PATIENT-REPORTED OUTCOMES

Are English and Chinese Versions of the Audit of Diabetes-Dependent Quality of Life Equivalent? An Exploratory Study Based on the Universalist Approach

Xu-Hao Zhang, PhD1, Kevin Tan, FRCP, FAMS2, Huwe-Huan Tan, MRCP3, Julian Thumboo, FRCP4,5, Shu-Chuen Li, PhD6,*

1Department of Pharmacy, National University of Singapore, Singapore; 2Diabetic Society of Singapore, Singapore; 3SingHealth Polyclinics, Singapore; 4Department of Rheumatology and Immunology, Singapore General Hospital, Singapore; 5Department of Medicine, National University of Singapore, Singapore; 6Discipline of Pharmacy and Experimental Pharmacology, School of Biomedical Sciences and Pharmacy, University of Newcastle, Callaghan, Australia

ABSTRACT

Objective: To translate and culturally adapt the UK English Audit of Diabetes-Dependent Quality of Life (ADDQOL) into Chinese for Singapore. Methods: Translation was integrated into investigation of conceptual, item, semantic, and operation equivalence. Conceptual equivalence, item equivalence, and operation equivalence were assessed by literature review, expert judgment, and cognitive debriefing. Semantic equivalence was studied by using an optimized procedure including forward and backward translation, clinician review, and cognitive debriefings. Cognitive debriefings were done with five Chinese-speaking diabetic patients at polyclinics. Reliability, responsiveness, and construct validity tests were used to evaluate measurement equivalence. English- and Chinese-speaking diabetic patients by convenient sampling at a Diabetes Society of Singapore’s public event were recruited for the measurement equivalence study. Mann-Whitney U tests, chi-square tests, and descriptive analyses were used for group comparisons and Spearman’s correlation coefficients for construct validity tests. Results: Forty-two English-speaking and 26 Chinese-speaking diabetic patients (45.5% females) with a mean age of 54.2 ± 10.07 years were recruited. Chinese-speaking respondents were more likely than the English-speaking group to be unemployed, less educated, and with poorer family functioning (P < 0.05). Conceptual equivalence, item equivalence, operation equivalence, and semantic equivalence were all demonstrated. Cronbach’s alpha for internal consistency and intraclass correlation coefficient for test-retest reliability were 0.94 and 0.65, respectively. Distributions of responses were found to be similar except for some difference that can be justified by different demographic background. Convergent validity was suggested by weak to moderate correlations between “Present QOL” on the ADDQOL and EuroQol five-dimensional questionnaire (r = 0.268; P = 0.185) and six-dimensional health state short form (derived from short form 36 health survey) scores (r = 0.351; P = 0.078); divergent validity was shown by a weak correlation between ADDQOL average weighted impact (AWI) and ADDQOL “Present QOL” scores (r = 0.027, P = 0.896), a moderate correlation between ADDQOL AWI and six-dimensional health state short form (derived from short form 36 health survey) mental scores (r = 0.247; P = 0.224), and a positive correlation between ADDQOL AWI and family functioning scores (r = 0.288; P = 0.182). Conclusions: The ADDQOL has been translated and culturally adapted successfully into a Chinese version for Singapore. Our study provides justification for further research with large sample sizes among the Chinese-speaking population in Singapore. Keywords: diabetes, equivalence, quality of life, translation.

Copyright © 2012, International Society for Pharmacoeconomics and Outcomes Research (ISPOR). Published by Elsevier Inc.

Introduction

The Audit of Diabetes-Dependent Quality of Life (ADDQOL) is a valid and reliable diabetes-specific quality of life (QOL) measure originally developed in the United Kingdom. It has two distinguishing features: one is to allow patients to indicate which aspects of life do not apply to them by using the “not applicable” (N/A) options; the other is the application of importance ratings of each domain so as to give a weighted score in the end [1]. The English version of the ADDQOL was culturally well adapted for use in Singapore without any modification, and the equivalence between the adapted and the original version was also demonstrated [2]. To date, however, a Chinese version of ADDQOL was not available. In Singapore itself, about 32% of the local ethnic Chinese are monolingual in Chinese [3]. Given the large number of monolingual Chinese-speaking diabetes patients in Singapore and the importance of cross-cultural data pooling and comparisons in health-related quality-of-life (HRQOL) studies, it is very important to have a well-adapted and validated Chinese version of ADDQOL for Singapore [4].

Conflicts of interest: The authors have indicated that they have no conflicts of interest with regard to the content of this article.

* Address correspondence to: Shu-Chuen Li, Discipline of Pharmacy and Experimental Pharmacology, School of Biomedical Sciences and Pharmacy, University of Newcastle, Callaghan, NSW 2308, Australia.

E-mail: Shuchuen.li@newcastle.edu.au.

2212-1099/$36.00 – see front matter Copyright © 2012, International Society for Pharmacoeconomics and Outcomes Research (ISPOR). Published by Elsevier Inc.

doi:10.1016/j.vhri.2012.03.005
A universalist approach to the cross-cultural adaptation of HRQOL instruments proposed by Herdman et al. [5] suggests that a questionnaire is not suitable for translation into the target language before conceptual equivalence and item equivalence are demonstrated. The universalist model of cross-cultural adaptation criticized a commonly used approach, where translation is completed first and then post hoc analysis is performed to demonstrate equivalence, especially the measurement equivalence. According to the universalist approach, six types of equivalence should be investigated in sequence as follows: 1) conceptual equivalence to investigate which domains are important to the concept in the target culture and the relationships between them, which can be achieved by reviewing local literature, consulting experts in the target culture, and discussing with target group; 2) item equivalence to critically examine the items used to tap those domains as the relevance of items may vary across cultures, which can also be achieved by literature review, expert judgment, and assessment by target population; 3) semantic equivalence to ensure that any translation that takes place leads to semantically equivalent items with the recommended translation process, which is to be done according to the following steps: initial discussion with the developer about the underlying concept (this step should be completed in the phase of “conceptual equivalence”), forward translation, backward translation, cognitive debriefing (CD), harmonization review, feedback by developer, revision, and proofreading and approval of final version by the developer [6]; 4) operational equivalence to ensure that the measurement methods used are appropriate to the culture in question, which can be investigated by using similar methods as mentioned in “item equivalence”; 5) measurement equivalence to examine the outcome of the process in terms of instrument behavior; reliability, responsiveness, construct validity (convergent and divergent validity, known-group validity) [3] tests are often used; and 6) functional equivalence to summarize the above-mentioned types of equivalence [5,6].

The purpose of this study was to translate and culturally adapt the English ADDQOL into Chinese for use in Singapore with the universalist approach. Because the English ADDQOL was previously adapted in Singapore without any modification, the one used for adaptation in our study was actually the same as the original UK version.

As for the tests of construct validity, the following four a priori hypotheses were generated on the basis of literature review:

I. Convergent and divergent validity
   1. An assumption that the “Present HRQOL” score will correlate moderately with the EuroQol five-dimensional questionnaire (EQ-5D) utility, six-dimensional health state short form (derived from short form 36 health survey) (SF-6D), and visual analogue scale scores [7,8].
   2. The ADDQOL mean weighted score will correlate moderately with “HRQOL without diabetes mellitus” and correlate weakly with the “Present HRQOL” score [9].

II. Known-group validity
   1. Participants who are more depressed (the score in the mental health in SF-6D) will have poorer ADDQOL scores [10].
   2. Participants who have better family functioning (higher score in family function measure [FFM]) will have better ADDQOL mean weighted scores [11].

### Methods

#### Study design and participants

The first part of the study was to use the universalist approach in translating and culturally adapting the English ADDQOL into a Chinese version. The second part of the study involved pilot testing the adapted Chinese version and evaluation of its equivalence with the English version.

Conceptual, item, and operational equivalence was assessed in the first part by local literature review, expert judgment, and CD among target subjects. Semantic equivalence was studied according to the recommended translation procedure, which will be described in the translation part of the methodology. Two local bilingual (Chinese and English) clinical experts in diabetes were involved in the judgment. Five native consented Chinese-speaking diabetic patients were recruited for the CD during the whole process of the first part.
Measurement equivalence was investigated by a pilot cross-sectional study as the second part. Inclusion criteria were English-speaking or Chinese-speaking Singaporean patients with diabetes (type 1 or type 2) aged 21 years and above who were able to complete questionnaires without any assistance. Participants who consented were asked to complete a booklet containing a demographic datasheet, diabetes knowledge test sheet (the results of which were used for another study), FFM, and a battery of HRQOL instruments including ADDQOL and two other generic measures (SF-6D and the EQ-5D questionnaire). Consented participants of the retest were mailed with a similar set of questionnaire 1 week later to evaluate the test-retest reliability.

Translation

Initial discussion with the developer, forward translation, cognitive briefing, backward translation, harmonization review, feedback, and approval by original developer were sequentially conducted for the entire translation process (the detailed translation process is described in Supplemental Materials found at doi:10.1016/j.vhri.2012.03.005).

Instrument

The ADDQOL

ADDQOL-13.3.03 is a 19-domain disease-specific instrument designed to measure individuals’ perception of the impact of diabetes on their QOL. It begins with two items assessing “present QOL” and “diabetes-dependent QOL.” The subsequent items are related to the 19 domains of working life, family life, social life, physical functioning, dietary freedom, and so on [2,3]. The impact of each domain is scored on a five-point scale (from 1 to 5). The corresponding importance is rated on a four-point scale (0 to 3). The weighted score of each domain is calculated by multiplying the impact and importance rating (−9 to +3). Of the 19 domains, there are five with N/A options. These N/A items were scored as missing values. As a result, domains that are not important to respondents are excluded from the mean ADDQOL weighted score. Last, the mean weighted score is converted to a final score on a 0 to 100 scale. A higher score indicates a better HRQOL.

The EQ-5D questionnaire, SF-6D, and FFM are described in Supplemental Materials found at doi:10.1016/j.vhri.2012.03.005 [12-22].

Statistical analysis

Data collected from the second part of the study were entered into an Excel spreadsheet (Microsoft Corporation, Redmond, WA) and analyzed by using the Statistical Package for the Social Sciences, version 12.0 (SPSS, Inc., Chicago, IL). Subjects with 6 or more missing items in ADDQOL or 1 or more missing value in the EQ-5D questionnaire or SF-6D were excluded from all analyses.

Group comparisons were made by using nonparametric tests with Mann-Whitney U tests for quantitative data and chi-square tests for qualitative data. Cronbach’s alpha and the intraclass correlation coefficient were calculated for internal consistency and test-retest reliability, respectively. Response distribution for each item, use of N/A options, and item ranking (weighted, unweighted, and change in order of ranking) were compared between two language groups as responsiveness tests, during which descriptive analyses and group comparisons were carried out. Spearman’s correlation coefficients were used to investigate construct validity. Statistical significance was set at P < 0.05 for the data analysis, and P < 0.01 or P < 0.001 was also reported where applicable.

Results

Characteristics of the subjects

Altogether 56 eligible English-speaking participants and 32 eligible Chinese-speaking participants were recruited in the study. During data analysis, 14 English-speaking participants and 6 Chinese-speaking participants were dropped because of incomplete responses as defined previously, leaving 68 participants (42 English-speaking participants and 26 Chinese-speaking participants) with complete responses for analysis. Table 1 shows respondents’ characteristics and scores of FFM and other measures.

Respondents who completed the Chinese ADDQOL were more likely to be unemployed (P < 0.01), have received fewer years of

<table>
<thead>
<tr>
<th>Item</th>
<th>Scale mean if item deleted</th>
<th>Scale variance if item deleted</th>
<th>Corrected item-total correlation</th>
<th>Squared multiple correlation</th>
<th>Cronbach’s alpha if item deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family life</td>
<td>-65.11</td>
<td>1419.23</td>
<td>0.36</td>
<td>0.51</td>
<td>0.94</td>
</tr>
<tr>
<td>Friendship and social life</td>
<td>-66.33</td>
<td>1385.02</td>
<td>0.60</td>
<td>0.88</td>
<td>0.94</td>
</tr>
<tr>
<td>Close personal relationship</td>
<td>-66.65</td>
<td>1371.92</td>
<td>0.60</td>
<td>0.88</td>
<td>0.94</td>
</tr>
<tr>
<td>Sex life</td>
<td>-67.44</td>
<td>1410.69</td>
<td>0.42</td>
<td>0.86</td>
<td>0.94</td>
</tr>
<tr>
<td>Physical appearance</td>
<td>-65.85</td>
<td>1346.78</td>
<td>0.66</td>
<td>0.83</td>
<td>0.94</td>
</tr>
<tr>
<td>Physical health</td>
<td>-66.52</td>
<td>1381.10</td>
<td>0.73</td>
<td>0.91</td>
<td>0.94</td>
</tr>
<tr>
<td>Work (employment)</td>
<td>-67.10</td>
<td>1368.00</td>
<td>0.57</td>
<td>0.88</td>
<td>0.94</td>
</tr>
<tr>
<td>Holiday</td>
<td>-66.73</td>
<td>1369.09</td>
<td>0.71</td>
<td>0.93</td>
<td>0.94</td>
</tr>
<tr>
<td>Leisure activities</td>
<td>-66.90</td>
<td>1375.88</td>
<td>0.67</td>
<td>0.96</td>
<td>0.94</td>
</tr>
<tr>
<td>Journeys</td>
<td>-66.20</td>
<td>1326.44</td>
<td>0.90</td>
<td>0.96</td>
<td>0.94</td>
</tr>
<tr>
<td>Self-confidence</td>
<td>-65.54</td>
<td>1286.34</td>
<td>0.82</td>
<td>0.90</td>
<td>0.94</td>
</tr>
<tr>
<td>Motivation</td>
<td>-66.12</td>
<td>1337.87</td>
<td>0.75</td>
<td>0.93</td>
<td>0.94</td>
</tr>
<tr>
<td>People’s reactions</td>
<td>-66.22</td>
<td>1312.41</td>
<td>0.81</td>
<td>0.97</td>
<td>0.94</td>
</tr>
<tr>
<td>Feelings about the future</td>
<td>-65.42</td>
<td>1335.29</td>
<td>0.82</td>
<td>0.97</td>
<td>0.94</td>
</tr>
<tr>
<td>Financial situation</td>
<td>-65.31</td>
<td>1295.02</td>
<td>0.90</td>
<td>0.97</td>
<td>0.94</td>
</tr>
<tr>
<td>Dependence on others</td>
<td>-66.48</td>
<td>1338.65</td>
<td>0.67</td>
<td>0.77</td>
<td>0.94</td>
</tr>
<tr>
<td>Living condition</td>
<td>-66.28</td>
<td>1314.90</td>
<td>0.80</td>
<td>0.95</td>
<td>0.94</td>
</tr>
<tr>
<td>Freedom to eat</td>
<td>-65.25</td>
<td>1384.91</td>
<td>0.48</td>
<td>0.93</td>
<td>0.94</td>
</tr>
<tr>
<td>Freedom to drink</td>
<td>-66.29</td>
<td>1422.88</td>
<td>0.33</td>
<td>0.96</td>
<td>0.95</td>
</tr>
</tbody>
</table>

Note. Cronbach’s alpha = 0.94; standardized item Cronbach’s alpha = 0.94. ADDQOL, Audit of Diabetes-Dependent Quality of Life.
<table>
<thead>
<tr>
<th>Domain</th>
<th>Impact scores unweighted</th>
<th>Importance ratings</th>
<th>Impact scores weighted by importance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min., Max. Mean ± SD P</td>
<td>Min., Max. Mean ± SD P</td>
<td>Min., Max. Mean ± SD P</td>
</tr>
<tr>
<td></td>
<td>English Chinese</td>
<td>English Chinese</td>
<td>English Chinese</td>
</tr>
<tr>
<td>Family life</td>
<td>−3.0 −3.0 −1.44 ± 1.10</td>
<td>0.3 1.3 2.38 ± 0.85</td>
<td>−3.81 ± 3.29 −4.79 ± 2.92 0.218</td>
</tr>
<tr>
<td>Friendship and social life</td>
<td>−3.0 −3.0 −1.33 ± 1.14</td>
<td>0.3 1.3 2.14 ± 0.65</td>
<td>−3.14 ± 3.05 −3.58 ± 2.61 0.549</td>
</tr>
<tr>
<td>Close personal relationship</td>
<td>−3.0 −3.0 −1.14 ± 1.12</td>
<td>0.3 0.3 1.95 ± 0.99</td>
<td>−2.79 ± 2.93 −3.25 ± 2.86 0.524</td>
</tr>
<tr>
<td>Sex life</td>
<td>−3.0 −3.0 −0.93 ± 1.02</td>
<td>0.3 0.3 1.40 ± 1.06</td>
<td>−1.76 ± 2.20 −2.46 ± 2.82 0.257</td>
</tr>
<tr>
<td>Physical appearance</td>
<td>−3.1 −3.0 −1.19 ± 1.11</td>
<td>0.3 0.3 2.02 ± 0.87</td>
<td>−2.88 ± 3.16 −4.16 ± 3.11 0.138</td>
</tr>
<tr>
<td>Physical health</td>
<td>−3.0 −3.0 −1.45 ± 1.02</td>
<td>1.3 0.3 2.02 ± 0.56</td>
<td>−3.07 ± 2.52 −3.38 ± 2.25 0.606</td>
</tr>
<tr>
<td>Work (employment)</td>
<td>−3.0 −3.0 −1.02 ± 1.14</td>
<td>0.3 0.3 1.60 ± 1.19</td>
<td>−3.36 ± 3.13 −2.81 ± 3.10 0.564</td>
</tr>
<tr>
<td>Holiday</td>
<td>−3.0 −3.0 −1.45 ± 1.15</td>
<td>0.3 0.3 1.83 ± 1.03</td>
<td>−3.14 ± 2.88 −3.17 ± 2.52 0.965</td>
</tr>
<tr>
<td>Leisure activities</td>
<td>−3.0 −3.0 −1.40 ± 1.04</td>
<td>1.3 0.3 2.05 ± 0.62</td>
<td>−3.07 ± 2.70 −3.00 ± 2.51 0.914</td>
</tr>
<tr>
<td>Local or long distance journeys</td>
<td>−3.0 −3.0 −1.64 ± 1.01</td>
<td>0.3 0.3 1.79 ± 0.81</td>
<td>−3.21 ± 2.82 −3.62 ± 2.73 0.566</td>
</tr>
<tr>
<td>Self-confidence</td>
<td>−3.0 −3.0 −1.48 ± 1.09</td>
<td>1.3 0.3 2.31 ± 0.64</td>
<td>−3.81 ± 3.20 −4.37 ± 3.25 0.492</td>
</tr>
<tr>
<td>Motivation</td>
<td>−3.0 −3.0 −1.38 ± 0.91</td>
<td>1.3 0.3 2.12 ± 0.74</td>
<td>−3.07 ± 2.42 −3.79 ± 2.95 0.280</td>
</tr>
<tr>
<td>People’s reaction</td>
<td>−3.0 −3.0 −1.07 ± 0.97</td>
<td>0.3 0.3 1.86 ± 0.65</td>
<td>−2.26 ± 2.40 −3.29 ± 3.17 0.135</td>
</tr>
<tr>
<td>Feelings about the future</td>
<td>−3.0 −3.0 −1.71 ± 1.02</td>
<td>0.3 0.3 2.12 ± 0.74</td>
<td>−4.17 ± 3.08 −4.48 ± 2.74 0.581</td>
</tr>
<tr>
<td>Financial situation</td>
<td>−3.0 −3.0 −1.50 ± 1.09</td>
<td>1.3 0.3 2.21 ± 0.61</td>
<td>−3.64 ± 3.14 −4.60 ± 3.13 0.227</td>
</tr>
<tr>
<td>Dependence on others</td>
<td>−3.0 −3.0 −1.07 ± 1.01</td>
<td>0.3 0.3 2.12 ± 0.84</td>
<td>−2.26 ± 2.55 −3.42 ± 3.24 0.105</td>
</tr>
<tr>
<td>Living condition</td>
<td>−3.0 −3.0 −1.40 ± 0.94</td>
<td>1.3 0.3 2.12 ± 0.63</td>
<td>−3.21 ± 2.62 −3.58 ± 3.14 0.609</td>
</tr>
<tr>
<td>Freedom to eat</td>
<td>−3.0 −3.0 −2.24 ± 0.80</td>
<td>1.3 0.3 2.19 ± 0.77</td>
<td>−5.26 ± 3.05 −4.65 ± 3.14 0.432</td>
</tr>
<tr>
<td>Freedom to drink</td>
<td>−3.1 −3.1 −1.81 ± 1.10</td>
<td>0.3 0.3 1.88 ± 0.94</td>
<td>−4.17 ± 3.13 −3.62 ± 3.06 0.479</td>
</tr>
</tbody>
</table>

* P < 0.05.
† P < 0.01.
education ($P < 0.05$), and had a lower level of housing ($P < 0.01$) and poorer family functioning ($P < 0.01$).

**Conceptual equivalence**

The perception of QOL among Chinese-speaking Singaporeans has been well demonstrated by several local studies [4,16,19]. The relevance of 19 domains to the Chinese-speaking Singaporean diabetes patients was confirmed by two local diabetes experts and respondents during the CD. Because domains are weighted in ADDQOL, the importance of the domains is allowed to vary between individuals and cultures.

**Item equivalence**

Initial qualitative examination of relevance of items was carried out by using the same procedures as described in the “conceptual equivalence” section. The results suggested that items can be used in the Chinese version without modification other than translation. Quantitative investigation of item equivalence will be demonstrated in the “measurement equivalence” section later.

**Semantic equivalence**

No significant problem surfaced during the translation process except for a few minor lexical issues. Among them, one was because sometimes an English word or phrase possesses multiple explanations in Chinese. During forward translation, the word “close” (in the context of “close personal relationship”) and another phrase “working life” were translated into two different Chinese terms, respectively. Similar problems were also found in the backward translation for the word “physically” and the phrase “living conditions.” Such problems were then solved by selecting the most appropriate Chinese term that could convey the original meaning indicated by the developer.

Some other discrepancies might be due to the difference in word order between the Chinese and English expressions. In the first CD, all five respondents found the translation of “much easier” for the impact scale option to be awkward. Nevertheless, it was used to maintain the thematic meaning (consistent word order with other impact scale options). In the second CD, the same problem was brought up again. After much lengthy discussion, in the end it was deemed suitable because consistency with the English version should be adhered to.

No major problem arose during the harmonization review. The Chinese Singaporean ADDQOL together with all the necessary reports were then sent to the original developer for final review. Because the version was approved without any change, it was thus adopted as the final Chinese version for use in Singapore.

**Operational equivalence**

The previous study of the English ADDQOL adaptation in Singapore and other studies of similar questionnaires used among Singaporeans have shown that the format of ADDQOL and the mode of self-completion would be feasible in Singapore [2,4,16,21,23]. Apart from literature review, this was also confirmed by researchers in outcomes research field in Singapore. In addition, respondents were able to complete the questionnaire without any trouble during CDs, which predicted the success of the testing methods.

**Measurement equivalence**

Reliability of the Chinese ADDQOL

Cronbach’s alpha indicates a measure of internal consistency [24]. In this study, the Cronbach’s alpha for the overall items is 0.94,
which indicated excellent reliability [25]. Table 2 shows detailed reliability results by items.

The time of completion for the readministration varied from 2 to 4 weeks, and the response rate was 42.3% (n = 11). One respondent did not specify his or her name was omitted from the test-retest reliability study. This lowered the response rate to 38.5% (n = 10). The intraclass correlation coefficient was 0.65, slightly lower than the commonly accepted level for group comparison.

Comparison of responsiveness between the Chinese ADDQOL and the English ADDQOL

Response distribution
Table 3 shows the response distribution of unweighted impact scores, importance ratings, and weighted impact scores of each domain by two languages. Unweighted impact scores of four domains, namely, "family life" (English vs. Chinese: −1.44 ± 1.10 vs. −2.06 ± 0.76), "friendship and social life" (English vs. Chinese: −1.33 ± 1.14 vs. −1.96 ± 0.75), "close personal relationship" (English vs. Chinese: was found between the two languages. In addition, the ranges of responses in terms of "unweighted impact score" and "importance ratings" were quite similar between the two language groups.

Use of the N/A option
The N/A option was provided for five domains, namely, "family life," "close personal relationship," "sex life," "work (employment)," and "holiday." The rank of N/A option use was similar between two groups, with domains of "sex life" and "work (employment)" being the top 2. Percentages were also similar in four domains except for the domain of "holiday" (English-speaking: 2 [4.8%]; Chinese-speaking: 4 [15.4%]) by two languages (Table 4).

Effect of weighting impact ratings
Weighting impact scores by importance ratings apparently changes the ranking of domains, which were originally demonstrated by unweighted scores (Table 5). Except for the two domains of "sex life" and "feelings about the future," all the other 17 domains showed slight (1 notch) to distinctive (10 notches) changes in both directions, which indicated the usefulness of weighting impact ratings.

Construct validity
Convergent and divergent validity was demonstrated by the following correlations (Table 6): "Present QOL" scores correlated moderately with EQ-5D questionnaire utility scores (r = 0.268; P = 0.185) and SF-6D index scores (r = 0.351; P = 0.078). Besides, ADDQOL mean weighted scores correlated moderately with "diabetes-dependent QOL" scores (r = 0.339; P = 0.090) but weakly with "Present (general) QOL" scores (r = 0.027; P = 0.896).

As for the known-group validity, results showed that lower ADDQOL mean weighted scores correlated moderately with lower SF-6D mental scores (r = 0.247; P = 0.224), suggesting that those who were more depressed reported greater negative impact of diabetes on their QOL; FFM scores correlated positively with ADDQOL scores (r = 0.288; P = 0.182), which provided the finding of "less negative impact of diabetes on QOL is associated with better family functioning" among the patients with diabetes mellitus.

Functional equivalence
The results of the conceptual equivalence, item equivalence, semantic equivalence, operational equivalence, and measurement equivalence listed above indicated that a reasonable degree of equivalence was achieved in all the five areas. Therefore, the functional equivalence between the Chinese ADDQOL and the English ADDQOL was illustrated in this study.

Discussion
To the best of our knowledge, our article is the first to report on the adaptation and evaluation of the original English ADDQOL into a Chinese version. The promising findings of our Singapore-based study could encourage further linguistic validation of the ADDQOL among other Asian populations.

Besides, the robustness of our findings is also strengthened by the use of the universalist approach proposed by Herdman et al. [5]. Unlike some other equivalent studies, we emphasized the importance of conceptual equivalence and item equivalence as the prerequisite for the translation of ADDQOL. We also integrated the translation process into the whole adaptation process. Therefore, we avoided the mistake of rigid assumption that QOL instruments would be equally valid in any culture. We thus carried out the investigation of measurement equivalence only when conceptual
Conclusion

The results of this exploratory study suggest that this Singaporean Chinese ADDQOL has achieved functional equivalence with both the original and the Singaporean-adapted English ADDQOL by demonstrating conceptual equivalence, item equivalence, semantic equivalence, operational equivalence, and measurement equivalence. It also provides justification for further research with larger sample sizes and further linguistic validation into other Asian versions to be used in Singapore and elsewhere.

Acknowledgments

The authors thank Prof. Clare Bradley and Ms. Rosalind Flowright for their kind review and revision of the manuscript.

Source of financial support: Funding for this study was provided from the National University of Singapore. Publication of the study results was not contingent upon sponsor’s approval.

Supplemental Materials

Supplemental material accompanying this article can be found in the online version as a hyperlink at doi: 10.1016/j.vhri.2012.03.005 or, if a hard copy of article, at www.valueinhjournal.com/issues (select volume, issue, and article).

REFERENCES