Assessment of the reliability and validity of the Dental Neglect Scale in Norwegian adults

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Aims To evaluate the reliability and construct validity of the Dental Neglect Scale (DNS) and to estimate the level of dental neglect in the adult Norwegian population. *Methods* A questionnaire containing socio-demographics, oral health attitude variables, self-reported service use and a translated version of the original DNS was tested in two samples: 1) a convenience sample of University employees (n=263) and 2) a proportionate random sample (n=2000) drawn from the national population register (age 16-79 years). The reliability assessment of the instrument was by internal consistency (Cronbach's alpha) and factor analysis (principal component) (n=1309). The test-retest comparisons (n=108) were analyzed by Spearman's rho for the sum-scores, and kappa statistics for single items. Logistic regression analyses were used to evaluate the construct validity of the DNS. *Results* The Cronbach's alpha coefficient for the overall construct of DNS was 0.67 (n=173) and 0.57 (n=1301). Only one factor was extracted, explaining a total of 36% of the scale variance (n=1301). Cohen's kappa for the test-retest comparisons ranged from 0.21-0.79 (n=108), and Spearman's rho for the test-retest sum-scores was 0.60. Higher neglect scores were positively related to a negative opinion about own dental health (OR=3.3), last dental appointment because of pain or other problems (OR= 2.3), less than 20 teeth (OR=2.2), drinking soft drinks with sugar every day (OR=2.1), non-regular dental service use (OR=2.2) and using floss or toothpicks seldom or never (OR=1.6). The prevalence of high dental neglect was 20%. *Conclusions* The analyses indicated construct validity for the Dental Neglect Scale but low reliability for some of its items. One fifth of this representative sample of Norwegian adults reported a high level of dental neglect.

Key words: Dental neglect, reliability, validity

Introduction

Evaluations of dental health care services are often based on detailed clinical examinations. The criteria for good oral health and the need for care in the population are judged by professionals. Methods based on self-reports are both effective, less costly and also less invasive compared to clinical examinations (Clarkson *et al.,* 1995). Moreover, they may improve the understanding of oral health problems and give additional information in the evaluation of health care services (Deyo and Carter, 1992). They may also give important information about subjects who are avoiding dental care, and therefore are not attending clinical screening. According to Locker and Miller (1994), individual self-assessment of dental health is one key determinant of utilization of dental care, and more use of self-report scales is likely (Locker and Miller, 1994).

Some specific criteria have to be satisfied before a patient-based instrument can represent an alternative or support to clinical examinations. The survey instrument has to provide specific and valid enough indications about the oral health in groups or populations. Theoretical concepts may have different meanings in different populations and cultures. It is generally accepted that both the reliability and the validity may be influenced by these differences in attitudes, beliefs and priorities, and that this may influence the reproducibility of the instru-

ment (Streiner and Norman, 1995). The instrument has to be sufficiently reliable in the way that subjects will give the same response if the instrument is used repeatedly, in a period with no intervention, before the validity can be consistently established (Streiner and Norman, 1995). Attempts are being made to develop patient-based instruments that fulfil these criteria, but there is generally a need for testing of reliability and validity in the population where the instrument is intended to be used (Streiner and Norman, 1995).

Dental neglect has been defined as behaviour and attitudes which are likely to have detrimental consequences for the individual's oral health (Thomson and Locker, 2000), or more specifically as *failure to take precautions to maintain oral health, failure to obtain needed dental care, and physical neglect of the oral cavity* (Thomson *et al.*, 1996). In a 1994 pilot study, Strauss and colleagues showed that it is possible to measure the construct "dental neglect" and to explore its association with oral health (Strauss *et al.*, 1994). Previous studies have shown that dental neglect is associated with lower social class, irregular use of dental care, and more oral health problems (Thomson and Locker, 2000; Jamieson and Thomson, 2002a, 2002b). These associations may indicate that the measurement of this construct may give important indications about oral health and oral health related behaviour and attitudes in groups and populations.

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The Dental Neglect Scale (DNS) was designed for use in adults by (Thomson and Locker, 2000), and is a modified version of the original Adelaide scale developed to measure child dental neglect based on parental responses (Thomson *et al,*. 1996). The DNS has been tested in a few populations. The Adelaide version of the scale was used among children in South Australia, and the DNS has been tested in three different samples in New Zealand, a cohort of 26-year-olds (Thomson and Locker, 2000) and in two samples of adults where the generalization of the findings was unclear (Jamieson and Thomson, 2002a; 2002b). The authors of these studies recommended further psychometric evaluation of the instrument, specifically reliability analyses based on test-retest design, but also validity assessments in different populations (Thomson *et al.*, 1996; Thomson and Locker, 2000; Jamieson and Thomson, 2002b). The results of previous studies are promising based on the clear indications of high neglect scores showing strong relationships to self-reports of bad dental health, irregular dental service use and unfavourable oral self-care behaviours among adults (Thomson and Locker, 2000; Jamieson and Thomson, 2002a, 2002b) . However, there is a need for psychometric evaluations of the DNS in other populations, and specifically in a representative sample of adults.

The aims of the present study were: 1) To evaluate the reliability of the Dental Neglect Scale (DNS) among adults in Norway; 2) to assess the construct validity of the scale by exploring the associations between dental neglect and self-reports of: number of natural teeth, oral health situation, oral health related habits and dental service use; and 3) to estimate the level of dental neglect in the general population of Norwegian adults.

Methods

Sample and study design

A translated version of the original DNS instrument was developed and tested in two independent samples of Norwegian adults: 1) a convenience sample of University employees at the Faculty of Dentistry, University of Bergen (n=253) (Sample 1) and 2) a proportionate random sample (n=2,000) drawn from the Norwegian national population register (age 16-79 years) by the Central Bureau of Statistics (CBS), the Omnibus survey in November-December 2003, (Sample 2). Information was available for 1,309 persons. Twenty-one persons had died or moved abroad.

The subjects in Sample 1 (n=253) were invited by mail to participate in a self-administered questionnaire survey including the DNS index, some global indicators of oral health and oral health behaviours. The response rate was 68.4% (173/253). The respondents (n=173) were asked to complete the same questionnaire a second time, after a time lag of 4 weeks. A total of 108 responded, giving a response rate of 62.4% (108/173).

The data from Sample 2 were obtained via telephone interview performed by trained interviewers and lasting for 30 minutes. In addition to a number of questions related to socio-demographic characteristics, the interview included identical variables as the questionnaire given to Sample 1. The response rate was 66.1% (1309/1979), and the main reasons for non-response were refusal (19.8%) or no contact (6.9%). The sample was representative of the Norwegian population aged 16 to 79 years with regard to age, gender, education and place of residence.

Measures

In addition to socio-demographics (age, gender, occupation and place of residence) the survey included self-reports of dental service use, oral health and oral health attitudes, measured by the following variables: *How many times have you been to the dentist during the last 5 years?* (regularly, at least once a year, 3-4 times, 1-2 times, have not been to the dentist the last five years); *Main reason for last dental appointment?* (regular control/treatment, because of pain, because of other acute problems (not pain)); *How many natural teeth do you have?* (participants were asked to count their number of teeth in the upper and lower jaw); and *What is your opinion about your own dental health?* (very good, good, neither good nor bad, bad, very bad). Self-reports of oral health related habits were recorded by the variables: *How often are you drinking soft drinks with sugar?*(more than once a day, daily, 3-6 times a week, 1-2 times a week, seldom or never) and *How often are you using dental floss/ toothpicks?* (more than once a day, daily, 3-6 times a week, 1-2 times a week, seldom or never).

The interview schedule included a translated version of the original DNS instrument. The index was translated into Norwegian by the authors and then back-translated into English by two independent bilingual persons. The wording of the DNS items is presented in Table 1. Item no 3, 4 and 6 were reversed, to make the total scale questions more balanced in a positive /negative direction.

Table 1. Distribution (%) of respondents by item and score (n=1,309)

#	Item	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
1	I keep up my home dental care	62.5	35.6	0.7	1.1	0
2	I receive the dental care I should	61.4	32.6	0.8	3.8	1.4
3	I need dental care, but I put it off	5.0	12.1	1.8	26.5	54.6
4	I do not brush as well as I should	2.8	10.7	3.3	36.4	46.8
5	I control snacking between meals as well as I should do	28.6	34.4	7.3	23.0	6.7
6	I consider my dental health to be not important	2.5	2.7	1.8	34.6	58.4

These items were recoded before computing sum-scores, to give higher scores representing more dental neglect.

Dental neglect has been shown to be associated with lower social class, irregular use of dental care, and more oral health problems (Thomson *et al.* 1996; Thomson and Locker 2000). The construct validity of the DNS was therefore evaluated by exploring the relationship between high DNS scores and the following variables used as validating criteria: self-reported dental health (very bad, bad, neither bad nor good vs. good/ very good); number of natural teeth (less than 20 vs. 20 or more); oral health related habits (use of dental floss/toothpicks seldom or never vs. sometimes or often); frequency of drinking soft drinks with sugar (once a day or more vs. less than daily); dental service use (non-regular vs. regular). The criteria for non-regular and regular use was 1-2 visits or never been to the dentist during the last five years vs. three or more visits to the dentist during the last five years. Geographical region and gender were included as control variables.

Statistical analyses

The data were analyzed using SPSS v12.0 (SPSS Inc., Chicago Ill.). Twenty percent or more missing item scores was the criterion exclusion (no sum-score). On this basis, a DNS score was not be calculated for four subjects.

The reliability assessment of the DNS instrument was estimated by internal consistency (Cronbach's alpha) (Sample 1 and 2) and split half (Sample 2).

Factor analysis (principal component) was based on data from Sample 2 (n=1,309). The test-retest comparisons were analyzed by Spearman's rho for the sum-scores, and Cohen's kappa statistics for single items and dichotomized DNS sum-scores (median split), based on data from Sample 1 (n = 108).

Differences between groups were analyzed with one-way ANOVA and χ^2 (cross-tabulation), and the strength of association between independent variables was assessed by Spearman's correlation coefficient.

Multiple logistic regression analyses were used to determine the individual associations for variables related to the outcome variable of dental neglect. A sum-score of one standard deviation or more above the mean was the criterion for high (score 1) vs. moderate/low dental neglect (score 0). The independent variables were dichotomized (1-0) with score 1 representing a hypothesized positive relationship to the dependent variable dental neglect. As the number of natural teeth was one of the independent variables, edentulous subjects were excluded in the logistic regression analyses.

Results

The mean age in Sample 1 (university employees) was 46.4 years with 33% men. In Sample 2 (general population) the mean age was 43.4 years with 50.5% men. The distribution of subjects in percent is presented according to DNS items and scores in Table 1, and according to self-reports of dental health (number of natural teeth and oral health), dental service use and oral health related habits in Table 2. Only 2.5% of the respondents were edentulous and 5% had less than 20 natural teeth. Four percent (54/1306) reported their dental health as bad or very bad, while 90.6% (1183/1306) reported good or very good dental health.

Four percent of the respondents had not been to the dentist during the last five years, while 66.8% (873/1306) had visited the dentist regularly. For 25% of the subjects (326/1303) the last dental visit was for emergency treatment (pain or other acute problems).

Eleven percent of the subjects (144/1264) reported to drink soft drinks with sugar once or more than once a day, and 70 % of the respondents (883/1264) used dental floss or toothpicks seldom or never.

Reliability analyses

The Cronbach's alpha coefficient for the overall construct of DNS was 0.67 among university employees (n=173) and 0.57 in the general population (n=1,301), with no differences for gender or age groups. When single items were removed, Cronbach's alpha ranged from 0.48 to 0.64 (n=1,301). Split-half analyses showed alpha values of 0.60 (items 1, 2 and 3) and 0.28 (items 4, 5 and 6) (n=1,301). Analyses including only random samples of cases using different sampling fractions did not give any alpha coefficients higher than 0.59.

In the factor analysis (principal component) (n=1,309) only one factor was extracted, explaining 37% of total scale variance (Eigenvalue greater than 1).

Consistency in terms of Cohen's kappa for the test-retest comparisons in Sample 1 (n=108) for single items ranged from 0.21 (*I receive the dental care I should*) to 0.80 (*I keep up my own dental care*), with only one kappa value higher than 0.50. The items were dichotomized into neglect (4, 5) / no neglect (1, 2, 3). Kappa analyses without dichotomization was done for the items where the same responses were represented in both the test and re-test conditions. These analyses gave lower Kappa values. The Kappa value for test-retest sum-scores (median split) was 0.45.

Spearman's rho for the test-retest sum-score was 0.60. The mean NSD sum-scores were 9.4 for the test condition vs. 9.9 for retest (*p*=0.06).

Validity analyses

Only 0.4% of the participants (5/1,309) refused to respond to one or more of the DNS items. Few missing values support the face validity of the DNS scale.

Table 3 shows the results of the multiple logistic regression analyses and the distribution of subjects with high dental neglect according to the independent variables included in the multivariate model. When controlling for age, gender, occupation and place of residence, subjects reporting bad or very bad own dental health were 3.3 times more likely to be included in the high dental neglect group compared to subjects reporting good or very good dental health (44% vs.18%). The likelihood of being included in the dental neglect group was also higher for self-reports of: last appointment because of pain or other problems (OR= 2.3), less than 20 teeth (OR=2.2), drinking soft drinks with sugar every day (OR=2.1), non-regular dental service use (OR=2.2) and using floss or toothpicks seldom or never (OR=1.6). Analyses exploring possible interaction effects between demographics and independent variables showed that having less than 20 teeth and using floss or toothpicks

Table 2. Mean (SD) DNS sum-scores according to age, gender, occupation, place of residence and variables related to dental neglect

Variables	n(%)	DNS score† Mean (SD)	95% CI
Age group			
16-24 years	206 (15.8)	11.3 (3.4)	10.8-11.8
25-44 years	494 (37.9)	11.1 (3.5)	10.8-11.4
45-66 years	452 (34.6)	10.3 (3.3)	10.0-10.6
67-79 years	153 (11.7)	9.5 (3.1)	9.0-10.0
Gender			
Male	661 (50.5)	11.0 (3.5)	10.7-11.3
Female	648 (49.5)	10.3 (3.3)	10.1-10.6
Occupation			
Unemployed last 3 months	50 (3.8)	12.9 (3.8)	11.8.13.9
Employed last 3 months	1253 (96.2)	10.6 (3.4)	10.4-10.7
Place of residence			
Northern Norway	253 (19.3)	11.5 (3.8)	11.1-12,0
Southern Norway	1056 (80.7)	10.4 (3.3)	10.2-10.6
Number of natural teeth			
Edentulous	33 (2.5)	11.3 (2.9)	10.3-12.4
Less than 20	65 (5.0)	11.7 (4.1)	10.8-12.7
20 or more	1199 (92.4)	10.6 (3.4)	10.4-10.8
Self-reported dental health			
Very bad	8 (0.6)	12.9 (3.1)	10.3-15.5
Bad	46 (3.5)	14.7 (4.7)	13.3-16.1
Neither good nor bad	69 (5.3)	12.3 (3.8)	11.4-13.2
Good	796 (60.9)	11.0 (3.2)	10.9-11,3
Very good	387 (29.6)	8.9 (2.6)	8.7-9.2
How many times have you been to the dentist during the last 5 years?			
Regularly	873 (66.8)	10.0 (3.0)	9.8-10.2
3-4 times	187 (14.3)	11.6 (3.5)	11.0-12.1
1-2 times	192 (14.7)	12.1 (3.9)	11.5-12.7
Not been to the dentist	54 (4.1)	13.3 (3.9)	12.2-14.3
Self-reported reason for last dental visit			
Regular check-up	977 (75.0)	10.2 (3.2)	10.0-10.4
Pain	126 (9.7)	13.0 (3.9)	12.3-13.7
Other acute problems	199 (15.3)	11.3 (3.2)	10.8-11.7
How often are you drinking soft drinks with sugar?			
More than once a day	59 (4.7)	12.7 (4.0)	11.7-13.8
Daily	85 (6.7)	11.6 (3.7)	10.8-12.4
3-6 times a week	155 (12.3)	11.2 (3.3)	10.7-11.7
1-2 times a week	361 (28.7)	10.5 (3.2)	10.2-10.8
Seldom or never	604 (47.8)	10.2 (3.3)	9.9-10.5
Use of floss or toothpicks			
Never or seldom	883 (69.9)	10.9 (3.5)	10.7-11.1
Often or more regularly	381 (30.1)	10.0 (3.0)	9.7-10.3

† Score range: 6-26

seldom or never was only significantly related to high dental neglect for women, but not for men.

The variables in the model accounted for 21% of the variance in terms of Nagelkerke's R^2.

Level of dental neglect

Twenty percent of the population sample had high dental neglect. The mean DNS score was 10.6 (SD 3.3; median 10.0; range 6-26). The age specific prevalence of dental neglect by age groups (16-24, 25-44, 45-66 and 67-79-year-olds) is shown in Table 2. There was a significant decrease in dental neglect from mean score 11.3 among 16-24 year-olds to 9.5 among the older age group (67-79 years of age) ($F (3, 1301) = 12.7$, $p<0.001$).

Subjects who had been unemployed during the last three months had higher mean DNS scores compared to the rest of the group, 12.9 and 10.5, respectively ($F (1, 1303) = 22.6$, $p<0.001$), and subjects living in the

Table 3. Odds Ratio (OR) and 95% confidence interval (CI) of assignment to the high neglect group when controlling for age, gender, occupation and place of residence (edentulous persons excluded)

Variables	n	% in the high neglect group	B	Odds Ratio	95% CI
Self-reported dental health					
Bad (score 1)	119	43.7	1.18	3.25	1.93-5.48
Good/ very good (score 0)	1168	17.7			
Main reason for last dental appointment					
Pain or other problems (score 1)	316	34.3	0.82	2.26	1.60-3.19
Regular control/treatment (score 0)	968	15.5			
Number of natural teeth					
Less than 20 (score 1)	39	41.0	0.81	2.24	1.04-4.83*
20 or more (score 0)	1095	20.9			
How often are you drinking soft drinks with sugar?					
Every day (score 1)					
Less than every day (score 0)	144	38.2	0.72	2.06	1.35-3.15
	1120	17.9			
Dental service use					
Non-regular (score 1)	238	36.6	0.77	2.17	1.51-3.11
Regular (score 0)	1049	16.4			
Use of floss or toothpicks					
Never or seldom (score 1)	883	22.7	0.45	1.56	1.09-2.25*
Often or more regularly (score 0)	381	14.4			

-2 Log Likelihood: 1026; 80% correctly predicted; Nagelkerke's R^2=0.21

* Only significant for women

northern part of the country had higher dental neglect than respondents living in other parts of the country, 11.5 vs. 10.4 (F (1, 1298) = 21.6, $p<0.001$).

Discussion

The present study Sample 2 is large and representative of the Norwegian adult population aged 16 to 79 years. A representative population-based sample reduces the risk of random errors, and permits generalization. As far as we know, this is the first testing of the DNS in a representative sample, and also the first testing of its reliability based on a test-retest design. Ideally the test-retest should have been performed in the general population sample, but a second telephone interview would have been too resource consuming.

The results of the present study indicate that the dental neglect construct, measured by the DNS is significantly related to bad oral health, negative oral health related habits and irregular dental service use. However, the results showed only moderate scale reliability. Test-retest values are generally considered good if the *r* values equal or exceed 0.70 (Litwin, 1995). The present study found test-retest values ranging from 0.21 – 0.80, and only one value exceeded 0. 70 (see Results section). The results also indicated a difference in mean DNS scores for the test and retest conditions, but not statistically significant (p=0.06). The test-retest sample was probably fairly homogeneous with low variation in terms of the construct. If the University employees found dental neglect not very relevant, this may have reduced the kappa values. Moderate internal consistency was, however, also confirmed by an alpha value of 0.57 in the general population sample,

and by analyses with scale items deleted showing further reduction of the alpha values.

Before the degree of validity of a scale can be established, the instrument has to be sufficiently reliable in that subjects give the same response when the instrument is used repeatedly within a short period of time. Validity results based on moderate or low reliability should therefore be interpreted with caution. Even though unreliable scores might influence the associations that indicate validity, the associations were moderately strong, and we have decided to present the results of the validity analyses and also the estimates of normative scores of dental neglect in the present population.

The prevalence estimates indicate that dental neglect scores are lower among adults in Norway compared to previous studies in other populations (Jamieson and Thomson, 2002a; 2002b). The present study was based on telephone interviews, while Jamieson and Thomson used mailed questionnaires. Hepner *et al.* (2005) found similar internal consistency reliability and mean scores of multi-item scales when comparing mail and telephone surveys (Hepner *et_al.,* 2005), and those of others are unlikely to have been significantly affected by the difference in methodology.

Dental care in Norway is well organized with good access for all age groups in most parts of the country. Seventy-five percent of the present general population sample reported regular check-up as the reason for their last dental visit, compared to about fifty percent of the sample in a New Zealand population (Jamieson and Thomson, 2002a). Dental neglect may represent a less relevant construct among adults in Norway, especially for employees at a dental school (test-retest sample), and

might be a reason for the low consistency. An internal consistency in the population sample of 0.57, and the fact that the normative scores for dental neglect were lower than reported in other populations (Jamieson and Thomson, 2002a; 2002b), supports the assumption that the neglect items are perceived as being of low relevance and thereby making the responses unstable and unreliable. This inconsistency was found in all age-groups.

Recent research has indicated that reversing of scale items from positive to negative wording or vice versa should be done with caution. According to Locker *et al* (2007) the reversing of items may change the loading into different factors, and may even represent a change in the scale mean (Locker *et al*, 2007). It is not possible, based on the present data, to evaluate to what extent the reversing of items has influenced the results and made the responses more inconsistent.

The present results indicate that the Dental Neglect Scale may represent a relevant instrument for population surveys aimed at identifying risk groups based on information about oral health, oral health related behaviour and attitudes. However, the results also show the importance and need for psychometric evaluations of scales before use in new populations. The study confirmed the need for further development and psychometric evaluations of the Dental Neglect Scale.

Only one factor was identified in the factor analyses, indicating that the items included in the scale measure the same factor, but it is still unclear what specifically the scale is measuring (Jamieson and Thomson, 2002b) . One suggestion might be to try to introduce additional items representing different attitudes of the neglect construct. Sanders *et al*, (2006). have in a recent study used an adaptation of the DNS where it was augmented with three additional statements measuring attitudes related to the importance of visiting the dentist (Sanders *et al*., 2006). The version with additional items resulted in a two-factor solution with two different subscales, one for dental self-care, and one for dental visiting. The results showed a higher reliability for dental visiting compared to dental self-care. The expended scale explained more of the variance compared to the present study, and the results also indicated that additional statements about dental visiting may increase the scales' predictive power of oral health. According to Jamieson *et al*., no qualitative techniques were used in the early stages of the development of the DNS (Jamieson and Thomson, 2002b). Sanders *et al* do not explain how the additional statements were developed (Sanders *et al*, 2006). We do not know if the different items of the DNS do represent what people think is dental neglect. Development of items should preferably not be based on criteria selected by professionals, but based on qualitative research exploring population based criteria for the theoretical concept. Only this way may the measurement obtained when using the instrument become stable and reliable.

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