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Changes in Periodontal Disease Experience From 26 to 32 Years of Age in a Birth Cohort

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Abstract

Background—Information is lacking on the natural history of periodontitis through the third and fourth decades of life.

Methods—Periodontal examinations were conducted at 26 and 32 years of age in a longstanding prospective study of a birth cohort born in Dunedin, New Zealand, in 1972 and 1973. At each age, gingival recession (GR) and probing depth (PD) were recorded at three sites per tooth using a diagonal half-mouth design (measurements were made in all four quadrants at 32 years of age, but longitudinal comparisons were made using only the half-mouth data).

Results—A total of 882 individuals were examined at both ages. The mean number of measured sites fell between 26 and 32 years of age. The overall prevalence of one or more sites with ≥4 mm combined attachment loss (CAL) rose from 18.6% to 21.8%, whereas there were greater increases in the proportion with two or more sites with ≥4 mm CAL (from 8.0% to 12.6%) and one or more sites with ≥5 mm CAL (from 3.6% to 8.0%). The extent and severity of CAL also increased. A total of 403 individuals (45.7%) had an increase in CAL ≥2 mm at one or more sites, whereas 110 (12.5%) had a CAL increase ≥3 mm at one or more sites. Seen in ~4% of sites, negative GR (i.e., gingival enlargement) had a substantial effect on PD-based estimates. An increase in PD ≥2 mm at one or more sites was experienced by 345 individuals (39.1%), whereas 88 people (10.0%) had an increase in PD ≥3 mm at one or more sites. The greatest mean attachment loss was experienced at disto-lingual sites on molars, and most manifested as PD increases. Notable increases in GR were seen with lower incisors and canines.

Conclusions—Periodontal loss of attachment continues among a sizable proportion of people from the third to the fourth decade of life; however, contrary to patterns in older adults, changes in the PD component are greater than the changes in the recession component. Incident attachment loss is most frequently observed at proximal sites on posterior teeth.

Keywords

Adults; cohort study; incidence; periodontal attachment loss

The only available information on the occurrence of periodontal disease in population-based samples of people in the third and fourth decades of life comes from cross-sectional studies (surveys). There are no reports from cohort studies, meaning that information is lacking on the natural history of periodontitis through what is probably a key period in the development of

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the condition. The term "natural history" refers to the progress of a condition from its initial development and clinical manifestation through to its persistence, remission, relapse, or resolution.[1] Therefore, a comprehensive picture of the natural history of periodontal disease in a population requires the following: 1) the prospective cohort study design be used; 2) the examined sample be representative (clinical or convenience samples are inappropriate because their data are not generalizable); 3) the unit of observation be many sites within each individual (and preferably from full-mouth assessments using multiple sites per tooth); 4) separate measurements of gingival recession (GR) and probing depth (PD); and 5) the recording of gingival inflammation. To date, no published study of younger adults meets all of these criteria. Understanding the natural history of periodontitis is important, not only for complete understanding of the condition but also so that the nature and timing of therapeutic and preventive efforts are appropriate.

Estimates from surveys indicate that periodontitis is well-established among middle-aged and older adults,[2] but what is not yet clear is when, in adulthood, destructive periodontitis typically becomes clinically detectable in populations and the nature of any differences among individuals. An earlier report on 26-year-old participants in our longstanding birth cohort study[3] indicated that chronic periodontitis was well-established among a sizable minority (nearly 20% had one or more sites with ≥4 mm combined attachment loss [CAL] and that attachment loss [AL] was more prevalent in interproximal sites than in buccal sites).

The aim of this study was to describe changes in the occurrence of periodontal loss of attachment (and its components) and gingivitis in this birth cohort between 26 and 32 years of age.

MATERIALS AND METHODS

The Dunedin Multidisciplinary Health and Development Study (DMHDS) is a longitudinal study of a birth cohort of children who were born at the Queen Mary Hospital, Dunedin, New Zealand, between April 1, 1972 and March 31, 1973.[4] The sample that formed the basis for the longitudinal study was 1,037 children, and they were assessed within a month of their third birthdays. Periodic collections of health and developmental data (including dental examinations) have been undertaken since then, and the current study uses data collected from dental examinations at 26 and 32 years of age. Over 90% of the cohort self-identified as being of European origin. Ethical approval for the study was obtained from the Otago Ethics Committee and all participants provided informed consent to take part in the study.

At 26 years of age, dental examinations were conducted by three examiners who had been previously calibrated and who examined 785, 100, and 45 study members, respectively. Periodontal measurements were made in two quadrants (quadrants 1 and 3 for study members whose study identification (ID) number was odd; quadrants 2 and 4 for those with an even ID number; the mix of odd and even ID numbers was approximately 50:50). Those measurements were made in only two quadrants because of time constraints. Three sites (mesio-buccal, buccal, and disto-lingual) per tooth were examined, and GR (the distance in millimeters from the cemento-enamel junction [CMJ] to the gingival margin) and PD (the distance from the tip of the probe to the gingival margin) were recorded (Figure 1), using a National Institute of Dental Research (NIDR) probe, which has a rounded 1-mm tip and six alternating 2-mm bands. Mid-buccal measurements for molars were made at the midpoint of the mesial root. All measurements were rounded down to the nearest whole millimeter at the time of recording. Where the gingival margin was situated >1 mm coronally to the CMJ, a negative value for GR was recorded. Gingival bleeding was assessed for each tooth by recording the presence or absence of blood at any of the three probing sites 10 seconds after probing and then recorded as "present" or "absent" for that tooth. Periodontal measurements were not conducted on study

members who reported a history of cardiac valvular anomalies or rheumatic fever. Plaque accumulation was measured using a modification of the simplified oral hygiene index (OHI-S),[5] which scores plaque accumulation on six index teeth as follows: "0" for no plaque detectable with an explorer; "1" for plaque covering not more than the cervical third of the tooth surface; "2" for plaque covering more than one-third but not more than two-thirds of the tooth surface; and "3" for plaque extending over more than two-thirds of the exposed tooth surface. We computed an individual's OHI-S score as the sum of the scores divided by the number of teeth scored; this differs from the original OHI-S, where the presence of calculus was scored in the same way as for plaque, and then the plaque and calculus scores were combined into an OHI-S score.

The dental examinations were repeated 6 years later, when study members were 32 years old. The clinical procedures were identical, except that a full-mouth examination was possible. Two examiners were used, and they examined 495 and 437 study members, respectively; the second examiner was the same one who had conducted 84% of examinations at 26 years of age. Replicate periodontal examinations were not possible during the assessments because of time constraints (due to the busy assessment day undergone by study members). However, replicate examinations were conducted on a separate sample of 16 adults on four occasions during the DMHDS data collection phase at 32 years of age, giving data for 1,423 measured sites. Intraclass correlation coefficients for the periodontal measurements pooled for the two examiners (with the individual examiner coefficients in parentheses) were 0.93 (0.94, 0.89) for mean GR, 0.68 (0.46, 0.83) for mean PD, and 0.69 (0.66, 0.86) for mean CAL. The κ value for the prevalence of one or more sites with ≥4 mm CAL was 0.5 (0.7, 0.8). Of the 1,423 replicated pairs of measurements, 99.6% were within ±2 mm, meaning that only 0.4% of replicated pairs differed by ≥3 mm. Thus, ≥2 mm was chosen as the minimum threshold representing true change(a low probability of being due to examiner error) for PD and CAL in this study. For GR, ≥1mm was chosen because of the greater ease of measurement (and associated lower likelihood of error) afforded by both landmarks being visible.

Data Analysis and Case Definitions

Because of the high prevalence of negative GR measures in this cohort (indicating gingival enlargement [GE], known previously as "gingival hyperplasia"), we decided to create two PD measures. Unadjusted PD was the traditional measure taken from the free gingival margin to the base of the pocket. Adjusted PD involved subtracting the distance from the free gingival margin to the point 1 mm coronal to the CMJ. We report both adjusted and unadjusted PD. For each of 26 and 32 years of age, the CAL for each site was computed by summing the measurements for GR and adjusted PD. Third molars were not included in the analysis of the periodontal data. For changes between 26 and 32 years of age, paired samples *t* tests were used to compare mean scores, and McNemar tests were used to test the significance of differences in proportions.

Using recently reported criteria,[6] a previously non-diseased site that increased ≥2 mm and resulted in a periodontal pocket that was ≥4 mm was classified as having incident disease, whereas a site showing progression was defined as having a pocket ≥4mm at 26 years of age that had increased by ≥2mm by 32 years of age. An incident case was an individual who had one or more sites that experienced incident disease or progression. As a complementary approach to determining person-level incidence, age-appropriate clinical case definitions[6] were created for the cohort at 26 and 32 years of age as follows: "healthy" individuals had no site with bleeding on probing and PD >3 mm; those with "moderate/severe" periodontitis had ≥10 sites with ≥4mm PD; and the remainder were designated "mild" cases.

RESULTS

Person-Level Results

A summary of the numbers taking part at each age (and their characteristics) is presented in Table 1. At 26 years of age, 1,019 (98.3%) of the 1,037 original study members were alive, and 980 (96.2% of the surviving cohort) participated in the assessments at 26 years of age. Dental examination data at 26 years of age were available for 930 individuals; 914 (98.3%) of those were periodontally examined, one refused to be examined, and 15 (1.6%) were not examined because of a medical contraindication to periodontal probing. Of the group for whom periodontal data were available, there were approximately equal numbers of males and females. At 32 years of age, periodontal examination data were available for 915 individuals, of whom 882 (96.4%) were examined at both ages. All subsequent analyses are limited to those 882 individuals, of whom 51.1% were males.

Summary data on the periodontal status of the cohort at 26 and 32 years of age are presented in Table 2. The data at 32 years of age are presented in three ways. First, to enable direct comparison with the data at 26 years of age, the half-mouth estimates (using the same sites) are presented. Second, the full-mouth estimates at 32 years of age are also presented. Third, the estimates are further subdivided based upon 1) CAL and 2) PD alone, with a further distinction between “raw” PD and that adjusted to take false pocketing into account (by adjusting PD downwards by the GR for each site where the GR was negative, indicating GE). Unless otherwise indicated, the following descriptions refer to the half-mouth comparisons. Between 26 and 32, the mean number of measured sites fell, reflecting the ongoing (non-third-molar) tooth loss among the cohort (where, between 26 and 32 years of age, caries-associated incremental tooth loss was experienced by 10.8% of participants, with third molars excluded; data not shown). Although the overall prevalence of one or more sites with ≥4mm CAL rose moderately over the 6-year observation period ($P > 0.05$), that for two or more sites with ≥4 mm CAL and one or more sites with ≥5 mm CAL rose more substantially ($P < 0.01$). The extent and severity of CAL also increased significantly. There was a substantial decrease in the extent of bleeding on probing, from over one-quarter of all measured sites at 26 years of age to less than one-tenth by 32 years of age. The mean OHI-S score also decreased.

The estimates based upon unadjusted PD showed substantial differences from adjusted PD measures. For example, the prevalence of one or more sites with ≥4mm PD (unadjusted) at 32 years of age was 40.1%, whereas that for one or more sites with ≥4 mm PD (adjusted) was only 24.6%, suggesting that the occurrence of GE had a substantial effect on the PD-based estimates. Accordingly, data on the prevalence and extent of GR (both negative and positive) are presented in Table 3. The prevalence of GE (one or more sites with negative GR) increased with age, and there were substantial differences between the half-and full-mouth estimates at 32 years of age. The prevalence of positive GR (i.e., true GR) did not change, although its extent did decrease between 26 and 32 years of age (paired samples *t* test; $P < 0.0001$). GE was far more common at proximal sites than at mid-buccal sites (4.0% and 0.3% of sites, respectively).

Data on periodontitis case status at 32 years of age and that at 26 years of age are presented in Table 4. The nearly three-quarters of the cohort who were healthy at 26 years of age had fallen to just over half by 32 years of age, and the approximately one-third who were mild cases at 26 had risen to 40% by 32 years of age. The four individuals who were moderate/severe cases at 26 years of age had risen to 31 by 32 years of age (whereas half of the former had improved to mild status). One-third of the mild cases at 26 years of age had resolved by 32 years of age, whereas one-third of the healthy 26-year-olds had worsened by 32 years of age. In other words, two-thirds of the healthy individuals remained that way by 32 years of age, whereas two-thirds of the unhealthy individuals either stayed the same or worsened by 32 years of age.

Where incident AL is concerned, 403 study members (45.7%) had an increase in CAL ≥2 mm at one or more sites, whereas 110 individuals (12.5%) had an increase in CAL ≥3mm at one or more sites. The former involved a total of 1,081 sites, and a mean of 1.2 (SD: 2.3) sites per study member (range: 0 to 19), whereas the latter involved a total of 213 sites, and a mean of 0.2 (SD: 0.9) sites per study member (range: 0 to 12). Where the incidence of increased PD is concerned, 345 individuals (39.1%) had an increase in PD ≥2 mm at one or more sites, whereas 88 individuals (10.0%) had an increase in PD ≥3 mm at one or more sites. The former involved a total of 884 sites, and a mean of 1.0 (SD: 2.0) sites per study member (range: 0 to 19), where as the latter involved a total of 156 sites, and a mean of 0.2 (SD: 0.8) sites (range: 0 to 13). These data suggest that the bulk of the incident disease observed in the cohort was due to increases in PD.

Site-Level Results

Data on the site-level changes in PD by baseline PD are presented in Table 5. Using ≥3 mm as the criterion for change, a total of 369 (the sum of the B sites, representing 1.04% of the 35,607 sites followed) experienced PD increase incidence, and 11 (the sum of the C sites, representing 0.03%) showed progression in PD. A total of 788 sites (2.21%) showed a decrease in PD (≥2 mm), with 38 sites (0.11%) showing a decrease ≥3 mm.

There were tooth and site differences in the experience of AL (Fig. 2). The greatest mean AL was experienced at disto-lingual sites on molars, and most of that was manifested as increases in PD (although upper molars experienced greater increases in GR than lower molars, on average). Increases in PD were also seen at mesio-buccal and disto-lingual sites on pre-molars and at mesio-buccal and disto-lingual sites on canines. Notable increases in GR were seen with lower incisors and canines.

DISCUSSION

To our knowledge, this is the first study to report on changes in periodontal disease in a representative sample of adults from the third to the fourth decades of life. The prevalence, extent, and severity of periodontal AL all increased during the 6-year observation period, whereas the extent of bleeding on probing was substantially reduced, along with a decrease in the quantity of plaque that was observed on index teeth. A sizable minority of participants were incident cases of AL, with most of that manifesting as increases in PD at proximal sites on posterior teeth. Incident GR was most apparent on the lower incisors.

Before discussing those findings, it is appropriate to first consider the weaknesses and strengths of the study. Time constraints during the oral examination at 26 years of age meant that full-mouth recording of periodontal status was not possible, but this was rectified at 32 years of age. This meant that the monitoring of changes between 26 and 32 years of age had to be done using the half-mouth approach. Accordingly, it is likely that the longitudinal data presented here are underestimates. Although it is not possible to state the degree of underestimation of the incident AL with any certainty, comparison of the half- and full-mouth estimates for disease prevalence, extent, and severity at 32 years of age (Table 2) indicates that there certainly has been some underestimation with respect to the cross-sectional data, but that it differs according to the parameter being examined. For example, the full-mouth estimates for the prevalence of one or more sites with ≥4 mm CAL, two or more sites with ≥4 mm CAL, and one or more sites with ≥5 mm CAL are (respectively) 33%, 55%, and 48% higher in relative terms or 7%, 6%, and 4% higher in absolute terms. That measurements were made at only three sites per tooth (instead of six sites) will also have led to some underestimation, but its magnitude is unknown. However, a recent study of the effect of partial recording protocols on estimates of periodontal disease prevalence found that the combination of the mesio-buccal, mid-buccal, and disto-lingual sites was associated with the least bias compared to estimates from the use of all six

sites per tooth.[7] This suggests that the use of those three sites in the current study may have minimized that partial-recording bias.

Where the study's strengths are concerned, the high retention rate and use of a complete birth cohort mean that the findings should be generalizable to the source population. However, there is the issue of whether the findings can be generalized with any degree of confidence to other western industrialized countries. In an earlier report describing periodontal disease prevalence at 26 years of age in the same sample,[3] we compared the estimates with those from other representative samples in New Zealand[8,9] and the United States[10] and observed that they appeared to be comparable, although methodological differences inevitably limited those comparisons. Similarly, the site-level data on PD changes over time (Table 5) show broadly similar patterns to those recently described in a sample of 891 pregnant United States women.[6] Given these similarities, we cautiously suggest that the patterns reported here may be typical of those observed among people of a similar age in other western industrialized countries.

The increase in disease prevalence among the cohort was not surprising, given the aging of study members into their third decade and the associated ongoing exposure to various etiological agents. Not surprisingly, those who experienced AL were (on average) more likely to experience that disease increase at proximal sites and at disto-lingual sites on molars or premolars, with most of that manifesting as increases in PD. This differs from a recent report from an older population, where disto-lingual sites on molars were also the most severely affected over time, but a high proportion of that AL manifested as increases in GR at those sites.[11] The reason for this difference is unclear, but it may involve age-related factors. It is noteworthy that, in keeping with findings from other cohort studies,[6,11] most site-level loss of attachment was experienced as incidence in previously healthy sites rather than progression in previously diseased sites. This underlines the need for clinicians to monitor all sites over time, not just those that have disease at the baseline consultation.

The occurrence of negative GR had a substantial effect on the PD-based estimates for periodontitis in this study. It is not an issue that has emerged before. Whether all of the negative GR manifested as GE is a debatable point. Our attempt to adjust the PD-based estimates for negative GR (by adding the GR to the PD for each site where GR was negative) was, in all likelihood, an overadjustment, as not all sites where the gingival margin was coronal to the CEJ would necessarily have had enlargement. However, a comparison of the CAL- and PD-based estimates in Table 2 suggests that the adjustment seems intuitively sound regardless of the age or the approach (whether half- or full-mouth). However, close examination of this issue in other populations of young adults is warranted before the merits (or otherwise) of this adjustment can be fully evaluated. It may be that different studies need different approaches. For example, where the aim of the study is to describe the occurrence and associations of periodontitis in a population, our adjustment would be valid. By contrast, in an analytical epidemiological study where periodontal disease was being used as an exposure variable, such an adjustment might not be valid, as the key exposure issue would be the surface area of inflamed (ulcerated) periodontal tissue that is in intimate contact with the plaque biofilm.[12] In that situation, the distinction between in- flamed periodontal tissue above the CEJ and that which is below it would essentially be an artificial one.

The reduction in the extent of bleeding on probing (from~30% to 8% of sites) from 26 to 32 years of age was substantial. At the same time, there was a reduction in mean OHI-S scores, indicating a decrease in the quantity of plaque that was observed on index teeth. Whether this was the reason for the reduction in bleeding on probing raises a number of issues, the first of which is the extent to which mean plaque scores represent the actual amount and composition of plaque biofilm. The second is the extent to which the amount of plaque on index teeth represents that on other teeth and sites. Neither of these can be satisfactorily dealt with here,

and whether or not a reduction in OHI-S score from 0.9 to 0.8 is clinically meaningful (and therefore able to account for the reduction in bleeding on probing) is debatable. It may be that the reduction in bleeding on probing occurred independently of the change in mean OHI-S score and, instead, was due to a continuing age-associated maturation of the periodontal tissues (and the paucity of longitudinal periodontal data on this age group means that this possibility cannot be discounted at this stage). Alternatively, it could have been due to changes in smoking behavior, although a large increase in smoking prevalence would probably be needed to account for a three-fold reduction in bleeding on probing. The role of smoking as a risk factor for periodontal disease progression in this cohort will be examined in future analyses.

CONCLUSIONS

Periodontal AL and increases in PD continue among a sizable proportion of people (likely to have been under-estimated in this study) as they age from the third decade of life into the fourth, while gingivitis (as represented by the extent of bleeding on probing) appears to become less prevalent. AL between 26 and 32 years of age does occur, and, contrary to patterns in older adults, the changes in the PD component are greater than the changes in the recession component. AL is most frequently observed at proximal sites on posterior teeth.

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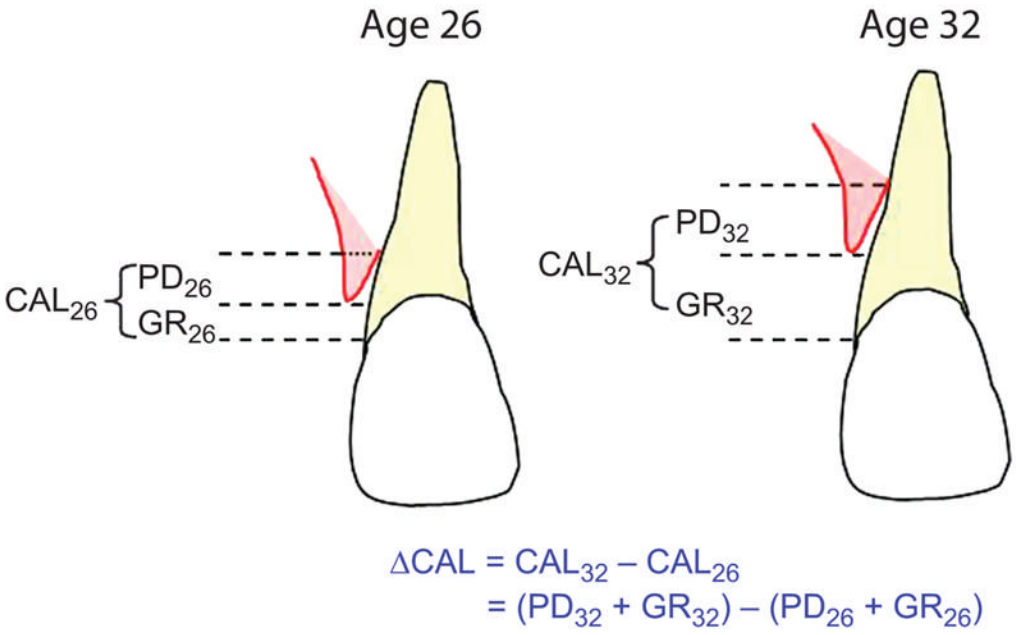

Figure 1.
Clinical measurements and the calculation of the change in CAL for each site.

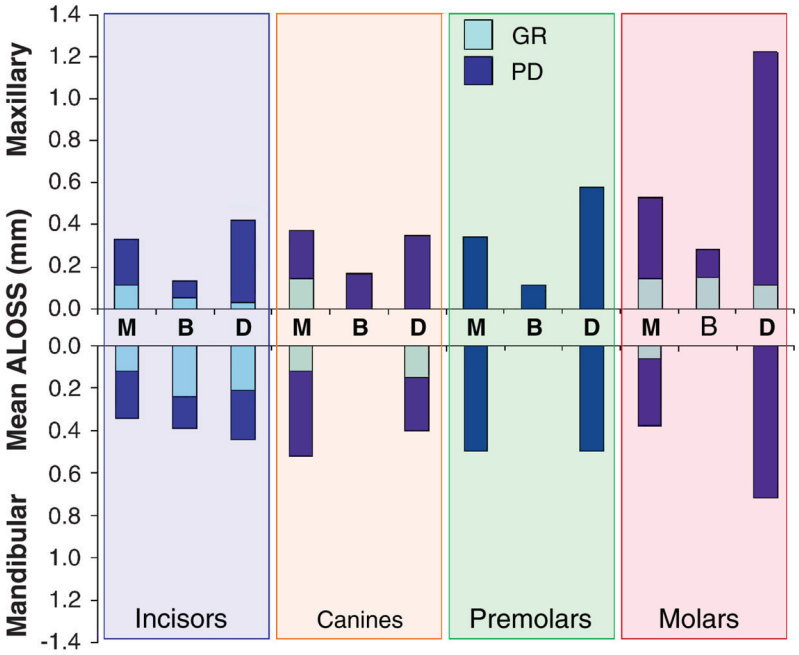

Figure 2.
Mean increase in AL (ALOSS) between 26 and 32 years of age, by tooth type, site measured, and the nature of the change (M = mesio-buccal; B = mid-buccal; D = disto-lingual).

Table 1

Number of Individuals Taking Part in the Assessments at Each Age by Gender

	Males*	Females*	All†
At baseline (3 years of age)	535	502	1,037
At 26 years of age (1,019 surviving)			
Dentally examined	472 (88.2)	458 (91.2)	930 (91.3)
Periodontally examined	465 (86.9)	449 (89.4)	914 (89.7)
At 32 years of age (1,015 surviving)			
Dentally examined	476 (89.0)	456 (90.8)	932 (91.8)
Periodontally examined	469 (87.7)	446 (88.8)	915 (90.1)
At both ages			
Dentally examined	459 (85.8)	442 (88.0)	901 (88.8)
Periodontally examined	451 (84.3)	431 (85.9)	882 (86.9)

*Parentheses contain percentages that use the number at baseline as the denominator.

†Parentheses contain percentages that use the number surviving at each age as the denominator.

Table 2

Summary Data on Periodontal Status at 26 and 32 Years of Age (N = 882)

	26 Years of Age*	32 Years of Age	
		Half-Mouth	Full-Mouth
Mean N sites measured (SD)	40.4 (2.6)	39.9 (3.3)	79.8 (6.2)
Periodontitis prevalence			
CAL-based estimates			
One or more sites with ≥4 mm CAL (%)	164 (18.6)	192 (21.8)	252 (28.6)
Two or more sites with ≥4 mm CAL (%)†	71 (8.0)	111 (12.6)	169 (19.2)
One or more sites with ≥5 mm CAL (%)†	32 (3.6)	71 (8.0)	103 (11.7)
Unadjusted PD only			
One or more sites with ≥4 mm PD (%)	272 (30.8)	269 (30.5)	354 (40.1)
Two or more sites with ≥4 mm PD (%)†	107 (12.1)	141 (16.3)	212 (24.0)
One or more sites with ≥5 mm PD (%)†	50 (5.7)	77 (8.7)	109 (12.4)
Adjusted PD only			
One or more sites with ≥4 mm PD (%)	131 (14.9)	169 (19.2)	217 (24.6)
Two or more sites with ≥4 mm PD (%)†	58 (6.6)	102 (11.6)	144 (16.3)
One or more sites with ≥5 mm PD (%)†	24 (2.7)	56 (6.3)	83 (9.4)
Extent of disease			
Mean% sites with ≥4 mm CAL (SD)†	1.0 (3.3)	2.0 (6.5)	2.0 (6.1)
Mean% sites with ≥5 mm CAL (SD)†	0.2 (1.2)	0.6 (3.2)	0.5 (2.8)
Mean% sites with ≥4 mm adjusted PD (SD)†	0.8 (2.8)	0.8 (2.4)	1.6 (4.7)
Mean% sites with ≥5 mm adjusted PD (SD)†	0.1 (0.6)	0.2 (0.9)	0.3 (1.8)
Mean% sites with ≥4 mm unadjusted PD (SD)†	1.6 (3.5)	2.3 (5.7)	2.2 (5.4)
Mean% sites with ≥5 mm unadjusted PD (SD)†	0.3 (1.4)	0.4 (2.0)	0.4 (2.0)
Severity of disease			
Mean CAL over sites with >2 mm CAL (SD)†	3.1 (0.2)	3.2 (0.3)	3.1 (0.3)
Mean unadjusted PD over sites with >2 mm PD (SD)†	3.1 (0.3)	3.2 (0.3)	3.1 (0.3)
Other periodontal measures			
Mean% teeth with bleeding on probing (SD)‡	29.6 (25.4)	8.3 (7.6)	8.4 (7.1)
Mean OHI-S score (SD)§	0.9 (0.5)		0.8 (0.5)

*Estimates at 26 years of age based upon half-mouth periodontal examinations only.

†Increase between 26 and 32 years of age is significant at the $P < 0.01$ level.

‡Reduction between 26 and 32 years of age is significant at the $P < 0.001$ level.

§OHI-S score based on six index teeth; half-mouth approach not used.

Table 3

Prevalence and Extent of Negative GR ≥1 mm (GE) and Positive GR at 26 and 32 Years of Age

		32 Years of Age	
	26 Years of Age*	Half-Mouth	Full-Mouth
"Negative" GR (GE)			
One or more sites with GE (%)	518 (58.7)	548 (62.1)	652 (73.9)
Mean N sites with GE (SD)	1.6 (2.4)	1.7 (2.4)	3.3 (4.5)
Range of sites with GE	0 to 20	0 to 18	0 to 29
Mean % sites with GE (SD)	3.9 (6.0)	3.1 (3.1)	4.3 (5.7)
Range of % sites with GE	0.0 to 47.6	0.0 to 24.0	0.0 to 37.3
"Positive" (true) GR			
One or more sites with GR >0 (%)	627 (71.1)	488 (55.3)	628 (71.2)
Mean N sites with GR >0 (SD)	2.6 (3.1)	1.6 (2.3)	3.6 (4.8)
Range of sites with GR >0	0 to 25	0 to 20	0 to 49
Mean % sites with GR >0 (SD)	6.5 (7.9)	4.0 (6.3)	4.6 (6.6)
Range of % sites with GR >0	0.0 to 59.5	0.0 to 70.8	0.0 to 62.8

*Estimates at 26 years of age based upon half-mouth periodontal examinations only.

Table 4

Periodontal Case Status at 32 Years of Age by That at 26 Years of Age*

		Periodontal Status at 32 Years of Age			
		Healthy	**Mild**	**Moderate/Severe**	**Totals†**
Periodontal status at 26 years of age	Healthy	400 (64.1)	217 (34.8)	7 (1.1)	624 (70.7)
	Mild	85 (33.5)	145 (57.1)	24 (9.4)	254 (28.8)
	Moderate/severe	0 (0.0)	2 (50.0)	2 (50.0)	4 (0.5)
	Totals	485 (55.0)	364 (41.3)	33 (3.7)	882 (100.0)

Parentheses contain row percentages unless otherwise indicated.

*After Moss et al.[6]

†Column percentages.

Table 5

Numbers of Sites (N = 35,607) Showing Changes in PD* From 26 to 32 Years of Age by PD at Baseline

	PD at Baseline					
	0 mm	**1 mm**	**2 mm**	**3 mm**	**4 mm**	**≥5 mm**
Total N sites	3,410	16,193	14,223	1,497	240	46
No change	3,203 (93.93)	15,850 (93.27)	13,493 (94.87)	1,251 (83.57)	112 (48.02)	45 (97.83)
PD increase from 26 to 32 years of age						
2 mm	194 (5.69) A	280 (1.73) A	225 (1.58) B	19 (1.27) B	4 (1.67) C	0 (0.00) C
3 mm	13 (0.38) A	59 (0.36) B	34 (0.24) B	10 (0.67) B	6 (2.50) C	0 (0.00) C
≥4 mm	0 (0.00) B	4 (0.02) B	16 (0.11) B	2 (0.13) B	1 (0.42) C	0 (0.00) C
PD decrease from 26 to 32 years of age						
2 mm	—	—	455 (3.20)	204 (13.63)	91 (37.92)	0 (0.00)
3 mm	—	—	—	11 (0.73)	26 (10.83)	1 (2.17)
≥4 mm	—	—	—	—	0 (0.00)	0 (0.00)

Parentheses contain percentages. The denominator for the percentages in each column is the total number of sites (in the first row of that column).

* Definitions of incident or progressing sites: A = not included in either; B = incidence; C = progression. Note that PD has been adjusted for sites with negative GR.