7.1)</td>
<td>0.3494</td>
</tr>
<tr>
<td>Widowed</td>
<td>259 (10.3)</td>
<td>1014 (15.3)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Locality</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dublin</td>
<td>681 (27.1)</td>
<td>1592 (24.1)</td>
<td>0.0023</td>
</tr>
<tr>
<td>Other urban</td>
<td>661 (26.4)</td>
<td>1840 (27.8)</td>
<td>0.1664</td>
</tr>
<tr>
<td>Rural</td>
<td>1166 (46.5)</td>
<td>3186 (48.1)</td>
<td>0.1588</td>
</tr>
<tr>
<td>Grew up in rural area</td>
<td>1440 (57.4)</td>
<td>3891 (58.8)</td>
<td>0.2331</td>
</tr>
<tr>
<td>Never lived abroad</td>
<td>669 (26.7)</td>
<td>1534 (23.2)</td>
<td>0.0005</td>
</tr>
<tr>
<td>Current or former smoker</td>
<td>1302 (51.9)</td>
<td>3609 (54.5)</td>
<td>0.0251</td>
</tr>
<tr>
<td>No health insurance or medical card</td>
<td>209 (8.3)</td>
<td>591 (8.9)</td>
<td>0.3681</td>
</tr>
<tr>
<td>Self-reported health</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Excellent</td>
<td>394 (15.7)</td>
<td>921 (14.2)</td>
<td>0.0294</td>
</tr>
<tr>
<td>Very good</td>
<td>897 (35.8)</td>
<td>2169 (33.4)</td>
<td>0.0069</td>
</tr>
<tr>
<td>Good</td>
<td>851 (34.0)</td>
<td>2227 (34.2)</td>
<td>0.8001</td>
</tr>
<tr>
<td>Fair</td>
<td>312 (12.4)</td>
<td>970 (14.9)</td>
<td>0.0065</td>
</tr>
<tr>
<td>Poor</td>
<td>52 (2.1)</td>
<td>215 (3.3)</td>
<td>0.0029</td>
</tr>
</tbody>
</table>

also shows the increase in edentulism with age was greater in females than males. Among the sample, the proportion of adults who were completely edentate, only edentate in the upper arch, and only edentate in the lower arch was also calculated (Table 4).

57% per cent of adults had one or more teeth in both arches (dentate or partially dentate), and a higher proportion of the sample was edentate in the lower arch, only compared with those edentate in the upper arch only and edentate in both arches.
Table 2. The oral health assessment sample by gender and age group (n=2504).

<table>
<thead>
<tr>
<th>Gender</th>
<th>Age groups</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>50–64 years</td>
<td>65–74 years</td>
</tr>
<tr>
<td>Male</td>
<td>511</td>
<td>422</td>
</tr>
<tr>
<td></td>
<td>42.0%</td>
<td>46.1%</td>
</tr>
<tr>
<td>Female</td>
<td>707</td>
<td>494</td>
</tr>
<tr>
<td></td>
<td>58.0%</td>
<td>53.9%</td>
</tr>
<tr>
<td>Total</td>
<td>1218</td>
<td>916</td>
</tr>
<tr>
<td></td>
<td>48.6%</td>
<td>36.6%</td>
</tr>
</tbody>
</table>

Table 3. Number and percentage of edentate/dentate sample by age group and gender (Base edentate/dentate, n=2504).

<table>
<thead>
<tr>
<th>Age group</th>
<th>Gender</th>
<th>50–64 years</th>
<th>65–74 years</th>
<th>75 years &amp; over</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Edentate</td>
<td>Male</td>
<td>15</td>
<td>33</td>
<td>71</td>
<td>142</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>4.7%</td>
<td>8.5%</td>
<td>14.4%</td>
<td>30.1%</td>
</tr>
<tr>
<td>Dentate</td>
<td>Male</td>
<td>496</td>
<td>674</td>
<td>386</td>
<td>423</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>95.3%</td>
<td>91.5%</td>
<td>85.6%</td>
<td>79.1%</td>
</tr>
<tr>
<td>Total Row %</td>
<td></td>
<td>92%</td>
<td>90.1%</td>
<td>90.4%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 4. Number and percentage of adults edentate in both arches, edentate in the upper arch, edentate in the lower arch, and partially dentate in both arches (Base edentate/dentate, n=2504).

<table>
<thead>
<tr>
<th>Upper &amp; lower arch edentate</th>
<th>Upper arch edentate</th>
<th>Lower arch edentate</th>
<th>Dentate or partially dentate in both arches</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>249</td>
<td>350</td>
<td>477</td>
</tr>
<tr>
<td>%</td>
<td>9.9%</td>
<td>14.0%</td>
<td>19.0%</td>
</tr>
</tbody>
</table>

Denture wear

Table 5 shows that 46.9% of the sample had some type of removable denture, 18.4% were wearing a complete upper denture (with or without another denture) while the remaining 28.4% had other combinations of partial dentures and complete dentures. While 9.9% of the sample was edentate, only 9.1% were wearing complete dentures for the upper and lower arches.

The percentage of adults wearing dentures increased with age irrespective of the type of denture. With increasing age, more adults had also lost their remaining teeth, and moved from partial to complete dentures. For example, in age group 50–64 years, 31.2% were denture wearers whereas in those aged 75 years and over, 73% were denture wearers and 23.8% had complete dentures.

Number of teeth

Figure 1 shows the frequency distribution of the number of teeth present in the OHA sample. It shows that 9.9% of adults had no teeth, and 54.3% of adults had 20 or more teeth. When the results in Table 6 are compared, it can be observed that although a higher proportion of females were edentate, females in the youngest age group, who were dentate, had a slightly higher mean number of teeth than males (21.5 vs 21.1). This suggests that the trend in higher tooth loss in older women in Ireland may be reversing, although this would need to be substantiated by a longitudinal study.

Tooth contacts

The percentage of dentate adults with fewer than 10 occlusal contacts, and 10 contacts or more, by age group and gender was calculated. Figure 2 shows that 56.8% of the dentate sample had...
Table 5. The proportion of denture wearers by age group and type of denture (Base edentate/dentate, n=2504).

<table>
<thead>
<tr>
<th>Age group</th>
<th>No upper or lower denture</th>
<th>Complete upper and lower dentures</th>
<th>Complete upper and partial lower dentures</th>
<th>Complete upper denture only</th>
<th>All other combinations of complete and partial dentures</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>50–64 years</td>
<td>838</td>
<td>68.8</td>
<td>42</td>
<td>3.5</td>
<td>10</td>
<td>0.8</td>
</tr>
<tr>
<td>65–74 years</td>
<td>392</td>
<td>42.8</td>
<td>98</td>
<td>10.7</td>
<td>51</td>
<td>5.6</td>
</tr>
<tr>
<td>75 years and over</td>
<td>100</td>
<td>27.0</td>
<td>88</td>
<td>23.8</td>
<td>24</td>
<td>6.5</td>
</tr>
<tr>
<td>Total</td>
<td>1,330</td>
<td>53.1</td>
<td>228</td>
<td>9.1</td>
<td>85</td>
<td>3.4</td>
</tr>
</tbody>
</table>

Figure 1. Percentage of adults by total number of teeth and the proportion with <20 teeth and ≥ 20 teeth. (Base edentate/dentate, n=2504). Mean number of teeth was 17.9, SD = 8.9, Median=21.

Table 6. Mean number of teeth per person by age group and gender (Base edentate/dentate, n=2504).

<table>
<thead>
<tr>
<th>Age groups</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>50–64 years</td>
<td>21.1</td>
<td>21.5</td>
<td>21.3</td>
</tr>
<tr>
<td>65–74 years</td>
<td>16.3</td>
<td>15.4</td>
<td>15.8</td>
</tr>
<tr>
<td>75 years &amp; over</td>
<td>11.9</td>
<td>11.1</td>
<td>11.5</td>
</tr>
<tr>
<td>Total</td>
<td>17.7</td>
<td>17.9</td>
<td>17.9</td>
</tr>
</tbody>
</table>
10 or more tooth contacts. Notably, 13.6% of dentate adults had no contacts; these adults were edentate in one arch, wearing dentures, had cross bites, teeth not in contact with other teeth, or just roots remaining. Table 7 shows that the proportion of dentate adults with 10 or more contacts decreased with age and was higher in females, although the gender difference narrowed in the older age groups.

Decayed, missing and filled teeth (DMFT)
Dental caries was recorded at cavitation (DMFT-c) and at visual caries level (DMFT-v). As the results indicated a difference of 0.1 between DMFT-c and DMFT-v (DMFT-c= 18.5, DMFT-v =18.6), it was decided to only report DMFT-c.

During the OHA it was possible to identify that some teeth were missing for reasons other than dental caries. These were missing premolars with no residual spaces (orthodontic extractions or congenital absence), third molars extracted due to impaction and teeth lost due to trauma. Where there was certainty about the reasons for loss these teeth they were recorded as missing for other reasons and not counted in the M component of DMFT. Where it was unclear, or there was doubt about the reasons for tooth loss, these teeth were recorded as missing due to caries. Similarly, in the edentate group third molar teeth were not recorded as missing due to caries. For this reason, the maximum DMFT score for edentate adults is shown as 28 but for dentate adults is 32.
Figure 3 shows that overall, 10.22% of adults had a DMFT score of 28, which includes the 9.9% who were edentate. The DMFT scores are negatively skewed with a greater percentage of adults having high values for DMFT. Only 1.8% of adults had a DMFT score of 1. Mean DMFT values by age group and gender are reported in Table 8. There was a difference of 4.9 in the mean DMFT between age group 50–64 years, and age group 75 years and over. Overall, females had a slightly higher mean DMFT (0.3) score than males, and this gender difference was present among all three age groups. Figure 4 shows the contribution of the decayed teeth, missing teeth, and filled teeth components of DMFT by age group and gender.

Of the total mean DMFT of 18.5, the contribution of decayed teeth was 0.6 in males and 0.3 in females, and was almost the same in all age groups. When compared to men, women in all age groups had fewer decayed teeth, more filled teeth, and women aged 75 years and over had more missing teeth, which suggests that women access treatment more. It is notable that in the youngest age group, the proportion of missing teeth was much lower than in the two older age groups, with corresponding higher proportions of filled teeth and the same proportion of decayed teeth. It remains to be seen whether this younger cohort can maintain more of their natural teeth as they age, as this would represent a major shift in the oral health of older adults in Ireland.

Table 8. Mean DMFT level by age group and gender (Base edentate/dentate, n=2504).

<table>
<thead>
<tr>
<th>Age groups</th>
<th>Male</th>
<th>Female</th>
<th>Total DMFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>50–64 years</td>
<td>16.4</td>
<td>17.0</td>
<td>16.7</td>
</tr>
<tr>
<td>65–74 years</td>
<td>19.4</td>
<td>19.6</td>
<td>19.5</td>
</tr>
<tr>
<td>75 years &amp; over</td>
<td>21.3</td>
<td>22.0</td>
<td>21.6</td>
</tr>
<tr>
<td>Total</td>
<td>18.3</td>
<td>18.6</td>
<td>18.5</td>
</tr>
</tbody>
</table>

Figure 3. Frequency distribution of the percentage of adults aged 50 years and over by DMFT score (Base edentate/dentate, n=2504). Mean= 18.5, SD= 6.3, Median=19.

Root caries

Root caries is reported as the mean number of decayed and filled roots as a proportion of the mean number of exposed roots with recession (Table 9). There was an increase in RCI (4.3 vs 10.2) and the mean number of decayed/filled roots (0.5 vs 1.1) and a decrease in the mean number of exposed roots (11.1 vs 10.3) with increasing age. This decrease in exposed roots may be due to the lower number of teeth with increasing age. Females aged less than 75 years had higher levels of root caries than males, but those aged 75 years and over had slightly lower levels than males.
Figure 4. Mean decayed, missing and filled teeth components of DMFT by age group and gender (Base edentate/dentate, n=2504).

### Table 9. Mean number of exposed roots, mean decayed/filled roots and Root Caries Index (RCI) by age group and gender (Base dentate, n=2255).

<table>
<thead>
<tr>
<th>Age groups</th>
<th>Mean decayed/filled roots (DFR)</th>
<th>Mean exposed roots (ER)</th>
<th>RCI</th>
<th>Total RCI</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Total</td>
<td>Male</td>
</tr>
<tr>
<td>50–64 years</td>
<td>0.4</td>
<td>0.5</td>
<td>0.5</td>
<td>11.6</td>
</tr>
<tr>
<td>65–74 years</td>
<td>0.8</td>
<td>0.9</td>
<td>0.9</td>
<td>11.1</td>
</tr>
<tr>
<td>75 years &amp; over</td>
<td>1.1</td>
<td>1.0</td>
<td>1.1</td>
<td>10.1</td>
</tr>
</tbody>
</table>

**Periodontal health**

The CPITN was used for the periodontal health assessment. The severity of periodontal disease was reported by the maximum CPITN score per person, and the extent as the mean number of sextants affected by the different scores for the dentate adults. Table 10 shows that the proportion of men and women with completely healthy periodontal tissues or bleeding gingivae or deep pockets was low, at less than 5%, in all age groups. The majority of older adults needed simple treatment for calculus and shallow pockets. The gender differences were small, with females tending to have better periodontal health status.

Table 11 shows the mean number of sextants per person affected by the different CPITN scores, stratified by age group and gender. In Table 10, it could be seen that less than 5% of the sample had deep periodontal pockets, while Table 11 shows that the mean number of sextants with deep pockets is also small (0.1–0.2). With respect to shallow periodontal pockets, the mean number of sextants affected was between 0.8 and 1.5, which suggests that pockets were not very extensive in this sample. The results from these two tables indicate that the periodontal treatment needs of this sample were neither complex nor extensive.

**Tooth wear**

Table 12 shows that in all age groups, fewer than 7% of respondents had no wear into dentine, while 50.6% had wear into dentine of less than one third of the worst surface. In all three age groups, there was more severe wear in males compared with females. In the age groups included in this study, some tooth wear would be considered to be physiological and for this reason, the low percentage with no wear is not unexpected.
National and international comparisons
In Ireland, there have been considerable improvements in the oral health status of adults as compared to previous Irish oral health surveys conducted in 1989–1990 and 2000–2002. The age group 65 years and over was characterised in each of the surveys. A summary of the principal oral health indicators in older adults in Ireland, from the last three surveys, is shown in Table 13. Caution is required when comparing the mean DMFT values as in this age group the two previous surveys used the WHO methodology, including teeth missing for all reasons in the calculation of mean DMFT. As explained above, in this study it was possible in some situations to identify teeth lost for reasons other than dental caries.

### Edentulism
Table 13 indicates that in Ireland, among adults aged 65 years and over, the prevalence of edentulism has decreased by more than two-thirds from 1989–90 to 2014–15 and most of that decrease has occurred since 2000–02. Though the prevalence of edentulism has decreased more dramatically in females compared to males, in 2014–5 the prevalence was still about 50% higher in females. A comparison of Irish and international prevalence of edentulism is shown in Table 14.

There are similar trends in the prevalence of edentulism with age in different countries, although the age groups and dates of the studies vary. For example, in the age group 75 years or older, the TILDA OHA sample in 2014–15 had a similar prevalence of...
Table 13. Changes in edentulism, mean number of teeth, DMFT and RCI among adults aged 65 years and over in Ireland from 1989–90 to 2000–02 and in the current study, 2014–15.

<table>
<thead>
<tr>
<th>Oral health indicators</th>
<th>Examination Year</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Edentate</td>
<td>2014–15</td>
<td>12.3</td>
<td>18.6</td>
<td>15.6</td>
</tr>
<tr>
<td></td>
<td>2000–02</td>
<td>34.6</td>
<td>45.6</td>
<td>40.9</td>
</tr>
<tr>
<td></td>
<td>1989–90</td>
<td>33</td>
<td>61</td>
<td>48</td>
</tr>
<tr>
<td>Mean number of teeth</td>
<td>2014–15</td>
<td>14.9</td>
<td>14.2</td>
<td>14.6</td>
</tr>
<tr>
<td></td>
<td>2000–02</td>
<td>9.9</td>
<td>7.4</td>
<td>8.5</td>
</tr>
<tr>
<td></td>
<td>1989–90</td>
<td>10.1</td>
<td>4.9</td>
<td>7.3</td>
</tr>
<tr>
<td>Mean DMFT</td>
<td>2014–15</td>
<td>20.0</td>
<td>20.2</td>
<td>20.1</td>
</tr>
<tr>
<td></td>
<td>2000–02</td>
<td>24.8</td>
<td>27</td>
<td>25.9</td>
</tr>
<tr>
<td></td>
<td>1989–90</td>
<td>25.6</td>
<td>28.8</td>
<td>27.3</td>
</tr>
<tr>
<td>RCI</td>
<td>2014–15</td>
<td>9.1</td>
<td>9.1</td>
<td>9.1</td>
</tr>
<tr>
<td></td>
<td>2000–02</td>
<td>12.7</td>
<td>10.6</td>
<td>11.6</td>
</tr>
<tr>
<td></td>
<td>1989–90</td>
<td>20.9</td>
<td>14.9</td>
<td>18.5</td>
</tr>
</tbody>
</table>

Table 14. Percentage edentulism by age groups, country and examination year.

<table>
<thead>
<tr>
<th>Country</th>
<th>Year of Examination</th>
<th>Age group</th>
<th>% Edentate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ireland</td>
<td>2014–15</td>
<td>50–64 years</td>
<td>3.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>65–74 years</td>
<td>11.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75 years and over</td>
<td>25.4</td>
</tr>
<tr>
<td>UK</td>
<td>2009</td>
<td>55–64 years</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>65–74 years</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75–84 years</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>85 years and over</td>
<td>47</td>
</tr>
<tr>
<td>USA</td>
<td>2012</td>
<td>65–74 years</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75 years and over</td>
<td>25.8</td>
</tr>
<tr>
<td>Australia</td>
<td>2006</td>
<td>55–74 years</td>
<td>13.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75 years and over</td>
<td>35.7</td>
</tr>
<tr>
<td>New Zealand</td>
<td>2009</td>
<td>55–64 years</td>
<td>14.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>65–74 years</td>
<td>29.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75 years and over</td>
<td>39.6</td>
</tr>
</tbody>
</table>

edentulism when compared to the USA in 2012. For the group aged 65–74 years, edentulism in the TILDA OHA sample (11.7% in 2015) and in the UK (15.0% in 2009) are comparable, taking account of the time difference between the studies.

Mean number of teeth. Table 13 above shows that there has been a doubling in the mean number of teeth in adults aged 65 years and older from 1989–90 to 2014–15 (7.3 to 14.6) in Ireland. This trend in females is particularly positive where the mean number of teeth almost doubled between 2000-02 and 2014–15. Although mean number of teeth is a crude measure of oral health status, as it gives no indication of the condition of these teeth, it is nonetheless a positive trend that natural teeth have been retained rather than extracted.

Table 15 shows that adults in Ireland, aged 65–74 years and 75 years and over, had a lower mean number of teeth when compared to the UK, New Zealand and Australia, despite the fact that the studies in these countries were completed 5–10 years before the TILDA study. Together, these findings suggest that in Ireland, fewer adults above 65 years may be completely edentate compared to this group of countries, but the mean number of teeth per person is also lower when compared to the UK, Australia and New Zealand. A possible explanation may be the different methods used in these studies. In this study the mean number of teeth was
Table 15. Mean number of teeth per person by age groups, country and year of examination.

<table>
<thead>
<tr>
<th>Country</th>
<th>Year of examination</th>
<th>Age group</th>
<th>Mean number of teeth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ireland</td>
<td>2014–15</td>
<td>50–64 years</td>
<td>21.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>65–74 years</td>
<td>15.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75 years and over</td>
<td>11.5</td>
</tr>
<tr>
<td>UK</td>
<td>2009</td>
<td>55–64 years</td>
<td>23.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>65–74 years</td>
<td>20.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75–84 years</td>
<td>17.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>85 years and over</td>
<td>14.0</td>
</tr>
<tr>
<td>Canada (CHMS)</td>
<td>2007–09</td>
<td>40–59 years</td>
<td>24.1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>60–79 years</td>
<td>19.4</td>
</tr>
<tr>
<td>New Zealand</td>
<td>2009</td>
<td>55–64 years</td>
<td>24.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>65–74 years</td>
<td>19.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75 years and over</td>
<td>18.1</td>
</tr>
<tr>
<td>Australia</td>
<td>2004–06</td>
<td>65–74 years</td>
<td>21.8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75 years and over</td>
<td>17.9</td>
</tr>
</tbody>
</table>

*Dentate sample only

calculated for the whole sample (edentate and dentate) whereas the studies of UK, Australia and New Zealand calculated mean number of teeth among dentate sample only.

Dental caries. There was a decrease in mean DMFT from 1989–90 to 2014–15, for those aged 65 years and older in Ireland (27.3 vs 20.1), as shown in Table 13. It is notable that most of this decrease in DMFT occurred since 2000-02. From 1989–90 to 2014–15, the gender difference in mean DMFT also reduced from 3.2 to 0.2.

Although there were differences in the calculation of the M component of DMFT in this study compared to 1989–90, the proportion of untreated decay in the DMFT decreased from 4% to 2.4%, and the proportion of filled teeth increased from 6% to 32.2% in the DMFT (data not shown). If the mean DMFT values were calculated in the same way, then these differences would be even greater. These findings, along with the doubling in the mean number of teeth (Table 13), suggest that adults over 65 years are not only keeping more of their teeth, but these teeth are in a healthier state. It also appears that these adults have accessed dental care which is more oriented to the maintenance of teeth compared to the past.

Table 13 also indicates that RCI reduced by more than half in Ireland from 1989–90 to 2014–15 (18.5 vs 9.1). The gender difference for RCI was reduced from 6 in 1989–90 to 0 in 2014–15. This is an encouraging finding, as it was thought that the prevalence of root caries in older people might increase with increased retention of natural teeth. This is because teeth tend to lose periodontal attachment with age and exposed root surfaces are vulnerable to the development of root caries.

Comparison of the mean DMFT among the TILDA OHA sample and other countries is shown in Table 16. It should be noted that in both the Australian and New Zealand surveys these mean DMFT values were for the dentate population as edentate people were excluded from the oral health assessments.

The TILDA OHA sample had a lower mean DMFT when compared to data from New Zealand and Australia, however, these studies took place 5–10 years before the Irish study which might account for some of this difference in mean DMFT. The inclusion of the edentate group in the TILDA calculation of mean DMFT would suggest that the difference in mean DMFT between Ireland and Australia and New Zealand may in fact be greater than it appears in this table.

Periodontal health. In Ireland, the changes over time in the proportion of adults aged 65 years and over with maximum CPITN score of ‘healthy’ has slightly reduced. There has also been a noticeable increase in the proportion of people with calculus and shallow pockets, but a substantial reduction in the proportion with deep pockets. It is also important to note the fall in the number of excluded sextants (X), which indicates that more sextants had the minimum number of teeth for the CPITN examination to be carried out. The increase in the proportion with calculus and shallow pockets probably also reflects increased tooth retention.

Discussion

Data on the health of the population is a key part of identifying needs, planning public health strategies and assessing the effectiveness of public health policies. This is especially true of oral health, which is sensitive to socioeconomic conditions, dietary trends, lifestyle and access to care. At the same time, most dental disease is preventable so there is the potential for improvement in oral health, and by extension general health, at relatively low cost. The last national survey of adult oral health in Ireland was...
Table 16. Mean DMFT by age groups, country and examination year.

<table>
<thead>
<tr>
<th>Country</th>
<th>Year of Examination</th>
<th>Age group</th>
<th>Mean DMFT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ireland</td>
<td>2014–15</td>
<td>50–64 years</td>
<td>16.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>65–74 years</td>
<td>19.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75 years and over</td>
<td>21.6</td>
</tr>
<tr>
<td>New Zealand</td>
<td>2009</td>
<td>55–64 years</td>
<td>21.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>65–74 years</td>
<td>24.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75 years and over</td>
<td>24.8</td>
</tr>
<tr>
<td>Australia</td>
<td>2004–06</td>
<td>55–64 years</td>
<td>21.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>65–74 years</td>
<td>23.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75 years and over</td>
<td>24.6</td>
</tr>
</tbody>
</table>

*Dentate sample only

Table 17. Changes over time in percentage of adults with maximum value of CPITN-severity score of H (healthy), B (bleeding), C (calculus), P1 (shallow pocket), P2 (deep pocket) and X (missing sextant) among dentate adults 65 years and over in Ireland (Base dentate).

<table>
<thead>
<tr>
<th>Year of examination</th>
<th>H</th>
<th>B</th>
<th>C</th>
<th>P1</th>
<th>P2</th>
<th>X</th>
<th>Total (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014–15</td>
<td>6.6</td>
<td>4.0</td>
<td>35.1</td>
<td>46.4</td>
<td>4.7</td>
<td>4.3</td>
<td>1085</td>
</tr>
<tr>
<td>2000–02</td>
<td>6.9</td>
<td>3.6</td>
<td>29.5</td>
<td>37.6</td>
<td>12.0</td>
<td>10.1</td>
<td>390</td>
</tr>
</tbody>
</table>

One of the concerns raised about maintaining oral health in older people is that, paradoxically, the retention of natural teeth needs more ongoing care than a complete loss of teeth. Without adequate regular plaque control, a healthy diet and some dental intervention, natural teeth can be susceptible to caries and periodontal disease which leads to pain, infection and loss of function. The susceptibility of older adults to dental disease may be heightened due to periodontal recession and an increase in medications that cause dry mouth. In Ireland, adults who become frail, dependent, or live in residential care will often lose access to dental services, except in an emergency. This study found a low level of untreated crown and root caries, and mostly mild periodontal disease, which suggest that independently-living older adults can maintain their oral health fairly well. Nonetheless, the level of root caries in those aged 75 years or older was double that of the younger age groups. The challenge will be to provide...
adequate care for the growing number of frail older people who, in the future, will have a far greater number of natural teeth.

This study made a broad assessment of oral health, using a methodology that allows for comparison to previous national oral health surveys and similar international studies. Other strengths of the study design were the large sample size and the extensive information collected during the CAPI, SCQ and health assessment. This will be extremely useful in further analysis that will link the objective measures of oral health with other health outcomes. The OHA sample also had similar characteristics to the TILDA cohort, suggesting that the findings should be representative of the overall sample. However, the study design had some limitations. The OHA participants were recruited from those attending a health centre assessment in Dublin; at Wave 1, participants who had a home-based assessment or did not complete a health assessment were older and had poorer health indicators than those who did attend a health centre, so it is likely that the oral health status of these participants is also poorer than the current OHA sample. Therefore, while it should be possible to generalise these results to the majority of the community-dwelling population aged 50 years and over, they may underestimate the prevalence and extent of oral health problems in adults with poorer health and those in residential care.

Conclusions

Data from this study shows that there has been considerable improvement in the retention of teeth among community dwelling adults aged 50 years and over in Ireland, as compared to previous Irish surveys. Since 1989-90, the proportion of edentate adults aged 65 years and over has decreased by two-thirds, and the mean number of natural teeth has more than doubled. However, tooth loss was still common among older adults, posing a challenge for our health services. Currently, there is little service provision for dentate older adults, especially those who become frail or dependent, suggesting the need for a qualitative change in the oral care for older people in Ireland.

If extrapolated to the whole population, these findings suggest that Ireland has more slowly followed international trends for improvement in the oral health status of older adults, observed in other developed countries like the UK, USA, Australia and New Zealand. These trends are very positive but they indicate a requirement for more maintenance care, restorative and periodontal treatment, and less need for complete dentures than previously. The findings of this study should provide a valuable resource for oral health policy and planning of oral health services for older people in Ireland.

Data availability

The data presented in this report was collected during Wave 3 of TILDA. Wave 3 data is available from the Irish Social Science Data Archive (ISSDA):


Accessing the data

To access the data, please complete a ISSDA Data Request Form for Research Purposes, sign it, and send it to ISSDA by email (issda@ucd.ie).

For teaching purposes, please complete the ISSDA Data Request Form for Teaching Purposes, and follow the procedures, as above. Teaching requests are approved on a once-off module/workshop basis. Subsequent occurrences of the module/workshop require a new teaching request form.

Data will be disseminated on receipt of a fully completed, signed form. Requests to access the OHA data should be made directly to TILDA (tilda@tcd.ie)

Consent

Ethical approval for this study was obtained from the Faculty of Health Sciences Research Ethics Committee in Trinity College Dublin and participants provided written informed consent before the health assessment.

Grant information

Financial support for TILDA was provided by the Irish Government, the Atlantic Philanthropies and Irish Life plc. We also gratefully acknowledge financial support from the Department of Health for the oral health assessments and from the Dublin Dental Hospital Board for the analysis.

The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Acknowledgements

The authors would like to acknowledge the contribution of the TILDA participants and TILDA team, especially Margaret Foley, Ann Hever and Christine McGarrigle.

References


Overview
There have been three waves of The Irish Longitudinal Study on Ageing (TILDA). In this work, the third wave is described during which time oral examinations were completed for a subset of participants aged 50 and over. The World Health Organization examination criteria was used to assess oral health as well as a number of previously used indices. Data on a variety of oral health indicators including number of retained teeth, number in occlusion, presence/absence of prostheses, caries, including root caries and periodontal disease indicators are presented and the results compared to previous Irish studies and findings from studies in other countries using similar criteria.

Overall comments:
There is a large amount of data of all types that was collected into this one paper. Typically the results of large studies are published in multiple papers that can orient the reader toward the findings in various discrete areas, such as edentulism, caries, periodontal findings, and allow discussion about each respective area. This paper has some of the characteristics of a monograph, displaying the results of all the data collected relating to all oral health findings and therefore the multitude of tables and figures is to be expected. I appreciate having all the OHA data in the TILDA displayed in one publication and suggest that the authors also provide an appendix of all the figures that one can readily negotiate when looking for a particular topic. However, unlike a monograph there is a lack of detailed discussion of findings relative to data about each specific finding. Usually only one reference is mentioned per topic and therefore the richness and meaning of the findings as compared to that found in other studies is often not expanded or expounded upon.

Comments on the Introduction:
While the sample size for the Oral Health Assessment (OHA) equaled 2504 individuals aged 50 and over, nearly ½ of the sample was made up of middle-aged adults from 50 to 64 year olds and those aged 75 and older only accounted for 14.8% (N = 371) of the entire OHA substudy. In most
developed nations, 50 year olds are not considered elderly nor are their oral health findings different from other middle-agers. Since TILDA is a Longitudinal Study on Aging, I was disappointed not to find more data about older adults, with details highlighting those 65+ and older by decades. Clearly the small sample size for the 75+ aged population precluded the ability of the investigators to analyze and present data. Therefore the authors’ focus in the Introduction that brings to the readers’ attention the significant growth occurring in the 65 and older and 80 and older age groups is puzzling as it whets the appetite to learn new findings that are not in fact available or presented. I suggest rewriting most of the Introduction to remove this emphasis.

Comments about Methodology:
If the goal was to achieve robust cell sizes of older adults for analytic purposes and to make policy recommendations, I wonder why an oversampling methodology of the oldest categories was not used. Since this study appears to be a convenience sample of the overall TILDA pool of subjects attending a Health Center in Dublin, I have concern about its ability to serve as a representation of the general population of Ireland, which appears to be an objective of TILDA. Should there be future TILDA with OHA components, over sampling would be valuable of older age groups and I would strongly recommend such a strategy. If a longitudinal study is planned for the future, the current middle aged and newly aged elderly of the OHA substudy of TILDA 3 could serve as a baseline population for another wave. Still the subject selection would need to be improved upon by including cohorts outside of Dublin, so that the results have true national representativeness.

Comments on Results:
Displaying the large amounts of data is challenging, I can appreciate the authors attempts to include all of their findings in this manuscript. I find the tables much more helpful as they actually show the results with the sample sizes noted at the basic levels, and for the most part the data is not collapsed into large categories, thus making it easier to compare with other studies. For those who want to make future comparisons of this data to newer datasets, it will be the Tables that will provide the data cited. The Figures were more difficult to interpret even though visually more appealing with their display of comparative and trend data; they have less practicality or comparability. Figure 4 contains a highly pictorial and easy to grasp display of the separate components of the DMFT findings by three age adult categories. This is the figure I suggest the authors retain.

In the Results section there are many comparisons between previous findings in earlier Irish studies, however no statistical analysis were completed to determine if these differences were significant. Table 17 highlights the difficulty in this approach with the comparisons between the 2000-02 and 2014-15 studies described in the narrative as “slightly” and “substantial” to describe differences rather than indicating on the table whether or not there are statistical differences between the two studies using convention p value cut-offs.

While much is made of the valuable opportunity the TILDA study presents due to its extensive record of physical, mental and socioeconomic data on participants, few correlations were drawn between the oral findings outside of gender and middle to early older age groups due to sampling inadequacies (recruited small sample size of 75 and older individuals and the limited sample collection site.) The opportunity to better characterize those variables associated with individuals with the greatest oral health needs was missed.

Because there are so many tables, it is difficult to flip through different pages to find the table and
narrative when they are not in proximity. While sometimes it is inevitable that tables and narratives are not on the same page, more effort needs to be made by the editor to place some of the smaller tables in close proximity to the relevant discussion.

**Comments on Discussion:**
I suggest that the authors be more careful about making generalizations about cause. In the discussion of the RCI findings on page 13, the authors state without citation that the explanation for an expected increase in root caries would be: “... because teeth tend to lose periodontal attachment with age and exposed root surfaces are vulnerable to the development of root caries.” While many would agree with the second statement, not all would agree with the first statement that periodontal disease as defined by attachment loss is an inevitable component of aging. Nor does this type of statement belong in the Results section for this discussion of potential causality should be covered in the Discussion.

I find statements such as, “The increase in the proportion with calculus and shallow pockets probably also reflects increased tooth retention.” If increasing tooth retention is aligned with calculus and shallow pockets, why not the other measured variables that trended in the same direction? If statistically significant comparisons were made and posted on the table, the readers would be able to determine if for example whether the increase in bleeding or the decrease in healthy tissue were significant? I again suggest that statistical analysis be run and the results indicated on the table so that readers can draw conclusions. While it might be difficult to compare results from various countries due to differing methodologies, where the CPITN was used in both Irish studies, one would expect some comparisons so that the importance or lack thereof could be appreciated.

It is in the Discussion section that one learns of the difficulties and differences in the OHA sub sample. The population sampled should have been described in the Methods section, not in the Discussion section. The characteristics defining the two different populations sampled may explain some of the significant jumps in improved health between the older Irish studies and the current studies in spite of the fact that the current OHA subgroup is representative of the TILDA study overall (Table 1). As a result the conclusions from this study may not be generalizable to the entire Irish population, especially those not living in the urban capital of the country.

**Comments on Conclusions:**
Conclusions should be based on the work and findings presented in this manuscript. Yet the authors say, “Currently, there is little service provision for dentate older adults, especially those who become frail or dependent, suggesting the need for a qualitative change in the oral care for older people in Ireland.” I am not sure why this statement is made in the Conclusion of the paper as this topic was not a part of the study and cannot be concluded from the data collected.

**Closing Thoughts:**
In the beginning of the article, the authors discuss the importance of this data to better inform policy makers in the development of a new national health care policy; however, little data was collected on the truly elderly population. This is a missed opportunity as limited health care dollars require that the at-risk population be studied to enable targeting of limited funds to cohorts at greatest need. I encourage future OHA studies, whether as part of TILDA or not, to do a better job of oversampling, especially the middle and oldest groups of elderly (75+ and 85+ years of age) and those who are living in a multitude of living arrangements and geographic settings, so that the
most accurate picture of oral disease in Irish elderly is captured.

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Partly

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Partly

Competing Interests: No competing interests were disclosed.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 09 January 2019

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W. Murray Thomson

Department of Oral Sciences, Sir John Walsh Research Institute, Faculty of Dentistry, University of Otago, Dunedin, New Zealand

General comments
Paper reports the findings of a simple descriptive analysis of oral epi data from participants in a cohort study of adults aged 50+. The title and abstract refer to “oral health status”, but what is actually being described here is tooth retention, dental caries experience and a snapshot of periodontal status, rather than “oral health” per se. The presentation of findings is not as systematic and easy to follow as it should be, because the authors give the impression of not being sure whether this paper will be a simple overview of the oral characteristics of the sample or a comparison of changes over time – and the Results section reflects that, with data in the later stages being brought in from earlier Irish work and from overseas studies. I suggest that they
confine the earlier Irish work and overseas data to the Discussion. A purely descriptive analysis like this one should be carefully and systematically presented, with a clear boundary between the study data and their comparison with earlier findings.

The authors insist on using the awful “compared with”; I suggest that they desist. Thus, “Of those aged 65 years and older, 15.6% were dentate compared with 40.9% in 2000-02” should be written as “Of those aged 65 years and older, 15.6% were dentate, while it was 40.9% in 2000-02” (or somesuch).

There are too many acronyms – do we really need OHA and MIP?

There are far too many small Tables – the authors should concentrate on having larger, more efficient Tables where the sociodemographic (and other) associations are presented to the reader.

**Section comments**

**Title**
The title is unnecessarily long–a shorter and more appropriate one is indicated.

**Abstract**
This will need to be rewritten once the paper has been revised, but the authors should consider the following: do not leave the reader to calculate %; be consistent with the number of decimal places for the % that you do present (these should be to 1 decimal place); do not use a hackneyed phrase such as “the results suggest”; and the conclusion should be a valid conclusion (what’s the take-home message from the study?).

**Introduction**
This is rather long and meandering. There are contentious assertions in paragraph 2 which should be omitted or tempered. The first clause of sentence 2 is vague – what do the AU mean here? Similarly, sentence 3 is unnecessary and can be contested – the great bulk of the evidence for the so-called “bidirectional relationship” is weak, fails to account for confounders, and is mostly the outcome of wishful thinking in interpreting cross-sectional data. Oral health is important enough in its own right without our having to try to justify investigating it using spurious associations with general health conditions.

In para 3, sentence 3 has structural problems and should be rewritten.

The last para of the Intro is actually Discussion and does not belong in the Intro.

**Methods**
There is insufficient information on the sampling procedures and what the sampling frame was. We are not told in the right place in Methods whether it is a simple random sample or a complex sample. Is it a national sample, or just people in and around Dublin? Also, these were people in Wave 3 – does this mean that they were also assessed earlier in Waves 1 and 2? If so, we need more information on that, and particularly on participation rates and loss to follow-up in earlier assessments.

Hyphenate “cross infection”.
The assessment of tooth contacts in the dentition does not actually mention the maxillary teeth – I presume that they are referring to contacts between the maxillary and mandibular teeth. And the term “functionality of the dentition” is unusual.

The RCI is not a measure of root surface caries prevalence, despite Katz having used that term in his original paper. The prevalence of a condition is the proportion of the population who have the condition – that should be reported here, alongside the RCI and the mean number of root DFT. The RCI is a sort of “attack rate” indicator.

Use the term “denture wearing”, not “denture wear” – that’s something else entirely...

Results
As a general principle, have one paragraph of Results text per Table and do not repeat Table data in the accompanying text (instead, summarise). Do not discuss your findings in the Results section (e.g. Results para 3, sentence 2 is Discussion).

Re: the data in Table 1 – describe the Table as reporting the sample characteristics, etc – the actual statistical testing is secondary. While on the latter, the authors do themselves a disservice, I think – while a lot of those P values are <0.05, this is due to the large N rather than any meaningful differences in proportions. For example, 27.1% and 24.1% living in Dublin – each of those I would summarise as approximately 1 in 4. Doing the analyses by each category of age group (or education level, etc) means a lot of tests – why not one cross-tabulation for each domain rather than 3?

Results para 4, last sentence – you cannot say that the gender difference “decreased with increasing age” – it was less marked in those who were older; you did not see it decrease... This is actually a surprising finding, by the way – in most epi studies of older people, you will see higher proportions of females in the older age groups. Why is yours different?

Table 3 should also present the edentulous and dentate proportions for each age group (genders combined). Table 4 is not really a stand-alone Table – consider presenting that information in Table 3 as well – you are going to have to restructure it anyway. Again, you cannot say (as you do at the end of page 4) that the proportion of edentate adults increased with age – again, it was higher in those who were older.

Table 5 should refer to denture wearing (see above!). Again, why repeat the table data in the text? We can see the Table, so point out the highlights. Again, there is the problem phrase “increased with age” (see above)...

Figure 1 – is this necessary? (ditto Figures 2, 3 and 4 – especially Figure 4...). Whereas Tables are a very efficient way of presenting a lot of information, Figures are not, and that information can be summarised and presented efficiently in the Results text – or as a Table, with mean numbers and SDs presented by sociodemographic characteristics – that would certainly be more informative. The last sentence of the “number of teeth” section is actually Discussion – and two data points do not make a “trend”.

To the periodontal data – the CPI is a bad index to use anyway, and even worse when used in a
longitudinal study. It’s too late now to point out that attachment loss data should have been collected. Again, the presentation of the data is not as informative as it might have been.

Discussion
See my earlier comments (page 1).

The last para of the Discussion misuses the term “extrapolated” – that should be “generalised”.

Is the work clearly and accurately presented and does it cite the current literature?
Partly

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Partly

Are all the source data underlying the results available to ensure full reproducibility?
No source data required

Are the conclusions drawn adequately supported by the results?
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Dental epidemiology, gerodontology, health services research

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.

Author Response 18 Aug 2021
Brian O’Connell, Trinity College Dublin, Dublin, Ireland

General comments
Paper reports the findings of a simple descriptive analysis of oral epi data from participants in a cohort study of adults aged 50+. The title and abstract refer to “oral health status”, but what is actually being described here is tooth retention, dental caries experience and a snapshot of periodontal status, rather than “oral health” per se. The presentation of findings is not as systematic and easy to follow as it should be, because the authors give the impression of not being sure whether this paper will be a simple overview of the oral characteristics of the sample or a comparison of changes over time – and the Results section reflects that, with data in the later stages being brought in from earlier Irish work.
and from overseas studies. I suggest that they confine the earlier Irish work and overseas data to the Discussion. A purely descriptive analysis like this one should be carefully and systematically presented, with a clear boundary between the study data and their comparison with earlier findings. 

Thank you for your helpful review and comments. We have done our best to reflect these suggestions in the revised version of the paper. Throughout the paper and in the title ‘oral health’ has been changed to ‘dental health’ and we have limited comparisons with previous and international data to the Discussion section.

The authors insist on using the awful “compared with”; I suggest that they desist. Thus, “Of those aged 65 years and older, 15.6% were dentate compared with 40.9% in 2000-02” should be written as “Of those aged 65 years and older, 15.6% were dentate, while it was 40.9% in 2000-02” (or some such).

This has been amended throughout the document

There are too many acronyms – do we really need OHA and MIP? We have removed OHA throughout the document and reduced the use of other acronyms as much as possible

There are far too many small Tables – the authors should concentrate on having larger, more efficient Tables where the sociodemographic (and other) associations are presented to the reader.

We have considered your suggestion about reporting the relationship between dental health and socio-economic status. This paper is already very long so we have decided to publish a separate paper on this topic by using socioeconomic variables from TILDA dataset. We have removed Table 4.

Section comments

Title
The title is unnecessarily long – a shorter and more appropriate one is indicated.
We understand the reviewer’s comments but the publisher requires a full description of the study type in the title according to the STROBE guidelines

Abstract
This will need to be rewritten once the paper has been revised, but the authors should consider the following: do not leave the reader to calculate %; be consistent with the number of decimal places for the % that you do present (these should be to 1 decimal place);

The percentages reported have been checked and all are now at one decimal place.
do not use a hackneyed phrase such as “the results suggest”; and the conclusion should be a valid conclusion (what’s the take-home message from the study?).

Changes has been made in the conclusions section to focus on the relevance of the findings of this cross-sectional study. We have removed the phrase ‘the results suggest’

Introduction
This is rather long and meandering. There are contentious assertions in paragraph 2 which should be omitted or tempered. The first clause of sentence 2 is vague – what do the AU
mean here? Similarly, sentence 3 is unnecessary and can be contested – the great bulk of the evidence for the so-called “bidirectional relationship” is weak, fails to account for confounders, and is mostly the outcome of wishful thinking in interpreting cross-sectional data. Oral health is important enough in its own right without our having to try to justify investigating it using spurious associations with general health conditions. These suggestions have been included in the revisions. The focus in the introduction is on dental health indicators and any association between dental health and systemic health.

In para 3, sentence 3 has structural problems and should be rewritten. This paragraph has been rewritten and is more focused.

The last para of the Intro is actually Discussion and does not belong in the Intro. The last paragraph has been removed

Methods
There is insufficient information on the sampling procedures and what the sampling frame was. We are not told in the right place in Methods whether it is a simple random sample or a complex sample. Is it a national sample, or just people in and around Dublin? Also, these were people in Wave 3 – We have given more information in the text to clarify these points. does this mean that they were also assessed earlier in Waves 1 and 2? If so, we need more information on that, and particularly on participation rates and loss to follow-up in earlier assessments. The dental health assessment was introduced in TILDA Wave 3 so we only have cross-sectional data. However, we are aiming to repeat dental assessment in the next TILDA wave to have longitudinal data.

Hyphenate “cross infection”. This has been corrected.
The assessment of tooth contacts in the dentition does not actually mention the maxillary teeth – I presume that they are referring to contacts between the maxillary and mandibular teeth. And the term “functionality of the dentition” is unusual. That is correct—tooth contacts (in Maximum Intercuspal Position) means contact between opposing pairs of teeth--this has been clarified in the text. The more usual term ‘functional dentition’ has been used to express the concept of a dentition that is adequate for normal function.

The RCI is not a measure of root surface caries prevalence, despite Katz having used that term in his original paper. The prevalence of a condition is the proportion of the population who have the condition – that should be reported here, alongside the RCI and the mean number of root DFT. The RCI is a sort of “attack rate” indicator. Yes, we agree. It represents the proportion of exposed root surfaces with root caries and it was used to allow for comparisons to be made with previous Irish national surveys. The text has been changed in the Methods section to clarify the meaning of the RCI. Use the term “denture wearing”, not “denture wear” – that’s something else entirely... The term has been changed to ‘denture wearing’.
Results
As a general principle, have one paragraph of Results text per Table and do not repeat Table data in the accompanying text (instead, summarise). Do not discuss your findings in the Results section (e.g. Results para 3, sentence 2 is Discussion).
The Results section has been revised as recommended.

Re: the data in Table 1 – describe the Table as reporting the sample characteristics, etc
The title of the table has been changed as suggested.
the actual statistical testing is secondary. While on the latter, the authors do themselves a disservice, I think – while a lot of those P values are <0.05, this is due to the large N rather than any meaningful differences in proportions. For example, 27.1% and 24.1% living in Dublin – each of those I would summarise as approximately 1 in 4. Doing the analyses by each category of age group (or education level, etc) means a lot of tests – why not one cross-tabulation for each domain rather than 3?
In order to compare the characteristics of the two different-sized samples–dental health and total TILDA -- the two-sample proportion test was chosen (following the advice of two independent experienced biostatisticians).
For the cross tabulation we measured the relationship between different categories of two variables. Although the proportions were not much different between the full TILDA and the dental samples, the Z test showed similarities between the two samples for 8 out of 23 characteristics (Table 1).

Results para 4, last sentence – you cannot say that the gender difference “decreased with increasing age” – it was less marked in those who were older; you did not see it decrease...
We understand this wording was misleading so all wording in results has been changed from decreased with age to the reporting of comparison between two age groups.
This is actually a surprising finding, by the way – in most epi studies of older people, you will see higher proportions of females in the older age groups. Why is yours different?
This may be because the dental sample is a convenience sample, unlike the TILDA cohort, which is nationally representative.

Table 3 should also present the edentulous and dentate proportions for each age group (genders combined).
Given the finding in previous national surveys that the prevalence of edentulism was much higher in females (Table 12), it was considered notable to demonstrate the change in this trend over time and among the different age cohorts in the present study

Table 4 is not really a stand-alone Table – consider presenting that information in Table 3 as well –
Table 4 has been deleted and the main results given in the text.

you are going to have to restructure it anyway. Again, you cannot say (as you do at the end of page 4) that the proportion of edentate adults increased with age – again, it was higher in those who were older.
This wording has been changed throughout the document.
Table 5 should refer to denture wearing (see above!). Again, why repeat the table data in the text? We can see the Table, so point out the highlights. Again, there is the problem phrase “increased with age” (see above)...

*As reported above, it has been changed*

Figure 1 – is this necessary? (ditto Figures 2, 3 and 4 – especially Figure 4...). Whereas Tables are a very efficient way of presenting a lot of information, Figures are not, and that information can be summarised and presented efficiently in the Results text – or as a Table, with mean numbers and SDs presented by sociodemographic characteristics – that would certainly be more informative.

*As the data was not categorical or normally distributed, we believe the figures give added information regarding the data distribution. This was limited to four figures, but can be reduced further if required.*

We agree with the suggestion, also mentioned previously, to publish a separate paper on dental health according to sociodemographic characteristics.

The last sentence of the “number of teeth” section is actually Discussion

*This has been removed – and two data points do not make a “trend”.*

*We understand the wording was misleading so it has been changed.*

To the periodontal data – the CPI is a bad index to use anyway, and even worse when used in a longitudinal study. It's too late now to point out that attachment loss data should have been collected. Again, the presentation of the data is not as informative as it might have been.

*Yes, we understand CPI is not an ideal index for longitudinal studies but the dental assessment was allocated only 10 minutes in the study, which was not enough time to measure attachment loss. Also, there was only time to measure index teeth. We have requested a more comprehensive periodontal measurements in the next wave of TILDA, but as the whole health assessment takes three hours or more, this remains to be decided. We understand the onerous nature of a lengthy assessment for respondents, some of whom are frail and do not even understand why a dental assessment is part of the health assessment! But that is another matter.*

**Discussion**

See my earlier comments (page 1).

*The Discussion has been revised according to these suggestions*

The last para of the Discussion misuses the term “extrapolated” – that should be “generalised”.

*The wording has been changed*

*Thank you again for your in depth and valuable input. We hope the changes described above have improved the paper and addressed your significant reservations.*

**Competing Interests:** No competing interests were disclosed.