Racial disparities in trajectories of dental caries experience


Abstract – Objectives: This study charted the trajectories of dental caries, including decayed teeth, missing teeth and filled teeth among older Americans over a 5-year period. In particular, it focused on racial differences in the levels of and rates of change in dental caries experience. Methods: Data came from the Piedmont Dental Study. The sample included 810 older Americans who were dentate at the baseline with up to 4 repeated observations between 1988 and 1994. Hierarchical linear models were employed in depicting intrapersonal and interpersonal differences in dental caries experience. Results: Different measures of caries outcomes exhibited distinct trajectories. On average, the number of decayed teeth decreased over time, whereas missing teeth increased. In contrast, the number of filled teeth remained stable during a 5-year period. Relative to their white counterparts, older black Americans had more decayed teeth and missing teeth but fewer filled teeth. Blacks and whites differed in the levels of dental caries but not in their rates of change except for missing teeth. Even when demographic and socioeconomic attributes were adjusted, racial variations in dental caries experience remained significant. Conclusions: Although significantly correlated, various dental caries outcomes move along different paths over time. In view of the persistent racial disparities in dental caries trajectories, future interventions to minimize such variations among older Americans in the levels of and the rates of change in dental caries experience are clearly warranted.

Oral health among older adults is a high priority in public health because of the growing population of older Americans, the disproportionate burden of oral diseases of older compared to younger Americans, and disparities in access to dental care (1, 2). Compared with younger individuals, elderly people have a higher prevalence of missing teeth, dental caries and periodontal diseases (3). Although edentulism in old age has declined, the prevalence of decayed teeth, filled teeth and periodontal disease have increased, as more of them have retained their natural teeth (3, 4). A lifetime of dental disease experience, tooth loss, medical conditions and medications adds to the complexity of oral care for older people. Thus, demand for dental care by older adults has increased substantially (2). Nonetheless, significant disparities persist in the access to dental care due to limited insurance coverage, a shortage of dental care providers, and increasing disability in old age, particularly in lower income and minority groups (2, 5, 6).

Although there is an increasing volume of research on socioeconomic disparities in oral health (7–9), few studies have focused on racial differences in the dynamics of dental caries experience among older adults. There is some evidence that older black Americans have more missing teeth and decayed teeth than white Americans (3, 10–13). However, much of the current research is based on cross-sectional data, which do not allow
the researcher to distinguish intrapersonal changes 
in dental caries over time from interpersonal differ-
ences (across age, gender and race/ethnicity).

The few longitudinal studies of dental caries 
experience among older adults available have 
focused on transitions between two points in time, 
particularly the incidence of dental diseases and 
their risk factors (14, 15). This approach does not 
fully capture the dynamic nature of dental caries 
experience, as it provides no basis for distinguishing 
among alternative functional forms of growth 
curves or trajectories (16). A more complete under-
standing of the dynamics of dental caries experi-
ence requires an analysis of trajectories in terms of 
their levels and rates of change.

In this study, we offer quantitative estimates of 
racial disparities in the trajectories of dental caries 
using longitudinal data derived from a population-
based sample of older Americans during a 5-year 
period (1988–1994). Based on a framework of social 
determinants of oral health, we view racial differ-
ces in dental caries experience trajectories as a 
result of social stratification (17, 18) with several 
underlying mechanisms including: (i) less advan-
taged socioeconomic circumstances, (ii) constraints 
placed on life style choices or (iii) stress as a result 
of perception of discrimination (19, 20). Extrapolat-
ing from prior research, we pose three hypotheses 
regarding racial differences in the trajectories of 
dental caries over time. First, the number of 
untreated decayed teeth decreases over time, par-
tially due to an increase in missing teeth in old age 
(14, 15). In addition, older black Americans have 
more decayed teeth than their white counterparts 
(21, 22), although the rate of increase in decayed 
teeth does not differ between blacks and whites 
(H1). Second, the number of missing teeth increases 
over time in old age in a linear or nonlinear fashion 
(23, 24), with black Americans having more miss-
ing teeth and a greater rate of increase than white 
Americans (25) (H2). Third, white Americans have 
more filled teeth than black Americans (26), but the 
rate of increase is similar for both groups, partially 
reflecting more missing teeth and less access to 
dental care among blacks (H3).

Materials and methods
Design and sample
Data came from the Piedmont Dental Study (PDS), 
a random subsample of the parent study, the Duke 
Established Populations for Epidemiologic Studies 
of the Elderly (Duke EPESE), which was based on 
a stratified random clustered sample of all people 
age 65 and over in the five adjacent counties in the 
Piedmont area of North Carolina in 1986. The PDS 
began in 1988 with a random subsample of 810 
dentate individuals from the Duke EPESE. These 
respondents were asked to participate again at 
18 months, 36 months and 60 months follow-up, 
except for those who became edentulous or died. 
The final analytical sample consisted of 810 partici-
pants at the baseline with 2926 observations over a 
period of 5 years.

Measures
Numbers of decayed, missing and filled teeth were 
obtained from dental examinations in 1988, 1990, 
1991 and 1994. From Duke EPESE in 1988, mea-
sures of social stratification including age, gender 
(male = 1) and race (white = 1) were acquired. In 
addition, education was indexed by years of 
schooling, whereas household income at the base-
line was indicated by quartiles, with the first quar-
tile reflecting the lowest income. A more extended 
description of the sample, collection of clinical 
data, and interview measures can be found else-
where (22, 27).

Data analysis
In this study, we offer quantitative estimates of 
racial disparities in the trajectories of dental caries 
by using longitudinal data derived from a popula-
tion-based sample of older Americans during a 5-
(HLMs) were used to chart the trajectories of 
decayed, missing and filled teeth (28). The counts 
for the dependent variables indicating dental caries 
were positively skewed and contained many zeros 
partially due to the large proportions of individu-
als with no decayed or filled teeth. Statistically, it 
might be better to treat them as ordinal instead of 
continuous variables (29, 30). We undertook our 
analyses by treating these measures as both contin-
uous and ordinal variables and obtained very simi-
lar results. For the ease of presentation, we include 
the results based on continuous variables.

The intra-individual differences in dental caries 
(e.g., number of decayed teeth) were modelled as 
follows in the Level-1 equation:

\[ Y_{IT} = \pi_{0i} + \pi_{1i} \text{Time} + \epsilon_{IT}, \]

where \( Y_{IT} \) is the number of decayed teeth of indi-
vidual i at time T, \( \pi_{0i} \) is the intercept (i.e. level) and 
\( \pi_{1i} \) is the slope (i.e. rate of change) over time. Time
is the distance (in years) of assessment from the baseline in 1988, when the respondent was first examined, and $e_{ij}$ is a random error. Time was centred on its grand mean (around 2.5 years). We also explored nonlinear changes with time by incorporating a quadratic term of the time variable (i.e. $Time^2_{ij}$) in Eq. (1).

Inter-personal variations in the trajectory of decayed teeth (i.e., intercept and slope) were specified in the Level-2 equation:

$$\pi_{pi} = \beta_{p0} + \sum \beta_{pq} X_{qi} + r_{pi}$$

where $X_{qi}$ is the $q$th time-constant covariate (e.g. age-at-baseline, gender, education) associated with individual $i$, and $\beta_{pq}$ represents the effect of variable $X_q$ on the $p$th growth parameter ($\pi_p$) (i.e. intercept and slope). $r_{pi}$ is a random effect with a mean of 0. All time-constant covariates (Level 2) were not centred. Bayesian information criterion (BIC) was used as the goodness-of-fit index to select the optimal models. All models were fitted by using HLM version 6.06 (31).

To minimize the loss of participants due to item nonresponse, multiple imputation (MI) was undertaken. In particular, five complete data sets were imputed with the NORM software developed by Schafer (32) and analyses were run on each of these five data sets with parameter estimates derived by averaging across five imputations and by adjusting for their variance. As a major advantage, multilevel models can include every participant in the estimation, regardless how many observations one contributed to the data set. With reference to attrition, multilevel models are predicated on the assumption of missing at random (MAR) that the probability of missing depends upon only the observed data for either the covariates or the outcome variables, hence permitting valid inference (28). In addition to MAR, to adjust for the selection bias due to attrition, we included dummy variables in the Level-2 equation to differentiate those with complete data during the period of study from those who dropped out of the study. They were viewed as confounding variables instead of predictors of dental caries experience.

### Results

The numbers of decayed teeth and missing teeth were substantially higher among blacks than white Americans, whereas the reverse was true for filled teeth (Table 1). In addition, the number of observations at the baseline was 810 which declined to 363 at the 60-month follow-up, largely due to edentulism, attrition or mortality. The reduction of mean number of missing teeth at 36 months follow-up may be a result of increasing number of individuals who became edentulous and thus were removed from the sample. At the same time, black and white participants did not differ in age and sex composition, although there were significant racial disparities in education and household income. As mentioned previously, we controlled the bias due to mortality and attrition by relying on the assumption of MAR and adjusting for attrition, death and proxy interview in our models (Table 2)

### Table 1. Dental caries experience over time

<table>
<thead>
<tr>
<th></th>
<th>Black</th>
<th></th>
<th>White</th>
<th></th>
<th>Total</th>
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<tr>
<td></td>
<td>Mean (SD)</td>
<td>N</td>
<td>Mean (SD)</td>
<td>N</td>
<td>Mean (SD)</td>
<td>N</td>
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<tr>
<td><strong>Decayed teeth</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline 1988</td>
<td>2.5 (3.5)</td>
<td>448</td>
<td>0.8 (1.9)</td>
<td>362</td>
<td>1.7 (3.0)</td>
<td>810</td>
</tr>
<tr>
<td>18 months follow-up</td>
<td>2.1 (3.1)</td>
<td>337</td>
<td>0.8 (1.7)</td>
<td>285</td>
<td>1.5 (2.6)</td>
<td>622</td>
</tr>
<tr>
<td>36 months follow-up</td>
<td>2.1 (2.9)</td>
<td>234</td>
<td>0.8 (1.4)</td>
<td>218</td>
<td>1.5 (2.4)</td>
<td>452</td>
</tr>
<tr>
<td>60 months follow-up</td>
<td>1.8 (3.1)</td>
<td>188</td>
<td>0.6 (1.6)</td>
<td>175</td>
<td>1.2 (2.6)</td>
<td>363</td>
</tr>
<tr>
<td><strong>Missing teeth</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline 1988</td>
<td>15.3 (7.9)</td>
<td>448</td>
<td>11.8 (7.8)</td>
<td>362</td>
<td>13.7 (8.0)</td>
<td>810</td>
</tr>
<tr>
<td>18 months follow-up</td>
<td>16.0 (8.2)</td>
<td>337</td>
<td>11.8 (8.1)</td>
<td>285</td>
<td>14.1 (8.4)</td>
<td>622</td>
</tr>
<tr>
<td>36 months follow-up</td>
<td>15.7 (7.5)</td>
<td>234</td>
<td>11.5 (7.7)</td>
<td>218</td>
<td>13.6 (7.9)</td>
<td>452</td>
</tr>
<tr>
<td>60 months follow-up</td>
<td>16.4 (7.6)</td>
<td>188</td>
<td>11.8 (7.9)</td>
<td>175</td>
<td>14.2 (8.0)</td>
<td>363</td>
</tr>
<tr>
<td><strong>Filled teeth</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Baseline 1988</td>
<td>2.3 (3.8)</td>
<td>448</td>
<td>10.5 (7.2)</td>
<td>362</td>
<td>6.0 (6.9)</td>
<td>810</td>
</tr>
<tr>
<td>18 months follow-up</td>
<td>2.4 (3.9)</td>
<td>337</td>
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<td>6.3 (7.0)</td>
<td>622</td>
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<tr>
<td>36 months follow-up</td>
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<td>218</td>
<td>6.6 (7.0)</td>
<td>452</td>
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<tr>
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<td>188</td>
<td>11.1 (7.0)</td>
<td>175</td>
<td>6.7 (7.0)</td>
<td>363</td>
</tr>
</tbody>
</table>
Trajectory of decayed teeth

Consistent with our hypothesis (H₁), the number of untreated decayed teeth decreased slightly over time (Model 1, Table 3). In addition, white Americans had fewer decayed teeth ($b = 1.311, \text{CI}_{95} = (0.969, 1.663)$), whereas there was no significant racial difference in the rate of change ($b = 0.076, \text{CI}_{95} = (-0.003, 0.154)$) (Model 2, Table 3). The number of decayed teeth decreased from 1.0 to 0.9 for whites, whereas it decreased from 2.4 to 2.0 for blacks (Fig. 1).

Racial difference in decayed teeth attenuated somewhat but remained significant when age, gender, education and income were controlled (Model 3, Table 3). In addition to racial differences, men had more decayed teeth, whereas those with higher household income had fewer
decayed teeth (Model 3, Table 3). Those who died during the period of observation had more decayed teeth, even with demographic and socioeconomic attributes controlled (Models 3 in Table 3).

**Trajectory of missing teeth**

In accordance with H2, the number of missing teeth increased over time (Model 1, Table 4). Relative to blacks, whites had not only fewer missing teeth (b = −4.100; CI95 = −5.178, −3.021) but also a lower rate of increase (b = −0.224; CI95 = −0.315, −0.132) over time (Model 2, Table 4). The number of missing teeth increased from 11.8 to 12.9 for whites, whereas it increased from 15.3 to 17.6 for blacks (Fig. 2).

With education and income controlled, racial differences in the level of missing teeth and the rate of change remained significant (Model 3, Table 4). Furthermore, older age was associated with a greater number of missing teeth and those with higher household income had fewer missing teeth (Model 3, Table 4). Finally, even with demographic and socioeconomic characteristics adjusted, those who dropped out during the period of observation had more missing teeth (Model 3, Table 4), whereas mortality and proxy interview did not appear to matter.

**Table 4. Multilevel regression analysis of the trajectory of missing teeth**

<table>
<thead>
<tr>
<th>Covariates</th>
<th>Model 1</th>
<th></th>
<th>Model 2</th>
<th></th>
<th>Model 3</th>
<th></th>
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<tr>
<td></td>
<td>Coef</td>
<td>P-value</td>
<td>Coef</td>
<td>P-value</td>
<td>Coef</td>
<td>P-value</td>
</tr>
<tr>
<td>Fixed effect</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>For intercept, π₀</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>14.529</td>
<td>&lt;0.001</td>
<td>−6.109</td>
<td>0.087</td>
<td>−0.757</td>
<td>0.838</td>
</tr>
<tr>
<td>Dropout for good (versus complete data)</td>
<td>2.101</td>
<td>0.003</td>
<td>1.991</td>
<td>0.004</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Returned after dropout (versus complete data)</td>
<td>1.181</td>
<td>0.183</td>
<td>0.914</td>
<td>0.302</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Death (versus complete data)</td>
<td>1.024</td>
<td>0.194</td>
<td>0.767</td>
<td>0.323</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proxy interview (Proxy versus nonproxy)</td>
<td>−0.534</td>
<td>0.623</td>
<td>−1.033</td>
<td>0.356</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (in years)</td>
<td>0.295</td>
<td>&lt;0.001</td>
<td>0.263</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex (Male versus Female)</td>
<td>−0.209</td>
<td>0.717</td>
<td>0.270</td>
<td>0.658</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Race (White versus Black)</td>
<td>−4.100</td>
<td>&lt;0.001</td>
<td>−2.409</td>
<td>&lt;0.001</td>
<td></td>
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<tr>
<td>Education years (in years)</td>
<td></td>
<td></td>
<td>−0.165</td>
<td>0.059</td>
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<tr>
<td>Household income (in quartiles)</td>
<td></td>
<td></td>
<td>−0.953</td>
<td>0.010</td>
<td></td>
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<tr>
<td>For linear time slope, π₁</td>
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<td></td>
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</tr>
<tr>
<td>Intercept</td>
<td>0.320</td>
<td>&lt;0.001</td>
<td>0.752</td>
<td>0.025</td>
<td>0.833</td>
<td>0.025</td>
</tr>
<tr>
<td>Dropout for good (versus complete data)</td>
<td>0.126</td>
<td>0.099</td>
<td>0.122</td>
<td>0.106</td>
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</tr>
<tr>
<td>Returned after dropout (versus complete data)</td>
<td>0.142</td>
<td>0.110</td>
<td>0.132</td>
<td>0.139</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Death (versus complete data)</td>
<td>−0.006</td>
<td>0.927</td>
<td>−0.007</td>
<td>0.916</td>
<td></td>
<td></td>
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<tr>
<td>Proxy interview (Proxy versus nonproxy)</td>
<td>−0.063</td>
<td>0.604</td>
<td>−0.109</td>
<td>0.349</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (in years)</td>
<td>−0.005</td>
<td>0.233</td>
<td>−0.005</td>
<td>0.278</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex (Male versus Female)</td>
<td>0.093</td>
<td>0.084</td>
<td>0.067</td>
<td>0.191</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Race (White versus Black)</td>
<td>−0.224</td>
<td>&lt;0.001</td>
<td>−0.204</td>
<td>0.001</td>
<td></td>
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</tr>
<tr>
<td>Education years (in years)</td>
<td></td>
<td></td>
<td>−0.015</td>
<td>0.101</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household income (in quartiles)</td>
<td></td>
<td></td>
<td>0.027</td>
<td>0.447</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Random effect Variance P-value Variance P-value Variance P-value

Intercept 66.489 <0.001 59.567 <0.001 57.888 <0.001

Fig. 1. Racial differences in number of decayed teeth (Model 2).
in contrast with its hypothesized increase (H3), the number of filled teeth decreased slightly over time (Model 1, Table 5), which may be explained by the heterogeneity in demographic attributes (Model 2, Table 5). Nonetheless, there is evidence in support of H3 that whites had more filled teeth than blacks (b = 7.982; CI 95% = 7.175, 8.788), and this difference remained stable over time (b = /C0 0.014; CI 95% = /C0 0.085, 0.058) (Model 2, Table 5; Fig. 3). When education and income were adjusted, racial differences in the level of filled teeth attenuated but remained significant (Model 3, Table 5). Older age was associated with fewer filled teeth but this effect was mitigated when socioeconomic attributes were included (Model 3, Table 5). Those with higher education and higher household income had more filled teeth but with the same rate of increase (Model 3, Table 5). Finally, those who dropped out, died and had at least one proxy interview did not differ from other respondents in the number of filled teeth, when demographic and socioeconomic attributes were adjusted (Model 3 in Table 5).

Discussion
Previous research based on PDS focused on racial differences in the incidences of tooth loss and caries in conjunction with their annual rates of increment (22, 33–38). Whereas prior research has documented racial disparities in dental caries experience at one or two points in time, we are able to depict racial variations in the level of dental caries experience and its rate of change over an extended period of time. During a period of 5 years, the number of untreated decayed teeth decreased; the number of missing teeth increased; and the number of filled teeth stayed stable. Older black Americans fare poorly relative to their white counterparts in the trajectories of dental caries experience, and these disparities persist even with SES adjusted.

Given that decayed, missing and filled teeth exhibit distinct trajectories, it may be inappropriate to combine measures of these three conditions to form the widely used index of DMFT (i.e. decayed, missing and filled teeth). This caution is further reinforced by the fact that at the baseline, the number of filled teeth was negatively correlated with missing teeth (r = −0.488, P < 0.001) and decayed teeth (r = −0.344, P < 0.001), whereas missing teeth was uncorrelated with decayed teeth (r = −0.008, P > 0.05). Moreover, good, self-rated oral health was negatively correlated with missing teeth (r = −0.237, P < 0.001) and decayed teeth (r = −0.218, P < 0.001) but positively correlated with filled teeth (r = 0.272, P < 0.001). Finally, DMFT is dominated by the number of missing teeth because of its greater range in comparison with those for decayed and filled teeth. Hence, DMFT is less useful in assessing dental caries experience among older adults because of increasing missing teeth (26). DMFT, if used at all, should probably be presented in conjunction with its components. Nevertheless, our observations remain to be replicated with data from individuals under the age of 65 before our conclusion could be extended to nonelderly persons.

According to prior research, incidence of coronal and root caries was lower among older blacks relative to older whites (22). In contrast, we found that white Americans were less likely to have decayed teeth, whereas the rate of change did not differ significantly between the blacks and whites. These differences may be due to the fact that previous studies have classified decayed and filled surfaces as caries (15, 22), whereas in the present research, the number of decayed teeth was measured without including filled teeth in that once a decayed tooth was filled, it was classified only as a filled tooth. Indeed, as noted by Lawrence and associates
whereas blacks had more decayed root surfaces than whites, they had fewer decayed and filled root surfaces combined than their white counterparts. Furthermore, instead of focusing on incidence only, our analysis of trajectories took into account the prevalence and incidence of dental caries experience conditions over time.

Racial differences are confounded as well as mediated by a number of other factors (e.g. age, gender and education). Older age was correlated with more missing teeth over time, whereas men were likely to have more decayed teeth. Racial differences are partially mediated by socioeconomic status (SES) such as education and household income. However, even when SES was adjusted, racial variations in dental caries experience remained significant. To better understand the mechanism underlying racial differences in dental caries experience, further research on other confounding and mediating factors is required. They may include health system, environmental risk factors, health status, dental service use and health behaviours (17, 18). Future interventions to minimize racial variations among older Americans in the levels of and the rates of change in dental caries experience are clearly warranted.

As with all scientific endeavours, this research can be improved. Although our database involves

### Table 5. Multilevel regression analysis of the trajectory of filled teeth

<table>
<thead>
<tr>
<th>Covariates</th>
<th>Model 1 Coef</th>
<th>P-value</th>
<th>Model 3 Coef</th>
<th>P-value</th>
<th>Model 4 Coef</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decayed teeth</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>5.887</td>
<td>&lt;0.001</td>
<td>9.383</td>
<td>&lt;0.001</td>
<td>–0.268</td>
<td>0.911</td>
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<td>Dropout for good (vs complete data)</td>
<td>–0.822</td>
<td>0.092</td>
<td>–0.598</td>
<td>0.166</td>
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<td>Returned after dropout (vs complete data)</td>
<td>–0.828</td>
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<td>–0.324</td>
<td>0.617</td>
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<td>Death (vs complete data)</td>
<td>–1.028</td>
<td>0.054</td>
<td>–0.531</td>
<td>0.254</td>
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<td></td>
</tr>
<tr>
<td>Proxy interview (Proxy vs nonproxy)</td>
<td>–0.917</td>
<td>0.074</td>
<td>–0.042</td>
<td>0.936</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (in years)</td>
<td>–0.084</td>
<td>0.015</td>
<td>–0.029</td>
<td>0.356</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex (Male vs Female)</td>
<td>–0.537</td>
<td>0.177</td>
<td>–1.279</td>
<td>0.001</td>
<td></td>
<td></td>
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<tr>
<td>Race (White vs Black)</td>
<td>7.982</td>
<td>&lt;0.001</td>
<td>4.907</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Education years (in years)</td>
<td></td>
<td></td>
<td>0.357</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Household income (in quartiles)</td>
<td></td>
<td></td>
<td>1.533</td>
<td>&lt;0.001</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| For linear time slope, \( \pi_t \)         |              |         |              |         |              |         |
| Intercept                                 | –0.036       | 0.048   | –0.085       | 0.757   | –0.076       | 0.976   |
| Dropout for good (vs complete data)       | 0.054        | 0.374   | 0.055        | 0.368   |              |         |
| Returned after dropout (vs complete data) | 0.010        | 0.848   | 0.010        | 0.845   |              |         |
| Death (vs complete data)                  | 0.090        | 0.198   | 0.087        | 0.214   |              |         |
| Proxy interview (Proxy vs nonproxy)       | –0.035       | 0.447   | –0.030       | 0.531   |              |         |
| Age (in years)                            | 0.001        | 0.895   | <0.001       | 0.918   |              |         |
| Sex (Male vs Female)                      | 0.018        | 0.639   | 0.024        | 0.545   |              |         |
| Race (White vs Black)                     | –0.014       | 0.707   | –0.008       | 0.837   |              |         |
| Education years (in years)                |              |         | 0.001        | 0.871   |              |         |
| Household income (in quartiles)           |              |         | –0.006       | 0.766   |              |         |

<table>
<thead>
<tr>
<th>Random effect</th>
<th>Variance</th>
<th>P-value</th>
<th>Variance</th>
<th>P-value</th>
<th>Variance</th>
<th>P-value</th>
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<tr>
<td>Intercept</td>
<td>45.566</td>
<td>&lt;0.000</td>
<td>28.831</td>
<td>&lt;0.000</td>
<td>22.475</td>
<td>&lt;0.000</td>
</tr>
</tbody>
</table>

![Trajectory of number of filled teeth by race](image)
as many as 4 repeated observations of a population-based sample of older Americans over a period of 5 years, it could be substantially expanded. For instance, in addition to older white and black Americans, Hispanic Americans and middle-aged respondents could be included. Furthermore, the period of observation could be extended. These enhancements would facilitate the analysis of long-term dental caries experience trajectories involving multiple racial/ethnic groups and birth cohorts, providing valuable information concerning the generalizability of our results. On the other hand, decayed teeth, missing teeth and filled teeth represent only a few of the dimensions of oral health. Other important dimensions may include, for example, periodontal diseases and dental health-related quality of life. Conceivably, trajectories of these outcome measures could be charted, and more importantly their dynamic linkages with the trajectories of decayed teeth, missing teeth and filled teeth need to be examined.

The present research is based on a variable-centred approach, which is predicated on the assumption that the population is homogeneous with respect to how the predictors operate on the outcomes. In contrast, a person-centred approach is based on the assumption that the population is heterogeneous with respect to how the predictors operate on the outcomes. For instance, using the group-based mixture models outlined by Nagin (39), Broadbent et al. (40) identified three distinct trajectories of dental caries experience measured by DMFS (decayed, missing and filled surfaces) up to age 32, although they did not focus on the effects of potential covariates. Further analysis of dental caries experience trajectories based on a person-centred approach would yield valuable information, particularly concerning the heterogeneity in changes in oral health over time.

In summary, decayed, missing and filled teeth exhibit distinct courses of change over time among older adults. Furthermore, older black Americans fare poorly relative to their white counterparts in the trajectories of dental caries experience. Racial disparities persist even when SES is taken into account.

Acknowledgements

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References