

# Development and validation of a self-reported periodontal disease measure among Jordanians

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**Background:** The development of self-reported measures of periodontal disease would be of great benefit to facilitate epidemiological studies of periodontal disease on a larger scale, and to allow for surveillance of the periodontal condition of populations over time. **Objectives:** To develop a culturally adapted self-reported measure of periodontal disease, test its predictive and discriminative validity and establish a cut-off value for this measure to diagnose periodontal disease. **Methods:** A total of 288 Jordanian adults completed the questionnaire assessing self-reported periodontal health (18 questions) and underwent periodontal examination. Of the 18 questions, six were significantly associated with at least one clinical definition of periodontitis and were used to constitute the self-reported periodontal disease measure. Receiver–operating characteristics (ROC) curve analyses were used to examine the overall discriminatory power, sensitivity and specificity, and corresponding cut-off points of the self-reported periodontal disease measure. **Results:** ROC analysis showed that the self-reported periodontal disease measure had an excellent performance to discriminate between those with and without periodontal disease, regardless of the clinical definition used. A score of 2, on a scale of 0 to 6, had the highest sensitivity and specificity to detect periodontal disease when defined by all study criteria. Significant associations were observed between self-reported periodontal disease measures and all clinical definitions in the regression analysis (the odds ratio ranged from 8.31 to 18.96), according to the clinical definition to be predicted. **Conclusion:** Self-reported periodontal disease measures have excellent predictive and discriminative validity when tested against clinical definitions, and severity and extent of periodontal disease.

**Key words:** Periodontal disease, self-reported, questionnaire, clinical attachment, pocket depth

## INTRODUCTION

The assessment of periodontal conditions requires collection of clinical data that are resource-intensive and require trained and calibrated dental examiners, sterilised instruments, dental equipment and infection-control protocols. Thus, periodontal status is not commonly assessed in major population-based health and behavioural surveys, and there is almost no surveillance for periodontal diseases. To monitor periodontal diseases in populations, there should be alternative approaches to the primary collection of clinical data. One alternative is the use of a valid self-reported measure of periodontal diseases.

The development of valid, low-cost and low-resource self-reported measures of periodontal disease would be of great benefit to facilitate epidemiological studies of periodontal disease on a much larger scale than used at present, allow for surveillance of the

periodontal condition of populations over time, link periodontal diseases with other diseases and conditions in major surveys and obtain data that would support the development of oral health programmes.

The validity of self-reported measures of periodontal diseases, and their agreement with the definitive diagnosis, have shown variability<sup>1–13</sup>. Previous studies varied in sample size, population characteristics, data-collection methods, gold-standard measures, type of questions included and statistical procedure used. Some researchers assessed the validity of each question alone, others grouped the related questions, whereas others used and validated the total scale score. Questions used in the previous questionnaires and scales were formulated to assess the awareness and perception of the disease, knowledge of doctors' diagnosis of periodontal disease, severity of periodontal disease, symptoms of periodontal disease (tooth mobility and recession) and treatment. A systematic

review by Blicher *et al.* mentioned examples of a good measure of periodontal disease, such as ‘Has any dentist/hygienist told you that you have deep pockets?’, which had a sensitivity of 55%, a specificity of 90%, a positive predictive value of 77% and a negative predictive value of 75% against clinical pocket depth<sup>14</sup>. Self-reported incident tooth loss was strongly predictive of the incidence of attachment loss in the remaining teeth and that when incident tooth loss was disaggregated into ‘loss due to periodontal reasons’ and ‘loss due to non-periodontal reasons’, the predictive ability was stronger<sup>15</sup>. Severe attachment loss was consistently associated with an increased risk for tooth loss, with or without other tooth-specific conditions<sup>15</sup>. Self-reported history of periodontal surgery was also a good surrogate for bone loss (positive predictive value 78% and negative predictive value 71%)<sup>16</sup>. Higher validity could potentially be obtained by the use of combinations of several self-reported questions and other predictors of periodontal disease<sup>14</sup>.

This study aimed to develop a culturally adapted self-reported measure of periodontal disease, test its predictive and discriminative validity and establish a cut-off value for periodontal disease diagnosis. The validity of the self-reported measure of periodontal disease was tested in a consecutive sample from a Jordanian population, using the clinical examination as the gold standard for diagnosis.

## METHODS

### Study design and sampling

This cross-sectional study was conducted among Jordanian adults (20 years of age or older) who were accompanying their relatives to appointments at dental clinics at Jordan University of Science and Technology. Of the 322 consecutive adults, with at least 20 teeth, who were invited to participate in the study during the study period between April and September, 2011, a total of 288 (89.4%) agreed to participate and signed the consent form. Subjects were first interviewed to fill in the self-reported periodontal questionnaire and then they underwent periodontal clinical examination. None of the participants needed antibiotic prophylaxis for periodontal examination and none was currently on antibiotic treatment. The study was approved by the Ethical Committee at Jordan University of Science and Technology.

### Development of the self-reported periodontal questionnaire

An initial form of the self-reported periodontal questionnaire was developed after reviewing the relevant

literature and existing self-reported measures. A total of 18 questions were identified, modified and adapted by the research team (Appendix 1). All questions had ‘yes/no’ answers. The questions were written in English and then adapted and translated into Arabic, using a backward–forward translation method, by three bilingual periodontists. The questionnaire was pilot tested on a group of 35 subjects, and any necessary changes on the format, wording and order of the questions were made.

Additional information about participants’ age, gender, occupation, education, smoking status, total family income, toothbrushing and use of oral hygiene auxiliary aids were collected using another questionnaire. Other questions were included to describe the previous dental visits and the type of previous treatments provided, and if the patient had a prosthetic replacement.

### Periodontal examination

After they filled in the self-administered self-reported periodontal questionnaire, all participants were examined by the same examiner, when seated a dental chair in a semi-supine position using dental light and in a dry field, to assess oral health parameters. Examination procedures were carried out using a sterilised examination kit consisting of mouth mirrors and standardised periodontal probes with Williams markings (Hu-Friedy, Chicago, IL, USA). The examiner who performed the periodontal examination was blinded to the responses of participants on the self-reported questionnaire. The oral hygiene and the periodontal status of all teeth, excluding third molars, were assessed using the plaque index of Silness & Løe<sup>17</sup>, the gingival index of Løe<sup>18</sup>, probing pocket depth and clinical attachment loss. Sterile dental mirrors and explorers were used to assess plaque accumulation and gingival status, whereas standardised periodontal probes were used to measure probing pocket depth and clinical attachment loss. The parameters were measured at six sites (mesiofacial, midfacial, distofacial, mesiolingual, midlingual and distolingual) per tooth. Data were recorded on a special examination form. Disease extent was defined by the percentage of sites with specific cut-off values for probing pocket depth and clinical attachment loss. The percentage of sites meeting the severity criteria for probing pocket depth and clinical attachment loss was calculated for each subject by dividing the number of sites meeting the criteria by the total number of sites measured. The severity of the disease was calculated by averaging probing pocket depth measurements (average probing pocket depth) and clinical attachment loss measurements (average clinical attachment loss).

### Reliability of the self-reported questionnaire and periodontal examination

Periodontal examinations and filling the self-reported questionnaire were repeated for 40 participants within 14 days. There was 100% agreement in the answers to the self-reported questions over the two occasions. The exact agreements for probing pocket depth and clinical attachment loss measurements were 98% and 97%, respectively.

### Periodontal disease definitions

A number of periodontitis definitions were used to test the predictive power of the self-reported questionnaire because there is no consensus on the best definition. The definitions that were based on periodontal examination included those of Hujuel *et al.* (at least one site with probing pocket depth  $\geq 4$  mm)<sup>19</sup>, Beck *et al.* (four sites or more with clinical attachment loss  $\geq 5$  mm and at least one site with probing pocket depth  $\geq 4$  mm)<sup>20</sup>, Machtei (two teeth or more with clinical attachment loss  $\geq 6$  mm and one site with probing pocket depth  $\geq 5$  mm)<sup>21</sup>, Lopez *et al.* (four teeth or more with at least one site with clinical attachment loss  $\geq 3$  mm and four teeth or more with at least one site with probing pocket depth  $\geq 4$  mm)<sup>22</sup>, Page and Eke (moderate periodontitis; two sites or more with interproximal clinical attachment loss  $\geq 4$  mm not on the same tooth, or two or more sites with interproximal probing pocket depth  $\geq 4$  mm not on the same tooth), Page and Eke (severe periodontitis; two sites or more with interproximal clinical attachment loss  $\geq 6$  mm not on the same tooth, and one site or more with interproximal probing pocket depth  $\geq 6$  mm)<sup>23</sup> and Borrell *et al.* (three sites or more with clinical attachment loss  $\geq 4$  mm and at least two sites with probing pocket depth  $\geq 3$  mm)<sup>24</sup>. The validity of the questionnaire was examined in relation to each of these definitions.

### Statistical analysis

Data were analysed using the Statistical Package for Social Sciences software, SPSS (SPSS Inc., Chicago, IL, USA) version 15. Means and standard deviations were used to describe continuous variables, and percentages were used to describe categorical variables. The differences in periodontal parameters according to age were analysed using one-way analysis of variance. Kappa statistics was used to assess the agreement between clinical definitions of periodontitis. Individual questions were studied in relation to the definitions and the extent of periodontal disease, and the severity of periodontitis, using the chi-square test and the independent *t*-test, as appropriate. Of the 18 questions, 12

were not significantly associated with all clinical definitions estimating the prevalence, extent and severity of periodontitis. The remaining six questions were significantly associated with at least one clinical definition of the periodontitis. Therefore, those six questions were used to develop the periodontal disease questionnaire/scale (Appendix 1). The self-reported periodontal disease measure score was computed by counting the number of 'yes' responses over the number of questions selected after validation. Receiver–operating characteristic (ROC) curve analyses were used to examine the overall discriminatory power, sensitivity and specificity, and corresponding cut-off points of the self-reported periodontal disease measure on each clinical periodontitis definition. The overall performance of the self-reported periodontal disease measure for detecting clinical periodontitis was assessed by computing the area under the curve (AUC). The best cut-off point for the self-reported periodontal disease measure was determined at the point on the curve where the sum of sensitivity and specificity was highest. The self-reported periodontitis scale was dichotomised based on the cut-off value established in this study. Multivariate logistic regression analyses were performed to evaluate the associations between the self-reported periodontal disease measure and clinical definitions after adjusting for other important variables, including age, education, income, smoking, toothbrushing and use of auxiliary aids.  $P < 0.05$  was considered statistically significant.

## RESULTS

### Participants' characteristics

A total of 288 (107 men and 181 women) dentate subjects were included in this study. The sociodemographic and relevant characteristics of the participants are shown in *Table 1*. All subjects were 20 years of age or older, and about half (45.1%) were older than 40 years.

### Severity and extent of periodontal disease

The severity and extent of periodontal disease, according to age, is shown in *Table 2*. The severity and extent of periodontal disease, as measured using most of the periodontal parameters, increased significantly with increasing age.

### Agreement between the clinical periodontal disease definitions

*Table 3* presents the Kappa agreement between the different clinical definitions used to define periodontal disease. The Kappa statistics ranged from 0.25 to

**Table 1** Sociodemographic and relevant characteristics of participants

Variable	n (%)
Sex	
Male	107 (37.2)
Female	181 (62.8)
Age	
<30 years	97 (33.9)
30–39.9 years	60 (21.0)
≥40 years	129 (45.1)
Monthly income (JD)*	
≤300 JD	124 (51.2)
>300 JD	118 (48.8)
Years of education	
≤12 years	170 (59.9)
>12 years	114 (40.1)
Smoking	
No	216 (75.0)
Past	3 (1.0)
Current	69 (24.0)
Brushing	
No	35 (12.2)
Regular	166 (57.6)
Irregular	87 (30.2)
Use of auxiliary aids	
No	238 (82.6)
Regular	24 (8.3)
Irregular	26 (9)
Use of mouthwash	
No	200 (69.4)
Regular	32 (11.1)
Irregular	56 (19.4)
Last visit to dentist	
<6 months	135 (46.9)
6–12 months	39 (13.5)
>12 months	105 (36.5)
Didn't visit	9 (3.1)
Dental prosthesis	
Fixed	113 (39.2)
Removable	10 (3.5)
None	165 (57.3)

\*US dollar = 0.71 Jordanian Dinar.

0.98, indicating moderate to strong agreement between the most definitions. The agreement between Machtei<sup>21</sup> and Page and Eke<sup>23</sup> was almost perfect (Kappa = 0.98). The definition of Hujoel *et al.*<sup>19</sup> had high agreement with other definitions.

### Self-reported periodontal disease questionnaire

Of the 18 questions in the self-reported periodontal disease questionnaire, only six were significantly associated with at least one clinical definition and/or extent and severity of the periodontal disease in the univariate and multivariate models and therefore those were subjected to further analysis. The frequency distribution for the responses to these questions is shown in *Table 4*. The most frequent positive response was for the question 'Do you have food impaction between your teeth?', where 75% of the participants reported 'yes'. The six questions were used to develop the periodontal disease questionnaire/scale and compute the scale score. The scale score was computed by counting

the number of 'yes' responses over the number of questions selected after validation.

### ROC curve analyses

The calculated AUCs of self-reported periodontal disease scale for distinguishing subjects with periodontal disease, according to different clinical definitions, are summarised in *Table 5*. The AUC values obtained ranged between 0.77 and 0.83 according to the clinical definition used. The values of AUCs indicate that the self-reported periodontal disease scale had an excellent performance to discriminate between those with and without periodontal disease, regardless of the clinical definition used. As defined by selected clinical criteria, the optimal cut-off value for the self-reported periodontal disease scale to detect clinically defined periodontal disease was 2. The score of 2 had the highest sensitivity and specificity to detect periodontal disease when defined by all study criteria. The sensitivity ranged between 0.61 and 0.83, and the specificity ranged between 0.68 and 0.83, according to the clinical definition used.

### Self-reported periodontal disease and periodontal clinical parameters

The differences in the dental and periodontal clinical parameters according to self-reported periodontal disease, as defined by the self-reported periodontal disease scale, are shown in *Table 6*. Subjects who met the criteria for self-reported periodontal disease had significantly higher extent and severity of periodontal disease, as measured by periodontal clinical parameters, compared with those who did not meet the self-reported definition.

The self-reported periodontal disease definition was tested in separate logistic regression models as the main predictor variable for each outcome variable (clinical periodontal disease definitions) after adjusting for age, income, education, smoking, toothbrushing and use of auxiliary aids (*Table 7*). Significant associations were observed between self-reported definition and all clinical definitions. The strength of the association in the regression analysis varied [(the odds ratios (ORs) ranged from 8.31 to 18.96] according to the clinical definition to be predicted. Of all definitions used, the self-reported definition had the strongest association with Machtei<sup>21</sup> (OR = 18.87), Page and Eke<sup>23</sup> (OR = 18.96) and Lopez *et al.*<sup>22</sup> (OR = 15.33) definitions.

### DISCUSSION

Clinical and radiographic measures of periodontal status are commonly used in dental research to estimate

**Table 2** Severity and extent of periodontal disease, according to age

Clinical parameter	Age (years)			P
	<30 Mean (SD)	30–39.9 Mean (SD)	≥40 Mean (SD)	
Average of:				
Gingival index	1.13 (0.64)	1.44 (0.75)	1.74 (0.76)	<0.005
Probing pocket depth (mm)	2.02 (0.22)	2.07 (0.30)	2.23 (0.53)	<0.005
Clinical attachment loss (mm)	2.03 (0.22)	2.15 (0.44)	3.03 (1.37)	<0.005
Gingival recession (mm)	0.01 (0.03)	0.08 (0.17)	0.81 (1.19)	<0.005
Average percentage of sites with:				
Probing pocket depth ≥3 mm	2.74 (11.91)	4.90 (15.65)	15.51 (28.67)	<0.005
≥4 mm	1.37 (6.36)	1.81 (8.27)	6.59 (18.58)	0.008
≥5 mm	0.33 (2.16)	0.995 (5.71)	2.87 (9.83)	0.026
≥6 mm	0.03 (0.20)	0.42 (3.02)	0.37 (1.39)	0.230
Clinical attachment loss ≥3 mm	3.33 (12.32)	7.89 (17.18)	37.67 (37.68)	<0.005
≥4 mm	1.55 (6.49)	3.66 (9.62)	27.66 (33.57)	<0.005
≥5 mm	0.43 (2.21)	1.87 (8.41)	16.54 (27.40)	<0.005
≥6 mm	0.02 (0.18)	0.03 (0.23)	2.13 (9.74)	0.027
Gingival recession ≥1 mm	0.68 (2.57)	4.06 (8.87)	30.75 (37.20)	<0.005
≥2 mm	0.14 (0.66)	3.00 (6.80)	22.57 (31.22)	<0.005
≥3 mm	0.097 (0.56)	0.64 (2.10)	11.71 (23.27)	<0.005
Bleeding on probing	32.17 (44.49)	47.91 (48.27)	40.14 (44.98)	0.104

**Table 3** Agreement (Kappa statistics) between different periodontal disease definitions

Periodontal disease definition	Kappa statistics					
	Beck <i>et al.</i> <sup>20</sup>	Machtei <sup>21</sup>	Lopez <i>et al.</i> <sup>22</sup>	Page and Eke <sup>23</sup> (moderate)	Page and Eke <sup>23</sup> (severe)	Borrell <i>et al.</i> <sup>24</sup>
Hujoel <i>et al.</i> <sup>19</sup>	0.86 *	0.56*	0.88*	0.53*	0.55*	0.85*
Beck <i>et al.</i> <sup>20</sup>	1	0.69*	0.88*	0.44*	0.67*	0.78*
Machtei <sup>21</sup>		1	0.67*	0.26*	0.98*	0.50*
Lopez <i>et al.</i> <sup>22</sup>			1	0.45*	0.65*	0.80*
Page and Eke <sup>23</sup> (moderate)				1	0.25*	0.62*
Page and Eke <sup>23</sup> (severe)					1	0.48*
Borrell <i>et al.</i> <sup>23</sup>						1

\*P &lt;0.05.

**Table 4** Responses to individual questions in the self-reported periodontal disease measure (questionnaire)

Question	No n(%)	Yes n(%)
1 Do you have periodontal disease or gum disease?	164 (56.9)	124 (43.1)
2 Have you ever been told by a dentist that you have periodontal/gum disease with bone loss?	194 (67.4)	94 (32.6)
3 Do you find any area more red than it should be?	211 (73.3)	77 (26.7)
4 Do you have mobility in your teeth?	241 (83.7)	47 (16.3)
5 Do you have food impaction between your teeth?	71 (24.7)	217 (75.3)
6 Do you notice that your teeth getting longer?	237 (82.3)	51 (17.7)

the prevalence, extent and severity of periodontitis. However, these measures are not practical, in terms of cost, time and convenience, to be used for monitor-

**Table 5** Calculated areas under the ROC curves (AUCs) and their 95% confidence interval (95% CI) of self-reported periodontal disease measure for detecting clinically defined periodontitis using different definitions

Clinical criteria for diagnosis	Area under the curve (95% CI)	Sensitivity	Specificity
Hujoel <i>et al.</i> <sup>19</sup>	0.79 (0.73–0.84)	0.71	0.74
Beck <i>et al.</i> <sup>20</sup>	0.80 (0.75–0.86)	0.76	0.72
Machtei <i>et al.</i> <sup>21</sup>	0.81 (0.75–0.86)	0.83	0.68
Lopez <i>et al.</i> <sup>22</sup>	0.83 (0.79–0.87)	0.80	0.73
Page and Eke <sup>23</sup> (moderate)	0.77 (0.71–0.82)	0.61	0.83
Page and Eke <sup>23</sup> (severe)	0.81 (0.75–0.87)	0.83	0.68
Borrell <i>et al.</i> <sup>24</sup>	0.81 (0.75–0.86)	0.72	0.76

ing periodontitis and to be used in large study populations. The evidence of the link between periodontitis and systemic diseases may require that assessment of



**Table 6** Differences in the periodontal clinical variables according to self-reported periodontitis, as defined by the self-reported periodontitis scale

Clinical parameter	Self-reported periodontal disease measure score				P
	<2 (n = 177)		≥2 (n = 111)		
	Mean	SD	Mean	SD	
Average periodontal index	1.19	0.57	1.50	0.57	0.000
Average gingival index	1.37	0.75	1.62	0.76	0.007
Severity of periodontal disease					
Average of:					
Probing pocket depth (mm)	2.07	0.36	2.21	0.47	0.005
Clinical attachment loss (mm)	2.38	0.99	2.71	1.14	0.010
Gingival recession (mm)	0.31	0.82	0.50	0.98	0.084
Extent of periodontal disease					
Percentage of sites with:					
Probing pocket depth ≥3 mm	5.80	18.68	13.82	26.61	0.003
Probing pocket depth ≥4 mm	2.41	11.38	5.99	16.59	0.031
Probing pocket depth ≥5 mm	1.23	7.08	2.21	7.54	0.264
Probing pocket depth ≥6 mm	0.21	1.85	0.35	1.33	0.512
Clinical attachment loss ≥3 mm	15.05	28.62	26.97	35.23	0.002
Clinical attachment loss ≥4 mm	10.50	24.31	18.75	28.75	0.010
Clinical attachment loss ≥5 mm	6.18	18.17	10.75	23.08	0.062
Clinical attachment loss ≥6 mm	0.76	7.18	1.30	5.53	0.500
Gingival recession ≥1 mm	12.46	27.31	18.66	31.34	0.078
Gingival recession ≥2 mm	8.67	21.80	14.16	26.04	0.055
Gingival recession ≥3 mm	4.31	14.41	7.17	19.50	0.155
Percentage of bleeding on probing	30.04	42.62	53.66	47.04	0.000

periodontal status is carried out by non-dental health professionals who lack experience in performing periodontal clinical examination. For these reasons, self-reported measures of periodontal disease are cost-efficient alternatives for periodontitis surveillance and periodontitis assessment by non-dental health professionals.

A number of self-reported questionnaire items have been tested for their validity to detect periodontal disease. No single question has been identified to correctly reveal whether or not an individual has periodontitis. However, the use of combinations of several self-reported questions might improve the sensitivity and specificity of that approach.

In our study, the questionnaire was self-administered and completed by the participants. In other studies, the methods of data collection vary and include self-administered questionnaire, questionnaires distributed by post, telephone interview and face-to-face interview.

**Table 7** Multivariate analysis of the association between self-reported periodontal disease and clinical periodontal disease definitions

Definition of periodontal disease (dependent variable)	Self-reported questionnaire score ≥2 versus <2 Odds ratio* (95% confidence interval)	P
Beck <i>et al.</i> <sup>20</sup>	9.13 (4.21–19.82)	<0.005
Machtei <sup>21</sup>	18.87 (5.58–63.81)	<0.005
Lopez <i>et al.</i> <sup>22</sup>	15.33 (6.54–35.96)	<0.005
Page and Eke <sup>23</sup> (a)†	11.14 (5.17–24.02)	<0.005
Page and Eke <sup>23</sup> (b)‡	18.96 (5.48–65.58)	<0.005
Borrell <i>et al.</i> <sup>24</sup>	8.31 (4.27–16.14)	<0.005

\*Adjusted for residency area, smoking, brushing, auxiliary aids, age, income and education.

†(a) Moderate periodontitis.

‡(b) Severe periodontitis.

In this study we used 18 questions to assess periodontal disease. These questions were used to assess self-reported symptoms, diagnosis of health professionals or treatment provided for them. After testing the individual questions, only six were found to be associated with periodontal disease clinical definitions in the univariate and multivariate models. These questions were scored and summed to develop a periodontitis score. The self-reported periodontal disease measure score was computed by counting the number of ‘yes’ responses over the six questions and the total score ranged from 1 to 6. In earlier studies, individual items in separate or combinations of items were tested for their validity.

In some studies, periodontal examination was used to validate self-reported measures<sup>7,25–27</sup>, whereas, in other studies, radiographs were used as a method of validation<sup>8,28</sup>. Because of the lack of consensus on the definition of periodontitis, different definitions were used in this study as outcome variables to assess the overall discriminatory power of the self-reported periodontitis scale. The measure of agreement (Kappa statistics) between the selected clinical definitions ranged from 0.25 to 0.98, indicating moderate to strong agreement between most of the definitions used. The use of different definitions allowed us to assess the self-reported periodontal disease measure against clinical periodontal disease definitions that reflect different disease severities.

The calculated AUCs of self-reported periodontal disease scale for distinguishing subjects with periodontitis ranged from 0.77 to 0.83, indicating that the self-reported periodontal disease measure had excellent performance to discriminate between those with and without periodontal disease, regardless of the clinical definition used. As defined by selected clinical criteria, the optimal cut-off value for the self-reported periodontal disease scale to detect clinically defined periodontal disease was 2. The score of 2 has the highest sensitivity and specificity to detect periodontal

disease when defined by all study criteria. The sensitivity ranged from 0.61 to 0.83 and the specificity from 0.68 to 0.83, according to the clinical definition used. This cut-off value was shown, in further analysis, to be sufficiently accurate to discriminate between those with and without periodontal disease. Subjects who met the criteria for self-reported periodontal disease, with a score of  $\geq 2$ , had significantly higher extent and severity of periodontal disease, as measured by most of the parameters, compared with those who did not meet the self-reported definition.

The self-reported periodontitis definition was tested in separate logistic regression models as the main predictor variable for each outcome variable (clinical periodontitis definition) after adjusting for age, education, income, smoking, toothbrushing and use of auxiliary aids. Significant associations were observed between self-reported definition and all clinical definitions. The strength of the association in the regression analysis ranged from 8.31 to 18.96, according to the clinical definition.

The results of this study should be interpreted with caution. When periodontitis is asymptomatic, people with this disease may be unaware of their periodontal status. Moreover, self-reported measures, based on whether patients were told by their dentists that they have periodontal disease, would probably underestimate the disease prevalence among a group of patients who are less likely to utilise dental services.

In conclusion, the self-reported periodontal disease measure has an excellent predictive and discriminative validity when tested against clinical definitions, severity and extent of periodontal disease. It is recommended be used for surveillance and monitoring periodontitis in large populations. Use of a self-reported periodontal health questionnaire must be considered as an effective and economical tool for large epidemiological studies.

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### Conflict of interest

The authors declare that they have no conflicts of interest.

### Declaration of Helsinki

The research was undertaken with the understanding and written consent of each subject and according to

the Medical Association Declaration of Helsinki (version, 2008) and the additional requirements.

### REFERENCES

1. Ansai T, Awano S, Soh I. Problems and future approaches for assessment of periodontal disease. *Front Public Health* 2014 28: 54.
2. Wu X, Weng H, Lin X. Self-reported questionnaire for surveillance of periodontitis in Chinese patients from a prosthodontic clinic: a validation study. *J Clin Periodontol* 2013 40: 616–623.
3. Taylor GW, Borgnakke WS. Self-reported periodontal disease: validation in an epidemiological survey. *J Periodontol* 2007 78: 1407–1420.
4. Dietrich T, Stosch U, Dietrich D *et al.* Prediction of periodontal disease from multiple self-reported items in a German practice-based sample. *J Periodontol* 2007 78: 1421–1428.
5. Dietrich T, Stosch U, Dietrich D *et al.* The accuracy of individual self-reported items to determine periodontal disease history. *Eur J Oral Sci* 2005 113: 135–140.
6. Genco RJ, Falkner KL, Grossi S *et al.* Validity of self-reported measures for surveillance of periodontal disease in two western New York population-based studies. *J Periodontol* 2007 78: 1439–1454.
7. Gilbert G, Litaker M. Validity of self-reported periodontal status in the Florida dental care study. *J Periodontol* 2007 78: 1429–1438.
8. Joshipura KJ, Pitiphat W, Douglass CW. Validation of self-reported periodontal measures among health professionals. *J Public Health Dent* 2002 62: 115–121.
9. Cascaes AM, Peres KG, Peres AM. Periodontal disease is associated with poor self-rated oral health among Brazilian adults. *J Clin Periodontol* 2009 36: 25–33.
10. Taani DQ, Alhaja E. Self-assessed bleeding as an indicator of gingival health among 12–14-year-old children. *J Oral Rehabil* 2003 30: 78–81.
11. Airila-Mansson S, Bjurshammar N, Yakob M *et al.* Self-reported oral problems, compared with clinical assessment in an epidemiological study. *Int J Dent Hyg* 2007 5: 82–86.
12. Andersson K, Gustafsson A, Buhlin K. Self-perceived oral function in elderly residents in a suburban area of Stockholm, Sweden. *Oral Health Prev Dent* 2004 2: 195–201.
13. Unell L, Söderfeldt B, Halling A *et al.* Oral disease, impairment, and illness: congruence between clinical and questionnaire findings. *Acta Odontol Scand Periodontol* 1997 55: 127–132.
14. Blicher B, Joshipura K, Eke P. Validation of Self-reported periodontal disease: a systematic review. *J Dent Res* 2005 84: 881–890.
15. Joshipura KJ, Pitiphat W, Douglass CW. Validation of self reported periodontal measures among health professionals. *J Public Health Dent* 2002 62: 115–121.
16. Gilbert GH, Shelton BJ, Fisher MA. 48-month periodontal attachment loss incidence in a population based cohort study: role of baseline status, incident tooth loss, and specific behavioral factors. *J Periodontol* 2005 76: 1161–1170.
17. Silness J, Loe H. Periodontal disease in pregnancy II. Correlation between oral hygiene and periodontal condition. *Acta Odontol Scand* 1964 22: 121–135.
18. Loe H. The gingival index, the plaque index and the retention index systems. *J Periodontol* 1967 38: 610–616.
19. Hujoel PP, Lydon-Rochelle M, Robertson PB *et al.* Cessation of periodontal care during pregnancy: effect on infant birthweight. *Eur J Oral Sci* 2006 114: 2–7.

20. Beck JD, Koch GG, Rozier GR *et al.* Prevalence and risk indicators for periodontal attachment loss in a population of older community dwelling blacks and whites. *J Periodontol* 1990 61: 521–528.
21. Machtei EE, Christersson LA, Grossi SG *et al.* Clinical criteria for the definition of “established periodontitis”. *J Periodontol* 1992 63: 206–214.
22. López NJ, Smith PC, Gutierrez J. Periodontal therapy may reduce the risk of preterm low birth weight in women with periodontal disease: a randomized controlled trial. *J Periodontol* 2002 73: 911–924.
23. Page RC, Eke PI. Case definitions for use in population-based surveillance of periodontitis. *J Periodontol* 2007 78: 1387–1399.
24. Borrell LN, Papapanou PN. Analytical epidemiology of periodontitis. *J Clin Periodontol* 2005 32(Suppl. 6): 132–158.
25. Taylor GW, Borgnakke WS. Self-reported periodontal disease: validation in an epidemiological survey. *J Periodontol* 2007 78: 1407–1420.
26. Slade GD. Interim analysis of validity of periodontitis screening questions in the australian population. *J Periodontol* 2007 78: 1463–1470.
27. Buhlin K, Gustafsson A, Andersson K *et al.* Validity and limitations of self-reported periodontal health. *Community Dent Oral Epidemiol* 2002 30: 431–437.
28. Pitiphat W, Garcia RI, Douglass CW *et al.* Validation of self-reported oral health measures. *J Public Health Dent* 2002 62: 122–128.

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## APPENDIX 1

The initial form of the self-reported periodontal questionnaire

No.	Question	No	Yes
1	Do you have periodontal disease or gum disease?	<input type="checkbox"/>	<input type="checkbox"/>
2	Have you ever been told by a dentist that you have periodontal/gum disease with bone loss?	<input type="checkbox"/>	<input type="checkbox"/>
3	Have you ever been told that you need periodontal or gum treatment?	<input type="checkbox"/>	<input type="checkbox"/>
4	Have you ever had any form of periodontal or gum treatment?	<input type="checkbox"/>	<input type="checkbox"/>
5	Do your gums usually bleed?	<input type="checkbox"/>	<input type="checkbox"/>
6	Has any dentist or dental hygienist told you that you have deep pockets?	<input type="checkbox"/>	<input type="checkbox"/>
7	Do you find any area more red than it should be?	<input type="checkbox"/>	<input type="checkbox"/>
8	Do you have mobility in your teeth?	<input type="checkbox"/>	<input type="checkbox"/>
9	Do you notice changes in your teeth?	<input type="checkbox"/>	<input type="checkbox"/>
10	Do you feel pain in your gum?	<input type="checkbox"/>	<input type="checkbox"/>
11	Do you have food impaction between your teeth?	<input type="checkbox"/>	<input type="checkbox"/>
12	Do you notice that your teeth getting longer?	<input type="checkbox"/>	<input type="checkbox"/>
13	Do you feel any sensitivity in your teeth?	<input type="checkbox"/>	<input type="checkbox"/>
14	Do you notice bad odor from your mouth?	<input type="checkbox"/>	<input type="checkbox"/>
15	Do you have any abscesses in your mouth?	<input type="checkbox"/>	<input type="checkbox"/>
16	Do you have calculus/tartar on your teeth?	<input type="checkbox"/>	<input type="checkbox"/>
17	Do you feel your mouth dry?	<input type="checkbox"/>	<input type="checkbox"/>
18	Have you ever had periodontal surgery?	<input type="checkbox"/>	<input type="checkbox"/>

The final self-reported periodontal disease measure (questionnaire) consists of six questions: Q1, Q2, Q7, Q8, Q11 and Q12.