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Shortening the Xerostomia Inventory

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Abstract

Objectives—To determine the validity and properties of the Summated Xerostomia Inventory-Dutch Version in samples from Australia, The Netherlands, Japan and New Zealand.

Study design—Six cross-sectional samples of older people from The Netherlands (N = 50), Australia (N = 637 and N = 245), Japan (N = 401) and New Zealand (N = 167 and N = 86). Data were analysed using the Summated Xerostomia Inventory-Dutch Version.

Results—Almost all data-sets revealed a single extracted factor which explained about half of the variance, with Cronbach's alpha values of at least 0.70. When mean scale scores were plotted against a "gold standard" xerostomia question, statistically significant gradients were observed, with the highest score seen in those who always had dry mouth, and the lowest in those who never had it.

Conclusion—The Summated Xerostomia Inventory-Dutch Version is valid for measuring xerostomia symptoms in clinical and epidemiological research.

Introduction

Xerostomia is the subjective sensation of dry mouth, and has been shown to affect sufferers' oral-health-related quality of life[1–3]. Measuring xerostomia is problematic, not only because it involves asking the sufferer, but also because there is a variety of questions which can be used[4]. The Xerostomia Inventory is a summated rating scale[5] which provides a single continuous scale score which represents the severity of chronic xerostomia, the underlying characteristic.

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The XI has been validated and used in a number of different studies to date[6–10]. The 11 items which make up the XI cover both experiential and behavioural aspects of the condition. However, despite the sound psychometric and statistical grounds for their inclusion in the original measure at that time, some of the 11 items (such as those pertaining to the eyes, nose or facial skin) appear to be superfluous and not directly related to dry mouth. There is a need to investigate whether shortening the measure by omitting those items unduly compromises its psychometric or statistical characteristics. A recent Dutch study[11] of 55 nursing home residents used such a shortened version, along with a reduction in Guttman-type response options from the usual five to three, occasioned by difficulties experienced by the participants in discriminating among the five response options. The findings of that study indicated that the shortened measure (dubbed the "Summated Xerostomia Inventory-Dutch Version") appeared to be valid, but that there is a need to determine the shortened measure's validity and properties in larger and more diverse samples and settings before any recommendations on its future use can be made.

The purpose of this study was to determine the validity and properties of the Summated Xerostomia Inventory-Dutch Version in samples from Australia, The Netherlands, Japan and New Zealand.

Methods

Data from studies of older people in Australia (South Australia and Melbourne), the Netherlands, Japan and New Zealand (two samples) were used in this study. Each is briefly described. All studies used the Xerostomia Inventory, although the Dutch study used the shortened version only.

The South Australian Dental Longitudinal Study (SADLS)

The South Australian Dental Longitudinal Study (SADLS) began in 1991, and is a prospective observational study of a representative cohort of older people (aged 60 or more) who were living in their own homes (in Adelaide and Mt Gambier) at baseline. The sampling strategy and data collection has been described previously[12]. Ethical approval was obtained from the University of Adelaide's Committee on the Ethics of Human Experimentation. Participants underwent an interview and dental examination at baseline, with assessments repeated two, five and 11 years afterward. Data used here are from the baseline assessment only.

The Dutch nursing home study

The Dutch cross-sectional nursing home study was carried out in a group of 50 physically impaired, mainly older residents. The population did not differ from other nursing homes in The Netherlands with respect to age, gender, main medical diagnoses, medication use, comorbidity, care dependency, and length of stay. Exclusion criteria were: apraxia, terminally ill, cognitive impairment, fever, dehydration, Sjögren's syndrome, and previously treatment with radiotherapy in the head and neck region. Resting, chewing- and acid-stimulated saliva was collected from the residents, the Xerostomia Inventory-Dutch version questionnaire was completed, and the Summated Xerostomia Inventory-Dutch version was assessed. The translation of the original questionnaire into Dutch was followed by back-translation in order to check that the items' original meaning had not been altered. The study design was reviewed and approved by a Medical Ethic Committee of The Netherlands. All subjects gave informed written consent about their participation in the study.

The Osaka study

Participants in this study were community-dwelling, independently living people over the age of 60 who attended weekly lectures at the Senior Citizens' College in Osaka. This college is one of the adult educational systems supported by the government of the Osaka prefecture, which enrolls volunteers for a period of one year. In 2005, at the end of a lecture on oral health issues, the study purpose and procedures were explained, and volunteers were sought to return on another day. The study protocol was approved by the Ethical Committee of Osaka University Graduate School of Dentistry. All participants gave written informed consent, after which they completed oral health questionnaires. For the Xerostomia Inventory, the translation of the original questionnaire into Japanese was followed by back-translation in order to check that the items' original meaning had not been altered. Following this, the Japanese version was pilot-tested with a small sample before field use.

The Melbourne study

In 2008–09, participants were recruited into a 12-month study to assess the impact of oral health education training for carers on the oral health of nursing home residents. A total of 500 residents from 20 randomly-selected nursing homes in Melbourne (Australia) gave consent to participate, and useable data for the Xerostomia Inventory were obtained from 245 of those. Participants underwent an interview and dental examination at baseline and again after 12 months. Data used here are from the baseline assessment only. This study was approved by the University of Melbourne Human Research Ethics Committee.

The New Zealand community sample

In 1997 and 1998, individuals were recruited for a short (6-month) longitudinal study of changes in xerostomia symptoms over time[8]. The study was approved by the Ethics Committees of New Zealand's 4 Regional Health Authorities, and written, informed consent was obtained from all participants. Two groups were chosen whose symptom trajectories were likely to differ substantially over the study period: the *Normal* group was a convenience sample of asymptomatic middle-aged and older individuals with otherwise stable perceptions of mouth dryness; and the *Onset* group comprised patients who were about to undergo radiotherapy for head/neck cancer (and would therefore be expected to develop more severe xerostomia after the baseline measurements). The former were recruited in Dunedin, while the latter were drawn from radiotherapy units at each of Auckland, Waikato, Palmerston North, Wellington, Christchurch and Dunedin hospitals, having first been approached by their dentist or physician. Recruitment of the *Normal* group (from the membership list of the Otago Medical Research Foundation Auxiliary) commenced when two-thirds of the *Onset* group had been recruited, so that the sex mix of the two groups would be similar, with twice as many males as females. The current analysis uses data from only the baseline stage of that study. The participants comprise a convenience sample rather than a representative one.

The New Zealand geriatric sample

During 2010, a consecutive clinical sample of 200 individuals referred as inpatients to Dunedin Hospital for geriatric assessment underwent a dental clinical assessment and interview. The study was approved by the Lower Southern Regional Ethics Committee. Useable data for the Xerostomia Inventory were obtained from 167 individuals; prior to admission, 38.3% had been living independently in their own homes, 58.1% had been living in their own homes with outside support, and 3.6% had been living in a nursing home. The participants comprise a convenience sample rather than a representative one.

The Xerostomia Inventory – original and shortened Dutch versions

The Xerostomia Inventory (XI) is an 11-item summated rating scale which combines the responses to 11 individual items into a single continuous scale score which represents the severity of chronic xerostomia; higher scores represent more severe symptoms. Respondents are asked to choose one of five responses ("Never", scoring 1; "Hardly ever", 2; "Occasionally", 3; "Fairly often", 4; and "Very often", 5) to the following statements referring to the previous 4 weeks: *I sip liquids to aid in swallowing food; my mouth feels dry when eating a meal; I get up at night to drink; my mouth feels dry; I have difficulty in eating dry foods; I suck sweets or cough lollies to relieve dry mouth; I have difficulties swallowing certain foods; the skin of my face feels dry; my eyes feel dry; my lips feel dry; and the inside of my nose feels dry*. Each individual's responses are scored and summed to give a single XI score. In the Summated Xerostomia Inventory-Dutch Version, five of those items (*my mouth feels dry when eating a meal; my mouth feels dry; I have difficulty in eating dry foods; I have difficulties swallowing certain foods;* and *my lips feel dry*) are used, with the respondent asked to choose one of three response options ("Never", scoring 1; "Occasionally", 2; and "Often", 5).

Data analyses

Confirmatory factor analyses were undertaken (using principal component analysis), after which reliability analyses were used to compute Cronbach's alpha. Summated Xerostomia Inventory-Dutch Version scale scores were then computed. Mean scores across the 4 categories of the global xerostomia item were computed and compared using analysis of variance. Using the New Zealand community sample data (because that study had a longitudinal component), the minimally important difference for change over time was determined from the mean change scores of those for whom "a little" improvement was reported. The latter was determined by examining the changes in response to the global xerostomia item at baseline and after two months.

Results

Data on the characteristics of the five data-sets are presented in Table 1. Sample size ranged from 50 (The Netherlands) to 637 (South Australia), with broadly similar age ranges (except for the NZ sample, which also included a 29-year-old). There were two institutionalised samples (Melbourne and The Netherlands) and three community-dwelling samples; only the South Australian sample was a representative one, but the data were not weighted for the current analysis. The proportion of females ranged from just under half (South Australia) to almost three-quarters (Melbourne).

Data on the outcome of the confirmatory factor analyses are presented in Table 2. Almost all of the data-sets revealed a single extracted factor which explained about half of the variance; there were satisfactory factor loadings for each of the five items. The internal reliability data were also acceptable, with Cronbach's alpha values of at least 0.70.

Data on the mean scale scores (and 95% CI) are presented by sample in Table 3. The mean scores were broadly similar, with the exception of the New Zealand community sample, which was higher than the others.

For four of the data-sets, mean Summated Xerostomia Inventory-Dutch Version scale scores are plotted against the global xerostomia item in Figure 1 in order to examine its criterion-related validity. Neither the Japanese study nor the Dutch one used both the XI and the standard question, so such a comparison was not possible with those data-sets. There were statistically significant gradients observed across the categories of the standard question. Those observed with the South Australian, Melbourne and NZ geriatric samples were very

similar; the NZ community one differed somewhat in both slope and magnitude, but the gradient was fundamentally the same, with the highest score seen in the 'Always' responders, and the lowest seen in the 'Never' group.

The minimally important difference was determined for the Summated Xerostomia Inventory-Dutch Version using the New Zealand community sample (the data for which were part of a longitudinal study used in determining the minimally important difference for the original XI[13]). It was found to be 4, indicating that a deterioration in Summated Xerostomia Inventory-Dutch Version scale score by 4 or more scale points can be considered to be clinically meaningful.

Discussion

This study aimed to examine the properties of the Summated Xerostomia Inventory-Dutch Version in a number of samples from Australia, The Netherlands, Japan and New Zealand. It has found that the reduced version of the instrument has acceptable psychometric properties and appears to be valid, at least with respect to self-reported oral dryness.

An examination of the study's weaknesses and strengths is appropriate before considering the findings. The non-representativeness of almost all of the samples is a weakness, because it means that the generalizability of the findings is limited. On the other hand, the relative uniformity of findings in using convenience samples from a number of different cultures is a strength, in that it suggests that the Summated Xerostomia Inventory-Dutch Version has validity in different settings and populations.

Turning to the findings, perhaps the first issue to be considered is whether the Xerostomia Inventory needed to be shortened in the first place. Typically, such scales are too long for practical field use, and an essential step in their development as suitable measures for day-to-day clinical and health services research use is the derivation of a short-form version which retains the most important properties and characteristics of the original form.[14] At 11 items, the original Xerostomia Inventory did not impose an onerous burden on respondents, but it could be argued that some of the items lacked face validity (such as *The skin of my face feels dry* and *My eyes feel dry*). Others were more appropriate to a behavioural checklist (such as *I get up at night to drink*, *I sip liquids to aid in swallowing food* and *I suck sweets or cough lollies to relieve dry mouth*). The Summated Xerostomia Inventory-Dutch Version was developed in order to eliminate those items and concentrate on the experiential aspects of dry mouth, and this is reflected in the five items which comprise it. We feel that the shorter measure has considerably better face validity than the original because the items are more salient. This should enhance the Xerostomia Inventory's acceptability to clinicians and researchers who are considering using it.

The measure was further shortened in these analyses by reducing the number of Guttman-type response options for the items from five to three. This was done in the Dutch study[11] because the participants found it difficult to distinguish the five response options, and we repeated it in the secondary analyses of the data from the other four studies. Was this likely to have affected the discriminative properties of the measure? The literature is surprisingly sparse on this issue. Reducing the number of options will, of course, reduce the variance in scores, but it could be argued that it is not likely to have compromised the measure's ability to discriminate among those with differing dry mouth severity. We were able to compare the 3-option scale scores with the 5-option scores in the data-sets for South Australia and the two New Zealand samples, and, not surprisingly, found Pearson correlations greater than 0.92 for those. Moreover, in comparing the standard xerostomia question and the 3-option and 5-option XI scale scores, we found that Spearman correlation coefficients for these did

not differ by more than 0.03. These findings suggest that the properties of the scale were not compromised by reducing the number of response options available to respondents. Work with the longitudinal data-set used in the New Zealand sample enabled determination of the minimally important difference for changes in scores over time, as was done for the longer measure.[13] It was 6 for the latter and 4 for the new version, reflecting the change in scoring. That an increase in score of 4 points appears to be clinically meaningful requires replication in other studies and settings.

The number of items or response options notwithstanding, the scores in Table 3 were broadly similar (with the exception of one sample), and suggest that a Summated Xerostomia Inventory-Dutch Version score of 8 is typical. Validation of the Summated Xerostomia Inventory-Dutch Version was done in the current study by examining mean scale scores across the four categories of a standard xerostomia question. While the observed gradients suggest that the newer measure is indeed valid, examination of its association with objectively-determined salivary flow rates in a population-based sample would be useful. It is recommended that (as with the original Xerostomia Inventory) the measure is used in tandem with the standard xerostomia question *How often does your mouth feel dry?* (response options 'Never', 'Occasionally', 'Frequently' and 'Always') in order to provide a validity check.

In summary, the Summated Xerostomia Inventory-Dutch Version has been tested in a number of diverse samples and appears to be a valid measure for discriminative use in clinical and epidemiological research.

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References

1. Ikebe K, Morii K, Kashiwagi J, Nokubi T, Ettinger RL. Impact of dry mouth on oral symptoms and function in removable denture wearers in Japan. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2005; 99:704–10. [PubMed: 15897857]
2. Locker D. Dental status, xerostomia and the oral health-related quality of life of an elderly institutionalized population. Spec Care Dentist. 2003; 23:86–93. [PubMed: 14650556]
3. Thomson WM, Lawrence HP, Broadbent JM, Poulton R. The impact of xerostomia on oral-health-related quality of life among younger adults. Health Qual Life Outcomes. 2006; 4:86. [PubMed: 17090332]
4. Thomson WM. Issues in the epidemiological investigation of dry mouth. Gerodontol. 2005; 22:65–76.
5. Thomson WM, Chalmers JM, Spencer AJ, Williams SM. The Xerostomia Inventory: a multi-item approach to measuring dry mouth. Community Dent Health. 1999; 16:12–7. [PubMed: 10697349]
6. Johnstone PAS, Peng YP, May BC, Inouye WS, Niemtzow RC. Acupuncture for pilocarpine-resistant xerostomia following radiotherapy for head and neck malignancies. Int J Radiat Oncol Biol Phys. 2001; 50:353–7. [PubMed: 11380221]

7. Bots CP, Brand HS, Veerman ECI, Korevaar JC, Valentijn-Benz M, Bezemer PD, et al. Chewing gum and a saliva substitute alleviate thirst and xerostomia in patients on haemodialysis. Nephrol Dial Transplant. 2005; 20:578–84. [PubMed: 15665029]
8. Thomson WM, Williams SM. Further testing of the xerostomia inventory. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2000; 89:46–50. [PubMed: 10630941]
9. Thomson WM, Spencer AJ, Chalmers JM, Slade GD. Is medication a risk factor for dental caries among older people? Evidence from a longitudinal study in South Australia. Community Dent Oral Epidemiol. 2002; 30:224–32. [PubMed: 12000346]
10. Thomson WM, Chalmers JM, Spencer AJ, Slade GD. Medication and dry mouth: findings from a cohort study of older people. J Public Health Dent. 2000; 60:12–20. [PubMed: 10734611]
11. van der Putten G-J, Brand HS, Schools JMGA, de Baat C. The diagnostic suitability of a xerostomia questionnaire and the association between xerostomia, hyposalivation and medication use in a group of nursing home residents. Clin Oral Investig. 2010 In press (Published online ahead of print).
12. Slade GD, Spencer AJ. Development and evaluation of the Oral Health Impact Profile. Community Dent Health. 1994; 11:3–11. [PubMed: 8193981]
13. Thomson WM. Measuring change in dry-mouth symptoms over time using the Xerostomia Inventory. Gerodontol. 2007; 24:30–5.
14. Slade GD. Derivation and validation of a short-form oral health impact profile. Community Dent Oral Epidemiol. 1997; 25:284–90. [PubMed: 9332805]

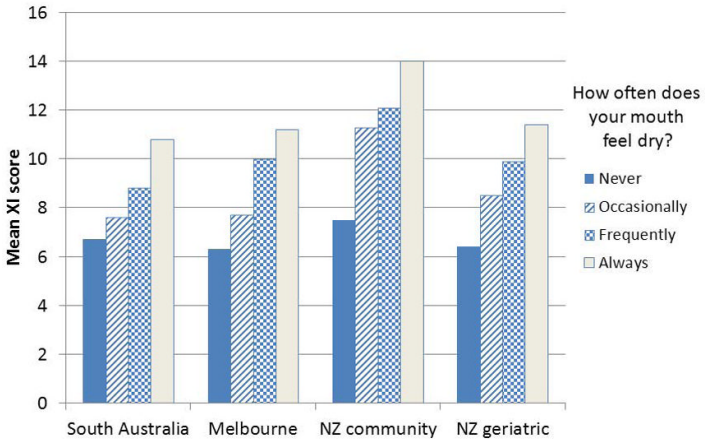

Figure 1.
Mean XI-Dutch scores by xerostomia standard question response categories.

Table 1

Characteristics of the participants, by study.

	South Australia	The Netherlands	Melbourne, Australia	Osaka, Japan	NZ community sample	NZ geriatric sample
Number of participants	637	50	245	401	86	167
Number of females (%)	291 (45.7)	30 (60.0)	169 (70.1)	206 (51.4)	28 (32.6)	97 (58.1)
Mean age (SD)	70 (7)	78 (10)	84 (9)	66 (4)	72 (10)	82 (6)
Age range	60–95	53–98	51–103	60–84	50–90	65–98
Nature of sample	Community-dwelling	Institutionalised	Institutionalised	Community-dwelling	Community-dwelling	Being assessed for hospital care[1]
Representative sample?	Yes	No	No	No	No	No

[1] Most had been living in their own homes prior to admission

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Table 2

Outcomes of confirmatory factor analyses for the shortened version, by study

	The Netherlands	South Australia	Melbourne, Australia	Osaka, Japan	Community group, New Zealand[1]	Geriatric group, New Zealand
Items and factor loadings						
My mouth feels dry when eating a meal	0.712	0.800	0.804	0.700	0.798	0.744
My mouth feels dry	0.742	0.673	0.673	0.736	0.738	0.750
I have difficulty in eating dry foods	0.565	0.785	0.727	0.724	0.766	0.794
I have difficulties swallowing certain foods	0.679	0.781	0.686	0.651	0.755	0.750
My lips feel dry	0.755	0.611	0.603	0.600	0.671	0.619
Meta data						
Number of factors extracted	1	1	1	1	1	1
Percent of variance explained	48.2	53.9	49.3	46.8	55.8	53.8
Eigenvalue	2.4	2.7	2.5	2.3	2.8	2.7
Cronbach's alpha	0.72	0.78	0.74	0.70	0.80	0.78

[1] For the NZ community group data, there were minor differences between the *Onset* and *Normal* groups (see Methods for description of these), with factor loadings of 0.785, 0.732, 0.704, 0.682 and 0.659 (*Onset*, explaining 50.9% of the variance) and 0.813, 0.750, 0.829, 0.846 and 0.746 (*Normal*, explaining 63.7% of the variance) respectively

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Table 3

Summary data on the Summated Xerostomia Inventory-Dutch Version, by study

	Mean XI-Dutch score (95% CI)	Range of scores
The Netherlands	7.8 (7.1, 8.5)	5 to 15
South Australia	7.6 (7.4, 7.8)	5 to 15
Melbourne, Australia	8.1 (7.8, 8.4)	5 to 15
Osaka, Japan	8.7 (8.5, 8.9)	5 to 15
NZ community sample	9.8 (9.1, 10.5)	5 to 15
NZ geriatric sample	8.6 (8.2, 9.0)	5 to 15