Objectives. The aim 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.

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

Results. All datasets revealed a single extracted factor which explained about one-half of the variance, with Cronbach alpha values ≥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.


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 that can be used.4 The Xerostomia Inventory (XI) is a summated rating scale5 that provides a single continuous scale score which represents the severity of chronic xerostomia, the underlying characteristic.

The XI has been validated and used in a number of different studies.6-10 The 11 items which make up the XI cover both experiential and behavioral 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 sta-
tistical characteristics. A recent Dutch study of 55 nursing home residents used such a shortened version, along with a reduction in Guttman-type response options from the usual 5 to 3, occasioned by difficulties experienced by the participants in discriminating among the 5 response options. The findings of that study indicated that the shortened measure (dubbed the “Summated Xerostomia Inventory–Dutch Version” [SXI-D]) appeared to be valid but that there was 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 the present 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.

MATERIAL AND METHODS

Data from studies of older people in Australia (2 samples: South Australia and Melbourne), The Netherlands, Japan, and New Zealand (2 samples) were used in this study. Each is briefly described. All studies used the XI, although the Dutch study used the shortened version only.

The South Australian Dental Longitudinal Study (SADLS)

The SADLS began in 1991, and is a prospective observational study of a representative cohort of older people (aged ≥60 years) who were living in their own homes (in Adelaide and Mt. Gambier) at baseline. The sampling strategy and data collection has been described previously. 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 2, 5, and 11 years afterward. Data used here are from the baseline assessment only.

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 regarding age, gender, main medical diagnoses, medication use, comorbidity, care dependency, and length of stay. Exclusion criteria were apraxia, terminal illness, cognitive impairment, fever, dehydration, Sjögren syndrome, and previously treatment with radiotherapy in the head and neck region. Resting and chewing- and acid-stimulated saliva was collected from the residents, the XI–Dutch Version questionnaire was completed, and the SXI-D was assessed. The translation of the original questionnaire into Dutch was followed by back-translation to check that the items’ original meaning had not been altered. The study design was reviewed and approved by a Medical Ethics Committee of The Netherlands. All participants gave informed written consent for their participation in the study.

Osaka study

Participants in this study were community-dwelling independently living people ≥60 years old 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 1 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 XI, the translation of the original questionnaire into Japanese was followed by back-translation 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.

Melbourne study

In 2008-2009, 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 their consent to participate, and useable data for the XI 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.

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. The study was approved by the Ethics Committees of New Zealand’s 4 Regional Health Authorities, and written informed consent was obtained from each of the 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 com-
prised 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, whereas 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, such that the gender mix of the 2 groups would be similar, with twice as many men as women. The current analysis uses data from only the baseline stage of that study. The participants comprise a convenience sample rather than a representative one.

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 XI were obtained from 167 individuals; before 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 versions

The 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 1 of 5 responses (“Never,” scoring 1; “Hardly ever,” 2; “Occasionally,” 3; “Fairly often,” 4; and “Very often,” 5) to the following statements referring to the preceding 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; the inside of my nose feels dry. Each individual’s responses are scored and summed to give a single XI score. In the SXI-D, only 5 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; my lips feel dry) are used, with the respondent asked to choose 1 of 3 response options (“Never,” scoring 1; “Occasionally,” 2; and “Often,” 3). In the secondary analyses of the non-Dutch data-sets, the original XI responses were recoded for consistency with the shortened Dutch version, as follows: 1 through 3; and 4 through 5.

Data analyses

Confirmatory factor analyses were undertaken (using principal component analysis), after which reliability analyses were used to compute Cronbach alpha. SXI-D 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 2 months.

RESULTS

Data on the characteristics of the 5 datasets are presented in Table 1. Sample sizes ranged from 50 (The Netherlands) to 637 (South Australia), with broadly similar age ranges. There were 2 institutionalized samples (Melbourne and The Netherlands) and 3 community-
dwelling samples; only the South Australian sample was a representative one, but the data were not weighted for the present analysis. The proportion of women ranged from just under one-half (South Australia) to almost three-fourths (Melbourne).

Data on the outcome of the confirmatory factor analyses are presented in Table II. All of the datasets revealed a single extracted factor that explained about one-half of the variance; there were satisfactory factor loadings for each of the 5 items. The internal reliability data were also acceptable, with Cronbach alpha values ≥0.70.

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

For 4 of the datasets, mean SXI-D scale scores are plotted against the global xerostomia item in Fig. 1 to examine its criterion-related validity. Neither the Japanese nor the Dutch study used both the XI and the standard question, so such a comparison was not possible with those datasets. There were statistically significant gradients observed across the categories of the standard question. Those observed with the South Australian, Melbourne, and New Zealand geriatric samples were very similar; the New Zealand 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 SXI-D 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 XI13). It was found to be 4, indicating that a deterioration in SXI-D scale score by ≥4 scale points can be considered to be clinically meaningful.

DISCUSSION

This study aimed to examine the properties of the SXI-D in a number of samples from Australia, The Netherlands, Japan, and New Zealand. It has

Table II. Outcomes of confirmatory factor analyses for the shortened version by study

<table>
<thead>
<tr>
<th></th>
<th>The Netherlands</th>
<th>South Australia</th>
<th>Melbourne, Australia</th>
<th>Osaka, Japan</th>
<th>New Zealand community sample</th>
<th>New Zealand geriatric sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Items and factor loadings</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My mouth feels dry when eating a meal</td>
<td>0.712</td>
<td>0.800</td>
<td>0.804</td>
<td>0.700</td>
<td>0.798</td>
<td>0.744</td>
</tr>
<tr>
<td>My mouth feels dry</td>
<td>0.742</td>
<td>0.673</td>
<td>0.673</td>
<td>0.736</td>
<td>0.738</td>
<td>0.750</td>
</tr>
<tr>
<td>I have difficulty in eating dry foods</td>
<td>0.565</td>
<td>0.785</td>
<td>0.727</td>
<td>0.724</td>
<td>0.766</td>
<td>0.794</td>
</tr>
<tr>
<td>I have difficulties swallowing certain foods</td>
<td>0.679</td>
<td>0.781</td>
<td>0.686</td>
<td>0.651</td>
<td>0.755</td>
<td>0.750</td>
</tr>
<tr>
<td>My lips feel dry</td>
<td>0.755</td>
<td>0.611</td>
<td>0.603</td>
<td>0.600</td>
<td>0.671</td>
<td>0.619</td>
</tr>
<tr>
<td>Metadata</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No. of factors extracted</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Percent of variance explained</td>
<td>48.2</td>
<td>53.9</td>
<td>49.3</td>
<td>46.8</td>
<td>55.8</td>
<td>53.8</td>
</tr>
<tr>
<td>Eigenvalue</td>
<td>2.4</td>
<td>2.7</td>
<td>2.5</td>
<td>2.3</td>
<td>2.8</td>
<td>2.7</td>
</tr>
<tr>
<td>Cronbach alpha</td>
<td>0.72</td>
<td>0.78</td>
<td>0.74</td>
<td>0.70</td>
<td>0.80</td>
<td>0.78</td>
</tr>
</tbody>
</table>

For the New Zealand community data, there were minor differences between the “onset” and “normal” groups (see Methods for description), with factor loadings of, respectively, 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).

Table III. Summary data on the Summated Xerostomia Inventory–Dutch Version by study

<table>
<thead>
<tr>
<th></th>
<th>Mean (95% CI)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Netherlands</td>
<td>7.8 (7.1-8.5)</td>
<td>5-15</td>
</tr>
<tr>
<td>South Australia</td>
<td>7.6 (7.4-7.8)</td>
<td>5-15</td>
</tr>
<tr>
<td>Melbourne, Australia</td>
<td>8.1 (7.8-8.4)</td>
<td>5-15</td>
</tr>
<tr>
<td>Osaka, Japan</td>
<td>8.7 (8.5-8.9)</td>
<td>5-15</td>
</tr>
<tr>
<td>New Zealand community sample</td>
<td>9.8 (9.1-10.5)</td>
<td>5-15</td>
</tr>
<tr>
<td>New Zealand geriatric sample</td>
<td>8.6 (8.2-9.0)</td>
<td>5-15</td>
</tr>
</tbody>
</table>

CI, confidence interval.

Fig. 1. Mean Xerostomia Inventory–Dutch (XI) scores by xerostomia standard question response categories.
found that the shortened version of the instrument has acceptable psychometric properties and appears to be valid, at least regarding self-reported oral dryness.

An examination of the study’s weaknesses and strengths is appropriate before considering the findings. The nonrepresentativeness 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 SXI-D has validity in different settings and populations.

Turning to the findings, perhaps the first issue to be considered is whether the XI 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. At 11 items, the original XI 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 behavioral 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 SXI-D was developed to eliminate those items and concentrate on the experiential aspects of dry mouth, and this is reflected in the 5 items that compose 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 XI’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 5 to 3. This was done in the Dutch study because the participants found it difficult to distinguish the 5 response options, and we repeated it in the secondary analyses of the data from the other 4 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 reduces 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 datasets for South Australia and the 2 New Zealand samples and, not surprisingly, found Pearson correlations >0.92. 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 dataset 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. 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 III were broadly similar (with the exception of 1 sample), and suggest that a SXI-D score of 8 is typical. Validation of the SXI-D was done in the present study by examining mean scale scores across the 4 categories of a standard xerostomia question. Although 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 (as with the original XI) that 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”) to provide a validity check.

In summary, the SXI-D has been tested in a number of diverse samples and appears to be a valid measure for discriminative use in clinical and epidemiologic research.

The authors acknowledge Dr. Mihiri Narayan for collecting the data in the Melbourne study. Professors A.J. Spencer and G.D. Slade are thanked for approving the use of the SADLS data.

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