

# Earlier depression and later-life self-reported chewing difficulties: results from the Whitehall II study

A. H. ALJAMEEL\*<sup>†</sup>, R. G. WATT\*, E. J. BRUNNER\* & G. TSAKOS\*  
*\*Department of Epidemiology and Public Health, University College London, London, UK and <sup>†</sup>Department of Periodontics and Community Dentistry, King Saud University, Riyadh, Saudi Arabia*

**SUMMARY** This study aimed to assess, whether depression in adulthood was associated with self-reported chewing difficulties at older age, and examine whether the strength of the association differed according to the number of depression episodes in earlier adult life. We used Whitehall II study data from 277 participants who completed a questionnaire in 2011. Depression was measured with the Center for Epidemiologic Studies Depression Scale (CES-D) in 2003 and 2008. The association between CES-D depression and self-reported chewing ability was assessed using regression models adjusted for some socio-demographic factors. Participants with depression at some point in their earlier adulthood had an odds ratio (95% CI) of 2.01 (1.06, 3.82) for reporting chewing difficulties in older adulthood, compared

to those without depression. The respective odds ratios were 1.42 (0.66, 3.04) for individuals with depression in only one phase, but 3.53 (1.51, 8.24) for those with depression in two phases. In conclusion, while further research is required, there was an association between depression and chewing difficulty that was independent of demographic and socio-economic characteristics. Furthermore, this increased odds for chewing difficulties was primarily among adults that experienced two episodes or a prolonged period of depression.

**KEYWORDS:** depression, chewing difficulties, oral health

Accepted for publication 30 August 2014

## Introduction

A major demographic transition is occurring in most middle- and high-income countries with a substantial ageing of the population. Currently, around 10 million people in the UK are over 65 years of age, and this estimate will nearly double to around 19 million by 2050 (1). An ageing population is accompanied by a transformation in many health conditions, including oral health. The latest national oral health survey of British adults showed that only 6% were edentulous, and the dentate have fewer missing teeth and more sound and untreated teeth than in the past (2). The older adult population is also likely to experience excessive comorbidity, as many different chronic diseases are age-related. One of the leading causes of morbidity and

mortality is mental illness (3), which has a rising prevalence across England especially among women (4). Ayuso-Mateos and colleagues showed that depression is a highly prevalent condition in Europe, and UK is one of the countries with the highest rates (7.8%) (5). Analysis of data from the Global Burden of Disease Study for 21 regions found that depressive disorders were ranked 11th (from 15th in 1990), their prevalence increased by 37% over the same period, and it is expected to further steadily increase in the future (6). The prevalence of depression is also higher among patients with other chronic diseases (7).

Studies have shown an association between common mental disorders, particularly depression and anxiety, and oral health and chewing ability; however, there is no agreement about the direction of the association and

there is some evidence that the association may be bidirectional (8–10). On the one hand, oral health might negatively impact on the psychological status of individuals. For example, a study found that oral conditions have been associated with problems on daily life activities and psychological wellbeing (11). On the other hand, depression may negatively impact on oral health and chewing ability through different pathways. In a population-based retrospective cohort study, Liao *et al.* (12) concluded that patients with depression were at an elevated risk of developing temporo-mandibular disorder (TMD), while a prospective cohort study showed that depression was associated with pain sensitivity and an increase in the risk of TMD (13), a condition that has a negative effect on chewing ability (14). There are different mechanisms linking depression to oral health conditions including chewing difficulties (8, 10).

Most of the studies on the association between depression and oral health and chewing difficulty were cross-sectional and were therefore limited in terms of looking at the direction of the association. Very few studies have examined the association longitudinally, and no study has assessed the effect of experiencing episodes of depression in early adulthood on the risk of chewing difficulties in later life. Therefore, this study used data from the Whitehall II study with the aim to assess whether experiencing depression in adulthood was associated with chewing difficulties at older age, and to also examine whether the strength of the associ-

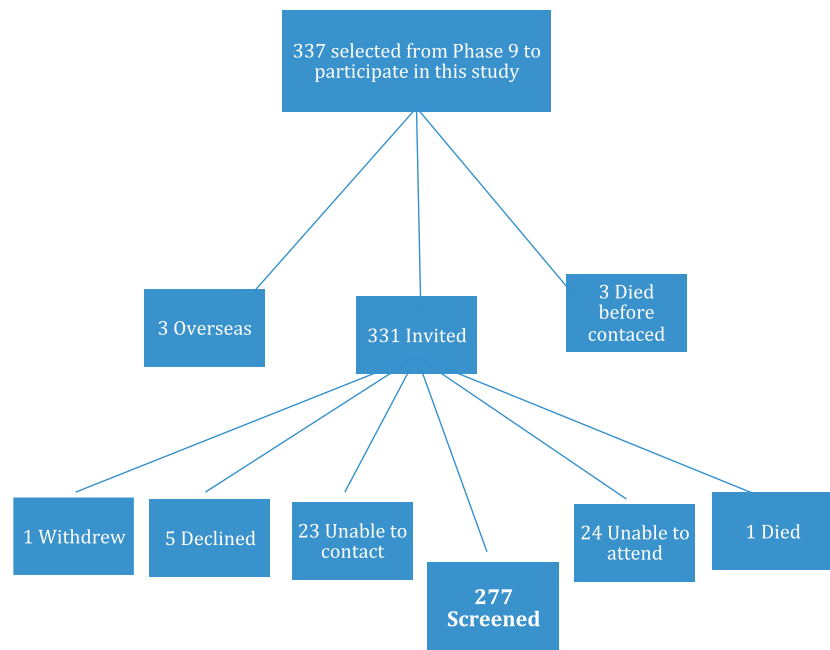
ation differed according to the number of depression episodes in earlier adult life.

## Material and methods

Whitehall II is a longitudinal, prospective closed cohort study set-up in 1985 to investigate the importance of the socio-economic gradient in health and disease by following a cohort of 10 308 working men and women employed in London offices of the British civil service (15). Since 1985, there have been a further ten phases of data collection. For this study, we focused on self-report oral health data collected at Phase 10, together with relevant questionnaire data from earlier phases.

### Participants and sample size

Phase 10 took place from February until mid-March 2011. A random sample of 255 people was selected from the people that attended a screening examination at Phase 9 (2008–2009). This sample was supplemented by inclusion of all participants with late onset depression, as the main aims of Phase 10 were to validate self-completed measures of psychiatric morbidity in older people, and to invite a subsample to take part in a neuroimaging study of late onset depression cases and never depressed controls giving a total Phase 10 sample 337 (Fig. 1).



**Fig. 1.** Sample selected from Whitehall II study, Phase 10.

### Variables

**Outcome.** Chewing ability (self-reported, at Phase 10); the original question, was 'In general, how well are you able to bite or chew food that you eat nowadays? answering options: no difficulty, a little difficulty, a fair amount of difficulty or a great amount of difficulty' For analysis reason and because of the very small number of participants in some categories, participants were grouped into two groups: those with little, fair or great amount of difficulty versus those with no difficulty chewing.

**Primary exposure.** Depression was measured using the Center for Epidemiologic Studies Depression Scale (CES-D) (16). CES-D consists of 20 items and summing of all items for each participant provides the total score; this can range between 0 and 60, with scores of 16 or more considered as cases of depression (17). We used Phase 7 (2003–04) and Phase 9 (2008–09) data in this analysis, and through the aforementioned cut-off point we calculated whether the participant had experienced depression in any of these two phases (yes vs. no). We also calculated the episodes of depression (none; only in one phase; in both phases) variable to assess whether there was a biological gradient in the association between depression and chewing ability. Participants who were taking antidepressant medications were considered as depressed even if their CES-D scores were below 16.

**Covariates.** Socio-demographic variables included sex, age (<70, and  $\geq$ 70 years), marital status (married, single, divorced and widowed), and deprivation rating using the Townsend index to capture neighbourhood material deprivation. Neighbourhood deprivation ratings ranged from 1 (least deprived) to 4 (most deprived).

### Ethical approval and consent

The study was approved by the Joint UCL/UCLH Committees on the Ethics of Human Research (Committee Alpha). All participants provided written informed consent.

### Statistical methods

Statistical analysis was carried out using STATA 11. Initially, descriptive statistics were used for the

characteristics of the study sample. Frequency of experience of depression (in phases 7 & 9) was also calculated. Associations between variables were explored by chi-squared and chi-squared test for trend. Logistic regression models were used to determine the strength of the association between exposure and outcome. Initially, a crude odds ratio (and 95% confidence interval) was calculated (model 1); this was then adjusted for sex, marital status and age group (model 2) and finally also for neighbourhood deprivation (sex, marital status, age and deprivation scores included in model 3). The likelihood ratio test was used to test the adequacy of sequential adjustment between models. For assessing the presence of biological gradient, respondents were grouped into; those with no previous experience of depression, those with depression in one phase (either at phase 7 or 9) and finally those who experienced depression in two phases (both at phase 7 and 9) in earlier adulthood. Depression in only one phase is indicative of one episode of depression, while a similar experience in both phases indicates either the existence of either two episodes of depression or a prolonged (more long term) experience of the condition. This biological gradient between depression and later chewing difficulty was examined using logistic regression analysis.

As there were 57 participants with missing CES-D values in one of the two phases (7, 9), we substituted missing values by 'depressed' if the participant reported depression in the other phase, and 'non-depressed' if otherwise. There were only five missing values (<2%) in our main outcome 'chewing difficulty' and were simply excluded from the analysis. Missing values for age group and deprivation were kept in the analysis as a separate category in these covariates.

## Results

From the 337 people contacted, 277 participated (response rate: 82%). Table 1 summarises the characteristics of participants by sex. Approximately 80% of both men and women did not report chewing difficulties. However, experience of depression in earlier adulthood was almost twice as prevalent in women (52%) than men (29%).

Depression in earlier adulthood was associated with reporting chewing difficulties ( $P = 0.007$ ), as around

**Table 1.** Descriptive characteristics of the study sample ( $N = 277$ ) at Phase 10

| Characteristic               | Female<br><i>N</i> (%)<br><i>N</i> = 83 | Male<br><i>N</i> (%)<br><i>N</i> = 194 | Total<br><i>N</i> (%)<br><i>N</i> = 277 |
|------------------------------|---|--|---|
| Age                          |   |  |   |
| <70                          | 44 (53.0)                               | 105 (54.1)                             | 149 (53.8)                              |
| ≥70                          | 35 (42.2)                               | 75 (38.7)                              | 110 (39.7)                              |
| Missing                      | 4 (4.8)                                 | 14 (7.2)                               | 18 (6.5)                                |
| Deprivation score            |   |  |   |
| 1 (Lowest deprived)          | 19 (23.0)                               | 63 (32.5)                              | 82 (29.6)                               |
| 2                            | 25 (30.1)                               | 61 (31.4)                              | 86 (31.0)                               |
| 3                            | 21 (25.3)                               | 45 (23.2)                              | 66 (23.8)                               |
| 4 (most deprived)            | 8 (9.6)                                 | 12 (6.2)                               | 20 (7.2)                                |
| Missing                      | 10 (12.0)                               | 13 (6.7)                               | 23 (8.3)                                |
| Marital status               |   |  |   |
| Married                      | 40 (48.2)                               | 156 (80.4)                             | 196 (70.8)                              |
| Single                       | 16 (19.3)                               | 17 (8.8)                               | 33 (11.9)                               |
| Divorced                     | 13 (15.7)                               | 12 (6.2)                               | 25 (9.0)                                |
| Widowed                      | 14 (16.8)                               | 9 (4.6)                                | 23 (8.3)                                |
| Depression in adulthood*     |   |  |   |
| No                           | 40 (48.2)                               | 137 (70.6)                             | 177 (63.9)                              |
| Yes                          | 43 (51.8)                               | 57 (29.4)                              | 100 (36.1)                              |
| Use of antidepressant        |   |  |   |
| No                           | 60 (72.3)                               | 165 (85.1)                             | 225 (81.2)                              |
| Yes                          | 15 (18.1)                               | 11 (5.6)                               | 26 (9.4)                                |
| Missing                      | 8 (9.6)                                 | 18 (9.3)                               | 26 (9.4)                                |
| Self-reported general health |   |  |   |
| Excellent                    | 9 (10.8)                                | 43 (22.2)                              | 52 (18.7)                               |
| Very good                    | 30 (36.2)                               | 98 (50.5)                              | 128 (46.2)                              |
| Good                         | 35 (42.2)                               | 42 (21.6)                              | 77 (27.8)                               |
| Fair                         | 8 (9.6)                                 | 11 (5.7)                               | 19 (6.9)                                |
| Poor                         | 1 (1.2)                                 | 0 (0.0)                                | 1 (0.4)                                 |
| Chewing difficulty           |   |  |   |
| No                           | 65 (78.3)                               | 152 (78.4)                             | 217 (78.3)                              |
| Yes                          | 17 (20.5)                               | 38 (19.6)                              | 55 (19.9)                               |
| Missing                      | 1 (1.2)                                 | 4 (2.0)                                | 5 (1.8)                                 |
| Number of natural teeth      |   |  |   |
| <21                          | 17 (20.5)                               | 34 (17.5)                              | 51 (18.4)                               |
| 21 or more                   | 55 (66.3)                               | 149 (76.8)                             | 204 (73.7)                              |
| Missing                      | 11 (13.2)                               | 11 (5.7)                               | 22 (7.9)                                |
| Denture wearers              |   |  |   |
| No                           | 30 (36.1)                               | 59 (30.4)                              | 89 (32.1)                               |
| Yes                          | 52 (62.7)                               | 131 (67.5)                             | 183 (66.1)                              |
| Missing                      | 1 (1.2)                                 | 4 (2.1)                                | 5 (1.8)                                 |

\*Depression measured by CES-D at Phase 7 and/or 9.

29% of those with depression in adulthood but only 15% of those who did not experience depression reported chewing difficulties (Table 2). Participants aged 70 years or over as well as those that were poorer reported higher prevalence of chewing difficulties compared to the younger and more affluent ones,

**Table 2.** Association between the presence of chewing difficulty and socio-demographic characteristics ( $N = 272$ )

| Characteristic                | Chewing<br>difficulty <i>N</i> (%) | <i>P</i> -value* |
|-------------------------------|------------------------------------|------------------|
| Sex                           |                                    |                  |
| Female                        | 17 (20.7)                          | 0.890            |
| Male                          | 38 (20.0)                          |                  |
| Age                           |                                    |                  |
| <70                           | 22 (15.2)                          | 0.084            |
| ≥70                           | 28 (25.7)                          |                  |
| Missing                       | 5 (27.8)                           |                  |
| Deprivation score             |                                    |                  |
| 1 and 2 (Less deprived)       | 27 (16.2)                          | 0.059            |
| 3 and 4 (more deprived)       | 24 (28.9)                          |                  |
| Missing                       | 4 (18.2)                           |                  |
| Marital status                |                                    |                  |
| Married                       | 37 (19.3)                          | 0.510            |
| Single                        | 5 (15.2)                           |                  |
| Divorced                      | 7 (29.2)                           |                  |
| Widowed                       | 6 (26.1)                           |                  |
| Depression in adulthood       |                                    |                  |
| No                            | 27 (15.3)                          | 0.007            |
| Yes, in one and/or two phases | 28 (29.2)                          |                  |
| Yes, in only one phase        | 13 (21.3)                          |                  |
| Yes, in both phases           | 15 (42.9)                          |                  |

\*Chi-squared test and chi-squared test for trend.

respectively, but the association was not significant for the former ( $P = 0.084$ ) and marginally so for the latter ( $P < 0.059$ ).

Compared to participants who had not experienced depression, people with depression at some point in their earlier adulthood (at phase 7 and/or 9) had 2.27 times (95% CI: 1.25–4.15) higher odds for chewing difficulties in older adulthood (Table 3). This estimate attenuated but remained significant after adjustment for sex, marital status and age (OR: 2.14, 95%CI: 1.14–4.03), as well as in the fully adjusted model that also accounted for neighbourhood deprivation (OR: 2.01, 95%CI: 1.06–3.82). Looking separately at participants that reported depression in one or both phases (exploring the effect of a potential biological gradient of depression episodes on the outcome), we found that people who had depression in one phase (at either phase 7 or 9) had an odds of 1.49 (95% CI: 0.72–3.12) for reporting chewing difficulties in older life, while those that experienced depression in both phases (at phase 7 & 9) had a much higher odds ratio of 4.14, (95% CI: 1.89–9.07).

**Table 3.** Association between CES-D depression and chewing difficulty. Logistic regression analysis ( $N = 272$ )

| Depression in adulthood       | Model 1                        | Model 2                        | Model 3                        |
|-------------------------------|--------------------------------|--------------------------------|--------------------------------|
|                               | OR (95% CI)<br><i>P</i> -value | OR (95% CI)<br><i>P</i> -value | OR (95% CI)<br><i>P</i> -value |
| No                            | 1                              | 1                              | 1                              |
| Yes, in one and/or two phases | 2.27 (1.25–4.15)<br>0.007      | 2.14 (1.14–4.03)<br>0.018      | 2.01 (1.06–3.82)<br>0.033      |
| Yes, in only one phase        | 1.49 (0.72–3.12)<br>0.285      | 1.46 (0.68–3.12)<br>0.327      | 1.42 (0.66–3.04)<br>0.365      |
| Yes, in both phases           | 4.14 (1.89–9.07)<br><0.001     | 3.86 (1.69–8.83)<br>0.001      | 3.53 (1.51–8.24)<br>0.004      |
| <i>P</i> -value for trend     | 0.001                          | 0.002                          | 0.005                          |

Model 1: crude, Model 2: sex, marital status and age adjusted, Model 3: model 2+deprivation score.

## Discussion

This study showed that depression in earlier adult life is significantly and strongly associated with self-reported chewing difficulties in older adulthood. After accounting for the effect of some demographic and socio-economic factors, this association was slightly attenuated but remained significant, with people that experienced depression earlier in their adult years having double the risk of reporting chewing difficulty later on in adulthood (60 years or over). Moreover, this was the first study to indicate a biological gradient in this association; compared to those without depression, the risk for chewing difficulties was much higher (and significant) among adults with two episodes or a prolonged period of depression and lower (and not significant) for those with only one earlier episode of depression.

Depression is a potential risk factor for impaired oral health status such as chewing difficulty, and it can affect the physical and functional oral health through different pathways. First, Slade *et al.* and Liao *et al.* (12, 13) suggested depression as a risk for temporo-mandibular disorder (TMD) by influencing the association between pain and motor activity; and there is evidence that TMD and pain might have a negative effect on chewing ability (8, 14). Second, depression might affect chewing ability also through reducing the motivation towards oral health-related behaviours, such as oral hygiene, dietary and smoking habits (18, 19). Third, depression may also affect oral health physiologically by reducing the amount of saliva or changing the immune response system (10), leading to higher risk of developing dental caries (20)

and periodontal diseases that collectively lead to greater risk of tooth loss and, therefore, impaired chewing ability. It is also important to note that depressed people might perceive their health worse than non-depressed people (21). Therefore, the possibility that people with depression may perceive that they have worse chewing ability even if they have the same masticatory ability of non-depressed people cannot be ruled out, particularly as chewing ability was measured through self-reports in our sample.

The association between depression and chewing difficulties slightly attenuated after adjusting for demographic variables, primarily age group. This confirmed the effect of age on chewing ability, as has already been shown with a decline in oral functioning ability in longitudinal studies of older adults (22). However, the fully adjusted findings showed that the association is strong over and above the effect of demographic and socio-economic characteristics.

The main contribution of this study was to assess the association between experiencing depression in adulthood and having chewing difficulties at older adult life using data from a well-established longitudinal cohort study. By having data on depression from two time points, it was possible to also assess whether the association differs depending on the episodes of depression in adulthood, and if there is any biological gradient in this relationship. Unfortunately, data on chewing abilities is not available at earlier Whitehall II phases, and therefore, only the prevalence of chewing difficulties was assessed; availability of chewing abilities data longitudinally would have allowed for the estimation of changes in chewing ability over time. However, at earlier waves participants were

younger, healthier, and all of them were employed, so they could be expected to have relatively good oral health status and chewing ability. In addition, chewing difficulties was only assessed using a self-reported question and was not supplemented by any clinical examination. As discussed earlier, there is a possibility that the reported chewing difficulty is actually a result of depressed mood and negative perceptions of health. We also acknowledge that our sample was relatively small, and simple approaches were used to deal with missing values in the data set. Being conservative in our approach towards dealing with missing data may have, if anything, underestimated the actual strength of the observed associations. Nevertheless, the sample proved sufficient in terms of showing an association between depressive symptoms and poor chewing ability that remained after adjustment for different confounders, including deprivation. One of the limitations in this study is that depression was assessed using an epidemiological tool (CES-D) and was not supplemented by clinical/medical diagnosis, although studies have shown that CES-D is a validated and useful tool for epidemiologic studies of depression (16). We do acknowledge that other factors, such as clinical oral health status or other socio-economic position measures such as neighbourhood deprivation could have further affected that association. However, due to lack of data availability, we could not explore this further. In line with other studies (8, 12–14), our findings showed that people's psychological illnesses, depression in this case, contribute to oral disease and functional problems, which are of great importance especially for elderly as they are likely to be the most vulnerable group for a decline in oral function. Despite these limitations, useful preliminary data have been gathered describing the association between experiencing depression and reporting chewing difficulties in older life.

Our results highlight the need for more integration between general and oral health to fully understand their associations, and therefore intervene accordingly. With an ageing population at higher risk of depression and also at increased risk of functional oral health problems, health promotion activities should consider using the common risk factor approach (23) and addressing the broader common determinants of these conditions. Moreover, people that suffer from depression during their earlier adult life should be signposted by dental services as a priority group, as

appropriate dental health care may partly counterbalance their increased risk for reduced oral health function in later life. This is particularly the case for those adults that experienced depression at two different time points for a prolonged period, as our results showed a strong and much higher risk than those for one episode of depression.

In conclusion, we found an association between depression and chewing difficulty that is independent of the effect of demographic and socio-economic characteristic. Individuals who experienced depression in their earlier adulthood were at greater risk of having chewing difficulties at older age. Furthermore, this increased risk for chewing difficulties was primarily among adults that experienced two episodes or a prolonged period of depression. Although these findings must be interpreted with caution, and further studies are needed to explore the association and examine its potential pathways.

### Acknowledgments

The Whitehall II Study has been supported by grants from the Medical Research Council; British Heart Foundation; Health and Safety Executive; Department of Health; National Heart, Lung, and Blood Institute (HL36310), United States, National Institutes of Health; National Institute on Aging (AG13196), United States, National Institutes of Health; Agency for Health Care Policy Research (HS06516); and the John D. and Catherine T. MacArthur Foundation Research Networks on Successful Midlife Development and Socio-economic Status and Health. The authors thank all participating civil service departments and their welfare, personnel, and establishment officers; the Occupational Health and Safety Agency; the Council of Civil Service Unions; and all members of the Whitehall II Study team.

### Competing interest

The authors declare that they have no competing interest.

### References

1. Shaw C. Variant population projections for the United Kingdom and its constituent countries. *Popul Trends*. 2002;109:15–26.

2. Steele JG, Treasure ET, O'sullivan I, Morris J, Murray JJ. Adult dental health survey 2009: transformations in British oral health 1968–2009. *Br Dent J.* 2012;213:523–527.
3. Cuijpers P, Smith F. Excess mortality in depression: a meta-analysis of community studies. *J Affect Disord.* 2002;72:227–236.
4. McManus S, Meltzer H, Brugha T, Bebbington P, Jenkins R. Adult psychiatric morbidity in England, 2007: results of a household survey. *The NHS Information Centre for Health and Social Care;* 2009:25–37.
5. Ayuso-Mateos JL, Vazquez-Barquero JL, Dowrick C, Lehtinen V, Dalgard OS, Casey P *et al.* Depressive disorders in Europe: prevalence figures from the ODIN study. *Br J Psychiatry.* 2001;179:308–316.
6. Murray CJL, Vos T, Lozano R, Naghavi M, Flaxman AD, Michaud C *et al.* Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet.* 2012;380:2197–2223.
7. Noel PH, Williams JW, Unutzer J, Worchel J, Lee S, Cornell J *et al.* Depression and comorbid illness in elderly primary care patients: impact on multiple domains of health status and well-being. *Ann Fam Med.* 2004;2:555–562.
8. Beandini DA, Benson J, Nicholas MK, Murray GM, Peck CC. Chewing in temporomandibular disorder patients: an exploratory study of an association with some psychological variables. *J Orofac Pain.* 2011;25:56–67.
9. Kimura Y, Wada T, Ishine M, Ishimoto Y, Kasahara Y, Hiro-saki M *et al.* Community-dwelling elderly with chewing difficulties are more disabled, depressed and have lower quality of life scores. *Geriatr Gerontol Int.* 2009;9:102–104.
10. Thomson WM, Slade GD, Spencer AJ. Dental caries experience and use of prescription medications among people aged 60+ in South Australia. *Gerodontology.* 1995;12:104–110.
11. Locker D, Clarke M, Payne B. Self-perceived oral health status, psychological well-being and life satisfaction in an older adult. *J Dent Res.* 2000;79:970–975.
12. Liao CH, Chang CS, Chang SN, Lyu SY, Morisky DE, Sung FC. The risk of temporomandibular disorder in patients with depression: a population-based cohort study. *Community Dent Oral Epidemiol.* 2011;39:525–531.
13. Slade GD, Diatchenko L, Bhalang K, Sigurdsson A, Fillingim RB, Belfer I. Influence of psychological factor on risk of temporomandibular disorders. *J Dent Res.* 2007;86:1120–1125.
14. Hansdottir R, Bakke M. Joint tenderness, jaw opening, chewing velocity, and bite force in patients with temporomandibular joint pain and matched healthy control subjects. *J Orofac Pain.* 2004;18:108–113.
15. Marmot M, Brunner E. Cohort profile: the Whitehall II study. *Int J Epidemiol.* 2005;34:251–256.
16. Radloff LS. The CES-D scale: a self-report depression scale for research in general population. *Appl Psychol Meas.* 1977;1:385–401.
17. Weissman M, Sholomskas D, Pottenger M, Prusoff B, Locke B. Assessing depressive symptoms in five psychiatric populations: a validation study. *Am J Epidemiol.* 1977;106:203–214.
18. Christensen L, Somers S. Comparison of nutrient intake among depressed and non-depressed individuals. *Int J Eat Disord.* 1996;20:105–109.
19. Anttila S, Knuuttila M, Sakki T. Relationship of depressive symptoms to edentulousness, dental health, and dental health behaviour. *Acta Odontol Scand.* 2001;59:406–412.
20. Anttila A, Knuuttila M, Sakki T. Depressive symptoms favour abundant growth of salivary *Lactobacilli*. *Psychosom Med.* 1999;61:508–512.
21. Moussavi S, Chatterji S, Verdes E, Tandon A, Patel V, Ustun B. Depression, chronic diseases, and decrements in health: results from the World Health Surveys. *Lancet.* 2007;370:851–858.
22. Locker D. Changes in chewing ability with ageing: a 7-year study of older adults. *J Oral Rehabil.* 2002;29:1021–1029.
23. Sheiham A, Watt RG. The common risk factor approach: a rational basis for promoting oral health. *Community Dent Oral Epidemiol.* 2000;28:399–406.

Correspondence: AlBandy H. AlJameel, Department of Epidemiology and Public Health, University College London, 1-19 Torrington Place, Room 310, London WC1E 7HB, UK.  
E-mail: a.al-jameel@ucl.ac.uk