Australian Dental Journal 2007;52:(1):55-60

Periodontal disease among 45–54 year olds in Adelaide, South Australia

DS Brennan,* AJ Spencer,* KF Roberts-Thomson*

Abstract

Background: The aims of this study were to describe the prevalence, extent and severity of periodontal disease among middle-aged adults, and to examine periodontitis by dental visit pattern, dental and health behaviour, socio-demographics and socio-economic status.

Methods: A random sample of 45–54 year olds from metropolitan Adelaide, South Australia was surveyed by mailed self-complete questionnaire during 2004–2005 with up to four follow-up mailings of the questionnaire to non-respondents (n=879 responded, response rate=43.8 per cent). Oral examinations were performed on 709 people who responded to the questionnaire (completion rate=80.7 per cent), providing an assessment of periodontal status.

Results: Prevalence of loss of attachment (LOA) of 6+ mm was 19.2 per cent, extent of sites with LOA of 6+ mm was 1.3 per cent, and severity of LOA of sites with LOA of 2+ mm was 2.4mm. Using a case definition for periodontitis of two or more sites with LOA of 5+ mm and one or more sites with PD of 4+ mm in a multivariate logistic regression showed higher odds of periodontitis for people who last visited for relief of pain (OR=1.93) and who smoked daily/occasionally (OR=3.84), while lower odds were observed for people who were born in Australia (OR=0.51) and spoke English as the main language at home (OR=0.34).

Conclusions: While periodontal disease was related to visit pattern and health-related behaviours, the relationship with place of birth and main language spoken at home indicated socio-cultural variation in disease not explained by behaviour among this cohort of 45–54 year olds.

Key words: Periodontal disease, 45–54 year olds, visit pattern, smoking status, socio-demographics.

Abbreviations and acronyms: CEJ = cemento-enamel junction; CPITN = Community Periodontal Index of Treatment Needs; FGM = free gingival margin; GR = gingival recession; ICC = intra-class correlation; LOA = loss of attachment; PD = pocket depth.

(Accepted for publication 14 June 2006.)

*Australian Research Centre for Population Oral Health, School of Dentistry, The University of Adelaide, South Australia.

INTRODUCTION

Periodontal diseases involve inflammation of the periodontal tissues that can be associated with recession of the gums or formation of periodontal pockets in the gums.[1] Following pocket formation and invasion by bacteria complete recovery of lost tooth support is impossible, and without adequate treatment active periodontitis can lead to tooth loss.[2] Patients with periodontitis have a higher prevalence of systemic diseases, take more medications and are more likely to suffer from multiple conditions compared to the general population.[3]

Previous surveys of oral health among the Australian population have reported periodontal disease using the Community Periodontal Index of Treatment Needs (CPITN) or related measures.[4,5] For example, there were surveys in Brisbane in 1984, Melbourne in 1985 and 1990, as well as the 1987–1988 National Oral Health Survey of Australia.[6-8] Given the limitations of the CPITN as a measure of periodontal disease,[9] more recent studies have employed more extensive periodontal measures that involve probing of multiple sites per tooth and recording both gingival recession and pocket depth in order to calculate loss of attachment scores.[10] While some age groups such as the elderly have been subject to intensive study,[11] there is a paucity of data on other groups, particularly middle-aged adults.

The Australian population has shown improved oral health over recent decades, with decreased tooth loss among adults.[12,13] Demographic changes are projected to maintain the pool of children and young adults, while the pool of middle to older aged adults is projected to increase.[14,15] With the decline in both edentulism and numbers of missing teeth, the dental needs of adults may increase due to the larger pool of teeth at risk.[16] Changing demographics and technological advances are expected to lead to higher patient expectations and to a greater demand for oral health care.[17] Middle-aged adults are likely to become an increasing focus in dental care due to their growth in number in the population and retention of natural dentitions.

Table 1. Distribution of explanatory variables and comparison of study participants with population profile

	*Population	Study participants	
Oral health status			(95% CI)
Number of teeth – mean	26.9	25.4	(24.9-25.8)
Denture (upper jaw) – %	13.7	13.6	(11.4-15.9)
Denture (lower jaw) – %	5.8	6.4	(4.7-8.0)
Dental visit pattern			
Last dental visit <12 months – %	65.4	61.5	(58.3-64.7)
Check-up at last dental visit – %	41.7	43.4	(40.1-46.7)
Last visit for relief of pain – %	–	15.4	(12.7-18.1)
Number of dental visits in last 12 months – mean	1.8	1.5	(1.4-1.7)
Visited private at last dental visit – %	95.2	86.1	(83.8-88.4)
Dental and health-related behaviour			
Toothbrushing 8+ times per week – %	–	78.7	(75.6-81.8)
Use of mouth rinse 1+ times per week – %	–	26.4	(23.1-29.7)
Smoking status: Daily/occasionally – %	–	14.8	(12.1-17.5)
Socio-demographics			
Female gender – %	51.2	52.0	(48.7-55.3)
Australian born – %	70.8	70.9	(67.9-74.0)
Indigenous – %	1.3	0.4	(0-4.3)
English main language at home – %	91.9	95.4	(94.0-96.8)
Education level of diploma or degree – %	–	42.3	(38.6-46.0)
Socio-economic status			
Concession card holder – %	15.4	19.0	(16.4-21.7)
Household income $80 000+ – %	24.5	23.8	(20.9-26.6)

*National Dental Telephone Interview Survey 2002: South Australia – Adelaide 45-54 year olds.

The aims of the study were to describe the prevalence, extent and severity of periodontal disease among middle-aged adults, and to examine periodontitis by a range of explanatory factors spanning dental visit pattern, dental and health behaviour, socio-demographics and socio-economic status.

METHODS

Sampling and data collection

A total of 2248 people aged 45–54 years were randomly sampled from metropolitan Adelaide, South Australia, using the electoral roll as a sampling frame. Sampled people were surveyed by mailed self-complete questionnaire during 2004–2005. A primary approach letter was initially mailed, followed a week later by the questionnaire, and then by a reminder card and up to four follow-up mailings of the questionnaire to non-respondents in order to achieve a higher response rate.[18] Respondents to the questionnaire were then approached by telephone to participate in an oral examination where clinical measures of tooth status, caries experience, periodontal disease and treatment need were recorded using standard criteria.[19] Oral examinations were conducted in dental clinics with adequate light, suction and drying aids. However, radiographic examination was not performed due to considerations of cost and exposure of respondents to radiation as part of research alone. A subset of n=11 cases was re-examined to assess reliability.

Variables measured

Periodontal status was assessed by calibrated dentists during the oral examination for all teeth present with measurement of gingival recession and probing depth at three sites per tooth (mesiobuccal, midbuccal, and distolingual). Measurements were rounded down to the nearest whole millimetre when recorded. Sites may have been excluded if the cemento-enamel junction (CEJ) could not be visualized or when large amounts of calculus prevented probing of pocket depth. Recession was defined as the distance from the CEJ to the free gingival margin (FGM), with negative recession marked where the CEJ is apical to the FGM by 1+ mm. Probing depth was defined as the distance from the FGM to the bottom of the gingival crevice or periodontal pocket. Bleeding on probing was recorded if any bleeding was observed within 10 seconds of probing at any of the three sites per tooth.

Analysis

Representativeness of the sample respondents was assessed by comparison to a range of oral health status, socio-demographic and dental visit pattern variables from a population survey.[13] Periodontal loss of attachment (LOA) was calculated by adding gingival recession (GR) and pocket depth (PD) at each site. Reliability was assessed using intra-class correlation (ICC).[20] Periodontal conditions were described according to prevalence, extent and severity. A case definition for periodontitis of two or more sites with LOA of 5+ mm and one or more sites with PD of 4+ mm was used to examine associations with the explanatory variables of dental visit pattern, dental and health behaviour, socio-demographics and socio-economic status using chi-square tests to test bivariate associations and a multivariate model was then constructed using logistic regression. Explanatory variables were entered as indicator variables with levels coded as 1 or 0 for the reference category.

Table 2. Prevalence, extent and severity measures

	Estimate	95% CI	
Prevalence score[a]			
LOA ⩾4mm	66.0	62.4	69.6
LOA ⩾5mm	36.7	33.0	40.4
LOA ⩾6mm	19.2	16.2	22.2
PD ⩾6mm	10.2	7.9	12.5
Extent score[b]			
LOA ⩾4mm	6.7	5.7	7.7
LOA ⩾5mm	2.7	2.1	3.3
LOA ⩾6mm	1.3	0.8	1.8
Severity score[c]			
Mean LOA	2.42	2.38	2.46

[a]Prevalence score: percentage of subjects with 1+ sites with LOA exceeding thresholds.
[b]Extent scores: mean percentage of sites with LOA exceeding thresholds.
[c]Severity score: mean LOA of sites with LOA ⩾2mm.

RESULTS

Response

A total 879 people responded giving a response rate of 43.8 per cent after adjusting for out of scope persons, such as those who could not be contacted. Oral examinations were performed on 709 people (giving an 80.7 per cent completion rate). The study participants generally showed a close approximation of the population profile (Table 1). Study participants had slightly fewer teeth, but there was no difference in denture wearing. Study participants had a slightly lower percentage visiting in the last 12 months and slightly fewer visits in the last 12 months, as well as a lower percentage that visited privately at the last visit, but there was no difference in the percentage receiving check-ups at the last dental visit. There were no differences in the percentage of females, Australian-born, or of Indigenous status, but study participants had a slightly higher percentage who spoke English as the main language at home as well as a slightly higher percentage who were concession card holders, but there was no difference in the percentage of persons from higher income households.

Reliability of measures

Reliability was ICC=0.79 for GR, ICC=0.96 for PD and ICC=0.95 for LOA. For extent of LOA of 4mm or more ICC=0.97, LOA of 5mm or more ICC=0.99 and LOA of 6mm or more ICC=0.99. For severity of LOA of 2mm or more ICC=0.94.

Prevalence, extent and severity

Prevalence of loss of attachment (LOA) of 4mm or more was 66 per cent, LOA of 5mm or more was 36.7 per cent, and LOA of 6mm or more was 19.2 per cent (Table 2). Prevalence of PD of 6mm or more was 10.2 per cent. Extent of sites with LOA of 4mm or more was 6.7 per cent, LOA of 5mm or more was 2.7 per cent, and LOA of 6mm or more was 1.3 per cent. Severity of LOA of sites with LOA of 2+ mm was 2.4mm.

Table 3. Prevalence of periodontitis by explanatory variables

	Per cent	95% CI	
Dental visit pattern			
Last dental visit: <12 months*	17.0	13.4	20.6
12+ months	24.8	19.3	30.3
Last visit for: Relief of pain**	34.5	24.9	43.9
Check-up/other	17.4	14.2	20.6
Dental and health-related behaviour			
Toothbrushing: 8+ times per week*	18.0	14.6	21.4
0-7 times per week	28.1	20.3	35.9
Use of mouth rinse:			
1+ times per week[NS]	23.4	17.1	29.7
0 times per week	17.9	14.5	21.3
Smoking status: Daily/occasionally**	41.7	31.8	51.6
Former smoker/ never smoked	15.7	12.7	18.7
Socio-demographics			
Gender: Male*	23.1	18.5	27.7
Gender: Female	16.5	12.6	20.4
Place of birth: Australia**	16.4	13.0	19.8
Overseas	27.7	21.3	34.1
Main language at home: English**	18.4	15.4	21.4
Other language	57.1	35.9	78.3
Education level: Diploma or degree[NS]	16.9	12.5	21.3
Primary/secondary/ certificate	21.5	17.3	25.7
Socio-economic status			
Concession card holder: Yes*	28.3	19.7	36.9
No	17.9	14.7	21.1
Household income: $80 000+*	12.9	7.9	17.9
<$80 000	22.0	18.2	25.8
Overall	19.7	16.7	22.7

*(P<0.05).
**(P<0.01).
NS (Not statistically significant).

Associations with periodontitis

Using a case definition for periodontitis of two or more sites with LOA of 5+ mm and one or more sites with PD of 4+ mm it was found that periodontitis was more prevalent among those with a time since last visit of 12+ months, who last visited for relief of pain, who had a toothbrushing frequency of 0–7 times per week, who smoked daily or occasionally, who were male, born overseas, who spoke a language other than English as the main language at home, who were concession card holders and had a household income of less than $80 000 (Table 3).

Multivariate model of periodontitis

Using the case definition for periodontitis of two or more sites with LOA of 5+ mm and one or more sites with PD of 4+ mm in a multivariate logistic regression, Table 4 showed higher odds of periodontitis for people who last visited for relief of pain (OR=1.93) and who smoked daily/occasionally (OR=3.84), while lower odds were observed for people who were born in Australia (OR=0.51) and spoke English as the main language at home (OR=0.34).

Table 4. Multivariate logistic regression of periodontitis by explanatory variables

	Odds ratio	95% CI	
Dental visit pattern			
Last dental visit: <12 months[NS]	0.84	0.53	1.35
12+ months (ref.)	–	–	–
Last visit for: Relief of pain*	1.93	1.09	3.41
Check-up/other (ref.)	–	–	–
Dental and health-related behaviour			
Toothbrushing: 8+ times per week[NS]	0.93	0.54	1.62
0-7 times per week (ref.)	–	–	–
Use of mouth rinse: 1+ times per week[NS]	1.40	0.86	2.28
0 times per week (ref.)	–	–	–
Smoking status: Daily/occasionally**	3.84	2.24	6.60
Former smoker/ never smoked (ref.)	–	–	–
Socio-demographics			
Gender: Male[NS]	1.27	0.80	2.02
Female (ref.)	–	–	–
Place of birth: Australia**	0.51	0.31	0.82
Overseas (ref.)	–	–	–
Main language at home: English*	0.34	0.12	0.97
Other language (ref.)	–	–	–
Education level: Diploma or degree[NS]	0.95	0.59	1.52
Primary/secondary/ certificate (ref.)	–	–	–
Socio-economic status			
Concession card holder: Yes[NS]	1.27	0.72	2.26
No (ref.)	–	–	–
Household income: $80 000+[NS]	0.68	0.37	1.24
<$80 000 (ref.)	–	–	–

*(P<0.05).
**(P<0.01).
NS (Not statistically significant).

DISCUSSION

Representativeness

While the overall response yield of n=879 provided sufficient numbers for analysis, the response rate was lower than anticipated. Particularly, since multiple follow-ups were employed to increase the response rate as per the total design method.[18] The use of the electoral roll should provide an adequate sampling frame for a population survey of 45–54 year olds. Generally, a response rate of 60 per cent is considered adequate,[21] with lower response rates requiring evidence to determine whether bias has been introduced. The issue is whether a lower response rate involves differential response among population sub-groups that could produce bias. In this case there was little evidence of response bias, with the main difference observed being the lower percentage of survey respondents that visited privately at the last dental visit compared to the population.

Case definition of periodontitis

In oral epidemiology the presence of periodontitis is determined against a case definition. Given the measurements available at one point in time, the case definition for periodontitis must be defined as loss of attachment or pocket depth exceeding some threshold value.[22] There are numerous case definitions of periodontitis in the literature.[23-25] For example, Machtei *et al.* have used a definition of clinical attachment loss of 6mm or more in two or more teeth and one or more sites with pocket depth of 5mm or more.[23] In this study we adopted the case definition used by Do *et al.*[26] that was based on the Beck *et al.* criteria,[24] with a modification to suit the younger age of participants in the study sample. This was adopted because of the similarity in multi-site full-mouth scoring system used in both studies. While clinical classification systems exist for periodontal diseases and conditions,[27] these serve as a context for establishing case definitions in oral epidemiology. The lack of radiographic evidence of bone loss and single point in time measurements are two major reasons why case definitions in oral epidemiological studies only approximate clinical classification systems. Further variability has been introduced by subtle differences in the thresholds used in case definitions of periodontitis.[28] Previous researchers have used combinations of pocket depth and clinical attachment loss, with the rationale being that this combination represents cumulative tissue destruction and active disease.[28] Thresholds of pocket depth and clinical attachment loss have been varied by age group studied, reflecting the age-related destruction of periodontal tissues in chronic periodontitis, the clinical classification with which these definitions are most readily aligned. The approach adopted here is consistent with previous epidemiological studies and current practice in oral epidemiology.

Dental visit pattern

A routine dental visit for a check-up has been found to be positively associated with tooth retention,[29] and regular dental attendance has been linked to less severe psycho-social impacts of oral disease.[30] More frequent visiting may result in more preventively oriented dental care. It has been shown that visiting for check-ups is associated with recall/maintenance as main diagnosis or condition and a service pattern that has higher rates of diagnostic and preventive services.[31] While both time since last visit and reason for last visit were associated with cases of periodontitis in the bivariate analysis, only last visiting for relief of pain was significant in the multivariate model, most likely reflecting that symptomatic attenders tended to visit infrequently with a lack of regular care associated with higher odds of periodontitis.

Dental and health-related behaviour

While oral hygiene has been linked to the aetiology of periodontitis,[32] toothbrushing was only significantly associated with periodontitis in the bivariate analysis but not in the multivariate model. This could reflect confounding with dental attendance, with frequent brushing clustered with a pattern of regular, check-up visits. Increased numbers of general health behaviours such as maintaining normal weight, exercising and high-quality diets have been associated with a lower

prevalence of periodontitis.[33] The health-related behaviour of smoking was significantly associated with periodontitis in both bivariate and multivariate analyses. This is consistent with the large volume of evidence for smoking as a risk factor for periodontitis such as Albandar *et al.*,[34] Bergstrom,[35] Do *et al.*,[26] Genco,[36] Kinane and Chestnutt,[37] and Kinane and Marshall.[38]

Socio-demographics

Gender, place of birth and language were all associated with periodontitis in the bivariate analysis, but gender was not significant in the multivariate model. This could be due to confounding effects of males having a less regular attendance pattern and less effective dental self-care behaviour. Males have been reported to be over-represented in risk behaviour groups for both oral and general health risk behaviours.[39] The association of place of birth and language with periodontitis in the multivariate model suggests socio-cultural links in this cohort that could be related to cultural practices and barriers to dental care. While some dental studies in Australia have indicated disadvantage among migrant groups,[40-44] suggesting children of more recent migrant groups are most at risk, there are reports that migrants are generally not disadvantaged in terms of their health status.[45-47] However, language barriers have been implicated in reduced access to services and quality of care provided to people from non-English-speaking backgrounds.[48,49]

Socio-economic status

While government concession card holder status and income were both significantly associated with periodontitis in the bivariate analysis they were not significant in the multivariate model. However, these socio-economic status variables are not only associated with each other, but are likely to be associated with both visit pattern and dental/health-related behaviour. Factors such as income and occupation have been related to use of dental services.[50] People from a high income household were more likely to have made a recent dental visit, while card holders were less likely to have visited recently.[13] People from low socio-economic status groups are more likely to smoke.[51]

Comparison to other studies

Compared to South Australian adults aged 60+ years, LOA of 4mm or more (89.1 per cent) was lower in the present study of 45–54 year olds (66 per cent), as might be expected among a younger age group.[10] Comparisons of the prevalence of periodontal disease among 45–54 year olds are limited to studies that have adopted the CPITN measurement and that are restricted to using prevalence of pockets. The prevalence of pockets of 6mm or more was higher (10.2 per cent) compared to earlier studies in 1984 (4.4 per cent) and 1987–1988 (6 per cent).[6,8] While this may suggest that prevalence of periodontal pockets has increased over time it is possible that these earlier studies may have underestimated the levels of periodontal disease due to the sextant level recording as opposed to multiple-site full mouth recording adopted in the present study.

CONCLUSIONS

While periodontal disease was not associated with socio-economic status it was related to visit pattern and health-related behaviours, and the relationship with place of birth and main language spoken at home indicated there was socio-cultural variation in periodontal disease not explained by behaviour among this cohort of 45–54 year olds.

ACKNOWLEDGEMENTS

The data collection was funded by a National Health and Medical Research Council project grant (application ID 250316) for 2003–2005.

REFERENCES

1. Australian Institute of Health and Welfare. Chronic diseases and associated risk factors in Australia, 2001. Canberra: AIHW, 2002.
2. Pihlstrom BL, Michalowicz BS, Johnson NW. Periodontal diseases. Lancet 2005;366:1809-1820.
3. Georgiou TO, Marshall RI, Bartold PM. Prevalence of systemic diseases in Brisbane general and periodontal practice patients. Aust Dent J 2004;49:177-184.
4. Ainamo J, Barmes D, Beagrie G, Cutress T, Martin J, Sardo-Infirri J. Development of the World Health Organization (WHO) Community Periodontal Index of Treatment Needs (CPITN). Int Dent J 1982;32:281-291.
5. Cutress TW, Ainamo J, Sardo-Infirri J. The community periodontal index of treatment needs (CPITN) procedure for population groups and individuals. Int Dent J 1987;37:222-233.
6. Powell RN, McEniery TM. The Brisbane Statistical Division Survey of Adult Dental Health 1984. 3. Dental health status and treatment needs. Aust Dent J 1988;33:109-115.
7. Wright FAC, Hammond RH, Lewis JM. Changes in periodontal conditions of adults from Melbourne, Australia. Int Dent J 1994;44:207-214.
8. Barnard PD. National Oral Health Survey of Australia, 1987-88. Canberra: Australian Government Publishing Service, 1993.
9. Baelum V, Papapanou PN. CPITN and the epidemiology of periodontal disease. Community Dent Oral Epidemiol 1996;24:367-368.
10. Slade GD, Spencer AJ. Periodontal attachment loss among adults aged 60+ in South Australia. Community Dent Oral Epidemiol 1995;23:237-242.
11. Thomson WM, Slade GD, Beck JD, Elter JR, Spencer AJ, Chalmers JM. Incidence of periodontal attachment loss over 5 years among older South Australians. J Clin Periodontol 2004;31:119-125.
12. Australian Bureau of Statistics. Dental health (persons aged 15 years or more) February–May 1979. Cat. No. 4339.0. Canberra: ABS, 1979.
13. Carter KD, Stewart JF. National Dental Telephone Interview Survey 2002. Adelaide: AIHW Dental Statistics and Research Unit, 2003.
14. National Health and Medical Research Council Expert Advisory Panel. The impact of change in oral health status on dental education, workforce, practices and services in Australia. Canberra: Commonwealth of Australia, 1993.

15. Australian Institute of Health and Welfare. Older Australia at a glance 2002. 3rd edn. AIHW Cat. No. AGE 25. Canberra: AIHW and DOHA, 2002.
16. Joshi A, Douglass CW, Feldman H, Mitchell P, Jette A. Consequences of success: do more teeth translate into more disease and utilization? J Public Health Dent 1996;56:190-197.
17. Douglass CW, Sheets CG. Patients' expectations for oral health care in the 21st century. J Am Dent Assoc 2000;131 Suppl:3S–7S.
18. Dillman DA. Mail and telephone surveys. The total design method. New York: Wiley, 1978.
19. US National Institute of Dental Research. Oral health surveys of the National Institute of Dental Research. Diagnostic criteria and procedures. Washington DC: US Department of Health and Human Services, 1987.
20. Fleiss JL. The design and analysis of clinical experiments. New York: Wiley, 1986.
21. Mangione TW. Mail surveys. Improving the quality. California: Sage, 1995.
22. Beck JD, Loe H. Epidemiological principles in studying periodontal diseases. Periodontol 2000 1993;2:34-45.
23. Machtei EE, Christersson LA, Grossi SG, Dunford R, Zambon JJ, Genco RJ. Clinical criteria for the definition of "established periodontitis". J Periodontol 1992;63:206-214.
24. Beck JD, Koch GG, Rozier RG, Tudor GE. Prevalence and risk indicators for periodontal attachment loss in a population of older community-dwelling blacks and whites. J Periodontol 1990;61:521-528.
25. Arbes SJ Jr, Agustsdottir H, Slade GD. Environmental tobacco smoke and periodontal disease in the United States. Am J Public Health 2001;91:253-257.
26. Do GL, Spencer AJ, Roberts-Thomson K, Ha HD. Smoking as a risk indicator for periodontal disease in the middle-aged Vietnamese population. Community Dent Oral Epidemiol 2003;31:437-446.
27. Armitage GC. Development of a classification system for periodontal diseases and conditions. Ann Periodontol 1999;4:1-6.
28. Borrell LN, Beck JD, Heiss G. Socioeconomic disadvantage and periodontal disease: the dental atherosclerosis risk in communities study. Am J Public Health 2006;96:332-339.
29. Cunha-Cruz J, Nadanovsky P, Faerstein E, Lopes CS. Routine dental visits are associated with tooth retention in Brazilian adults: the Pro-Saude study. J Public Health Dent 2004;64:216-222.
30. Richards W, Ameen J. The impact of attendance patterns on oral health in a general dental practice. Br Dent J 2002;193:697-702.
31. Brennan DS, Spencer AJ. Provision of diagnostic and preventive services in general dental practice. Community Dent Health 2003;20:5-10.
32. Amarasena N, Ekanayaka AN, Herath L, Miyazaki H. Tobacco use and oral hygiene as risk indicators for periodontitis. Community Dent Oral Epidemiol 2002;30:115-123.
33. Al-Zahrani MS, Borawski EA, Bissada NF. Periodontitis and three health-enhancing behaviours: maintaining normal weight, engaging in recommended level of exercise, and consuming a high-quality diet. J Periodontol 2005;76:1362-1366.
34. Albandar JM, Streckfus CF, Adesanya MR, Winn DM. Cigar, pipe, and cigarette smoking as risk factors for periodontal disease and tooth loss. J Periodontol 2000;71:1874-1881.
35. Bergstrom J. Tobacco smoking and risk for periodontal disease. J Clin Periodontol 2003;30:107-113.
36. Genco RJ. Current view of risk factors for periodontal diseases. J Periodontol 1996;67(10 Suppl):1041-1049.
37. Kinane DF, Chestnutt IG. Smoking and periodontal disease. Crit Rev Oral Biol Med 2000;11:356-365.
38. Kinane DF, Marshall GJ. Periodontal manifestations of systemic disease. Aust Dent J 2001;46:2-12.
39. Sanders AE, Spencer AJ, Stewart JF. Clustering of risk behaviours for oral and general health. Community Dent Health 2005;22:133-140.
40. Calache H, Wright FAC. The dental status of four-year-old children in the Brunswick Child Development Study. Aust Dent J 1987;32:126-131.
41. Srikandi TW. The dental status of 15-year-old South Australian students. Aust Dent J 1987;32:110-115.
42. McAllan LH. A survey of the gingival health of Indo-Chinese child refugees. Part II. Aust Dent J 1988;33:91-95.
43. Wright FAC, Spencer AJ. Oral studies and service utilization of 5-6 year old children of migrant parents. J Int Ass Dent Child 1980;11:13-18.
44. Spencer AJ, Wright FAC, Brown LM, Brown LP. Changing caries experience and risk factors in five- and six-year-old Melbourne children. Aust Dent J 1989;34:160-165.
45. Young C. Mortality, the ultimate indicator of survival: the differential experience between birthplace groups. In: Donovan J, d'Espaignet ET, Merton C, van Ommeren M, eds. Immigrants in Australia: a health profile. Canberra: AGPS, 1992:34-70.
46. Powles J, Gifford S. How healthy are Australia's immigrants? In: Reid J, Trompf P, eds. The health of immigrant Australia. A social perspective. Sydney: Harcourt, Brace, Jovanovich, 1990:77-107.
47. Brennan DS, Spencer AJ. Variation in dental service provision among adult migrant public-funded patients. Aust N Z J Pub Health 1999;23:639-642.
48. National Health Strategy. Removing cultural and language barriers to health. Issues paper no. 6. Canberra: Department of Health, Housing and Community Services, 1993.
49. Schofield T. The health of Australians of non-English-speaking background: key concerns. Aust J Pub Health 1995;19:117-119.
50. Roberts-Thomson K, Brennan DS, Spencer AJ. Social inequality in the use and comprehensiveness of dental services. Aust J Pub Health 1995;19:80-85.
51. Australian Bureau of Statistics. National Health Survey: summary of results, 2001. ABS Cat. No. 4364.0. Canberra: ABS, 2002.

Address for correspondence/reprints:
David S Brennan
Australian Research Centre for Population Oral Health
School of Dentistry
The University of Adelaide
Adelaide, South Australia 5005
Email: david.brennan@adelaide.edu.au