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BRIEF COMMUNICATION

Reliability and validity of the Taiwan (Mandarin Chinese) version of the chronic respiratory questionnaire

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Abstract
Purpose The chronic respiratory disease questionnaire (CRQ) has been validated and proved useful in assessing therapies for pulmonary diseases. We translated the CRQ into a Taiwan (Mandarin Chinese) version and surveyed its validity and reliability.
Methods The CRQ includes 20 items divided into four domains: dyspnea, fatigue, emotional function, and mastery. We followed a forward-back translation procedure to create the Taiwan version. A cross-sectional survey was conducted among outpatients with chronic obstructive pulmonary disease. Participants underwent tests including the CRQ, the medical outcomes study short form (SF-36), the St. George respiratory questionnaire (SGRQ), lung function tests (LFTs), and a graded exercise test (GET). We used Cronbach's alpha to evaluate the internal consistency of the CRQ, intraclass coefficient for test–retest reliability, and Spearman's correlation for validity.
Results Thirty-six men and 4 women (mean age 67.9 ± 9.9 years) were recruited. Evidence of good internal consistency, test–retest reliability, convergent, discriminant, concurrent, and construct validity of the CRQ was shown. Spearman's correlation showed moderate-to-strong correlation between the CRQ scores and scores of the SGRQ, subscales of the SF-36, and the results of LFTs and GET.
Conclusions The Taiwan version of the CRQ shows good validity, internal consistency, and test–retest reliability.

Keywords Pulmonary disease · Chronic obstructive · Quality of life · Questionnaires

Abbreviations

CRQ	The chronic respiratory disease questionnaire
HQOL	Health-related quality of life
COPD	Chronic obstructive pulmonary diseases
SF-36	Medical outcomes study 36-item short-form health survey
SGRQ	St. George respiratory questionnaire

Subscales of the SF-36

PF	Physical functioning
RP	Role limitations due to physical problems
GH	General health perceptions
VT	Vitality
SF	Social functioning
RE	Role limitations due to emotional problems
MH	Mental health

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LFT	Lung function tests
GET	Graded exercise test
FVC	Forced vital capacity
% pred	Percent of predicted value
FEV1	Forced expiratory volume in one second
MVV	Maximum expiratory ventilation,
VO2peak	Maximal oxygen consumption
VE	Minute ventilation
VEpeak	Minute ventilation at peak exercise
RER	Respiratory exchange ratio
AT	Anaerobic threshold
HR	Heart rate
SatO2	Oxygen saturation
r_s	Spearman's rho

Introduction

Self-perceived health-related quality of life (HQOL) in patients with pulmonary diseases correlates poorly with spirometry, exercise tests, or even the ability to perform daily activities [1–8]. Thus, proper measurement tools are needed to delineate the impact of the disease progression or therapeutic effects on HQOL. The chronic respiratory disease questionnaire (CRQ) [9] was developed to measure HQOL in patients with chronic obstructive pulmonary diseases (COPD) and has been validated and proved useful in assessing a variety of therapies for COPD [10–15]. A Taiwan version of the CRQ is needed; therefore, we translated the questionnaire and assessed its reliability and validity.

Materials and methods

The CRQ consists of 20 items intended to obtain information in four domains: dyspnea, fatigue, emotional function, and mastery. In items under the dyspnea domain, subjects are asked to choose or name the five most important daily activities that make them dyspneic and then specify the severity of dyspnea in these activities. Thus, the dyspnea items are individualized. All items ask the subjects to grade function or conception using a seven-point scale. The score of each domain is obtained by averaging the item scores.

Translation of the CRQ

We used a forward-back translation process to create the Taiwan (Mandarin Chinese) version of the CRQ. A pulmonologist and a physiatrist independently produced two forward-translation versions, and then a third physician compared the translations and decided on a reconciliation version. A professional translator rendered the reconciliation version into an English back-translation version. This English version was submitted to McMaster University for review. The second Taiwan version was produced after making minor modifications to the first version and then used for a comprehension "pre-test" on 5 patients with COPD. Using the pretest result as basis, we made one minor modification to the second version to render a definite edition.

Population studied

We conducted a cross-sectional survey, recruiting outpatients with COPD who had forced expiratory volume in one second (FEV1)/forced vital capacity (FVC) less than 70% in 2005 and 2006. The exclusion criteria were as follows: (1) hospitalization or emergency room visit because of pulmonary conditions within one month and (2) history or evidence of disabling diseases negatively influencing exercise ability and quality of life (e.g., severe musculoskeletal disorders, cardiac problems, intermittent claudication.). The Institutional Review Board of our hospital approved this study, and all the patients provided written informed consent.

Test procedure

All the patients completed three questionnaires upon participating in this study: the Taiwan version of the CRQ, the Taiwan version of the medical outcomes study 36-item short-form health survey (SF-36), and the Chinese language version of the St. George respiratory questionnaire (SGRQ). The SF-36 is one of the most widely used measures of subjective health status [16–18]. It contains 36 items comprising eight subscales: physical functioning (PF), role limitations due to physical problems (RP), bodily pain, general health perceptions (GH), vitality (VT), social functioning (SF), role limitations due to emotional problems (RE), and mental health (MH). All subscales are transformed into a 0–100 scale, with 100 indicating the best status. The SGRQ measures HQOL in patients with asthma or COPD [19]. It consists of 50 items and yields 4 scores (symptoms, activity, impacts, and total scores) ranging from 0 to 100, with 100 indicating the worst condition. The validity and reliability of the Chinese language version have been examined [20]. Most of the patients could finish all the questionnaires within 30 min with the help from a study nurse. We made sure that our study nurses adhered to the administrating guidelines/standard operating procedures provided by McMaster University (for the CRQ) and St George's Hospital Medical School (for the SGRQ). All patients were again asked to

complete the CRQ at an interval of 2 weeks to evaluate its test–retest reliability.

Pulmonary function tests (PFTs) and graded exercise tests (GET) were performed within one week after the questionnaires were completed. PFTs included functional residual capacity (FRC), residual volume (RV), total lung capacity (TLC), FEV1, FVC, maximum expiratory ventilation (MVV), and transfer factor for carbon monooxide (TLCO). Symptom-limited cycle ergometer GET, which was conducted in accordance with the guidelines published by the American Thoracic Society/American College of Chest Physician [21], measured oxygen consumption (VO_2), production of carbon dioxide (VCO_2), minute ventilation (VE), tidal volume, breathing frequency, arterial oxyhemoglobin saturation ($SatO_2$), and heart rate (HR).

Statistical analysis was conducted using Statistical Package for the Social Sciences 10.0 for Windows. Cronbach's alpha reliability coefficient was used to evaluate the internal consistency of the CRQ. Intraclass correlation coefficient was used in examining test–retest reliability. We calculated the Spearman's correlation coefficient among the scores of the three questionnaires to examine the concurrent validity of the CRQ. The Mann–Whitney U test and Spearman's correlation were used to check the correlation between CRQ domain scores and clinical variables. The level of significance was set at $P < 0.05$. A Spearman's rho (r_s) between 0.3 and 0.5 was considered moderate correlation, and r_s exceeding 0.5 was taken as strong correlation [22]. All continuous variables are presented as mean ± standard deviation.

Results

Thirty-six men and 4 women between 29 and 85 (67.9 ± 9.9) years old were recruited. Thirty-four subjects completed the GET. The results of PFTs and GET are listed in Table 1. The domain scores, Cronbach's alpha, and intraclass coefficients of the CRQ at the first/second administration are summarized in Table 2. All the domains of the CRQ showed good internal consistency and test–retest reliability. The convergent and discriminant validity of the CRQ were supported by the correlations between individual items and their corresponding domain scores, as well as the much poorer correlations between the items and scores of non-corresponding domains (Table 3).

The dyspnea domain correlated with FVC, FVC as percentage of predicted value (%pred), FEV1, FEV1%pred, FEV1/FVC, $SatO_2$ at rest, anaerobic threshold (AT), and peak exercise. The fatigue domain showed a negative correlation with VE/MVV%pred, respiratory exchange ratio (RER) at AT and HR obtained at AT, and peak exercise during GET. The emotional domain negatively correlated with RER at AT and maximum VE%pred. The mastery domain correlated with $SatO_2$ at AT. The CRQ total score correlated with SatO2 at rest and negatively correlated with

Table 1 Summary of the results of the lung function tests and the graded exercise test

	Mean	Standard deviation	Range
Lung function tests ($N = 40$)			
FVC (liters)	2.42	0.73	1.46–4.31
FVC % pred (%)	79.9	18.6	51.8–114.6
FEV1 (liters)	1.30	0.54	0.54–2.50
FEV1% pred (%)	55.0	20.2	25.3–98.4
FEV1/FVC	51.4	9.5	35.2–69.9
MVV (liters)	45.2	19.6	15.0–100.2
Graded exercise test ($N = 34$)			
VO2max (ml/min)	1,140	330	494–1,739
VEpeak (liters)	39.5	12.4	20.2–72.0
VEpeak % pred (%)	72.3	26.2	22.3–114.2
RER at AT	0.86	0.07	0.71–1.00
RER at peak exercise	0.96	0.12	0.69–1.21
Heart rate at rest (bpm)	86	12	61–115
Heart rate at reference stage (bpm)	96	14	65–122
Heart rate at AT (bpm)	110	16	76–146
Heart rate at peak exercise (bpm)	130	19	86–169
$SatO_2$ at rest (%)	94.4	2.4	88–98
$SatO_2$ at reference stage (%)	92.4	4.3	75–97
$SatO_2$ at AT (%)	92.4	3.5	81–97
$SatO_2$ at peak exercise (%)	89.5	6.1	72–98

FVC forced vital capacity, *% pred* percent of predicted value, *FEV1* forced expiratory volume in one second, *MVV* maximum expiratory ventilation, *VO2peak* maximal oxygen consumption, *VEpeak* minute ventilation at peak exercise; *RER* respiratory exchange ratio, *AT* anaerobic threshold, *HR* heart rate, *SatO2* oxygen saturation

Table 2 The CRQ: domain scores, Cronbach's alpha, and intraclass coefficient

	CRQ domain			
	Dyspnea	Fatigue	Emotion	Mastery
Domain score				
1st test	4.1 ± 0.9	4.8 ± 1.1	5.2 ± 1.0	5.2 ± 1.0
2nd test	4.1 ± 0.9	4.7 ± 1.0	5.2 ± 1.0	5.4 ± 1.0
Cronbach's alpha				
1st test	0.72	0.82	0.80	0.70
2nd test	0.79	0.83	0.85	0.71
Intraclass coefficient	0.77	0.82	0.89	0.90

VE/MVV%pred, RER at AT, and HT at AT. The correlations between CRQ scores and physiologic parameters are summarized in Table 4.

The CRQ total score correlated with most of the SGRQ scores and SF-36 subscales, except for the SGRQ symptom score and the BP, RE, and MH subscales of the SF-36. The dyspnea domain of the CRQ showed moderate-to-strong correlations with the activity, impact, and total scores of the SGRQ, as well as with the PF, RP, and VT subscales of the SF-36. The fatigue domain correlated with the activity, impact, and total scores of the SGRQ, as well as with the VT, GH, and SF subscales of the SF-36. The emotional function domain correlated with the impact, activity, and total scores (SGRQ) and the SF-36 RE, SF, and MH subscales. Finally, the mastery domain showed moderate correlation with the SGRQ impact and total score, as well as with the PF and SF subscales of the SF-36. The correlation between the CRQ scores and the scores and subscales of the other two questionnaires are listed in Table 5.

Discussion

The current study showed that the Taiwan version of the CRQ has good internal consistency, test–retest reliability,

Table 3 Correlation between the CRQ items and domain scores

	CRQ domain			
	Dyspnea	Fatigue	Emotion	Mastery
Dyspnea items				
Item 1	0.648† (<0.001)	0.076 (0.643)	0.252 (0.117)	0.197 (0.222)
Item 2	0.843† (<0.001)	0.002 (0.988)	0.125 (0.441)	0.158 (0.331)
Item 3	0.653† (<0.001)	0.161 (0.328)	0.124 (0.451)	0.070 (0.672)
Item 4	0.525† (0.001)	0.251 (0.140)	−0.012 (0.945)	−0.091 (0.599)
Item 5	0.661† (<0.001)	0.089 (0.623)	0.054 (0.766)	−0.140 (0.437)
Fatigue items				
Item 8	0.140 (0.388)	0.691† (<0.001)	0.513† (0.001)	0.303 (0.058)
Item 11	0.107 (0.513)	0.690† (<0.001)	−0.318 (0.046)	0.460* (0.003)
Item 15	0.082 (0.614)	0.827† (<0.001)	0.509† (0.001)	0.225 (0.163)
Item 17	0.162 (0.319)	0.891† (<0.001)	0.657† (<0.001)	0.388 (0.013)
Emotion items				
Item 6	0.119 (0.466)	0.425* (0.006)	0.792† (<0.001)	0.468* (0.002)
Item 9	0.022 (0.894)	0.335 (0.035)	0.505† (0.001)	0.318 (0.046)
Item 12	0.149 (0.360)	0.404 (0.010)	0.817† (<0.001)	0.479* (0.002)
Item 14	0.189 (0.243)	0.632† (<0.001)	0.768† (<0.001)	0.476* (0.002)
Item 16	−0.017 (0.919)	0.448* (0.004)	0.675† (<0.001)	0.511† (0.001)
Item 18	0.270 (0.092)	0.253 (0.116)	0.542† (<0.001)	0.487* (0.001)
Item 20	−0.002 (0.991)	0.638† (<0.001)	0.708† (<0.001)	0.330 (0.037)
Mastery items				
Item 7	0.083 (0.609)	0.200 (0.216)	0.403 (0.010)	0.758† (<0.001)
Item 10	0.181 (0.265)	0.325 (0.041)	0.423* (0.007)	0.678† (<0.001)
Item 13	0.224 (0.164)	0.371 (0.018)	0.531† (<0.001)	0.695† (<0.001)
Item 19	0.011 (0.948)	0.330 (0.038)	0.402 (0.010)	0.697† (<0.001)

Spearman's correlation, *P* values in parentheses

* 0.5 ≥ Spearman's rho > 0.3 † Spearman's rho > 0.5

Table 4 Correlation between the CRQ scores and results of lung function tests and graded exercise test

	CRQ scores				
	Dyspnea	Fatigue	Emotion	Mastery	Total
LFTs ($N = 40$)					
FVC	0.356* (0.024)	0.229 (0.156)	0.066 (0.687)	0.081 (0.618)	0.247 (0.125)
FVC % pred	0.509† (0.001)	0.173 (0.287)	0.102 (0.531)	0.097 (0.551)	0.287 (0.072)
FEV1	0.345* (0.029)	0.107 (0.512)	−0.084 (0.608)	−0.018 (0.913)	0.144 (0.377)
FEV1% pred	0.418* (0.007)	0.098 (0.551)	−0.069 (0.673)	−0.003 (0.983)	0.150 (0.357)
FEV1/FVC	0.393* (0.013)	−0.098 (0.551)	−0.191 (0.245)	−0.088 (0.594)	−0.027 (0.867)
MVV	0.259 (0.139)	0.072 (0.688)	−0.147 (0.408)	0.061 (0.733)	0.145 (0.412)
GET ($N = 34$)					
VO2peak	0.114 (0.520)	−0.132 (0.456)	−0.189 (0.284)	−0.177 (0.316)	−0.105 (0.556)
VEpeak	0.101 (0.570)	−0.044 (0.805)	−0.196 (0.267)	−0.242 (0.168)	−0.077 (0.666)
VEpeak % pred	0.066 (0.715)	−0.178 (0.320)	−0.402* (0.020)	−0.344 (0.050)	−0.252 (0.157)
VE/MVV % pred	−0.333 (0.067)	−0.433* (0.015)	−0.227 (0.219)	−0.259 (0.159)	−0.486* (0.006)
RER at AT	−0.364 (0.057)	−0.408* (0.031)	−0.395* (0.038)	−0.126 (0.524)	−0.479* (0.010)
RER peak exercise	0.043 (0.810)	−0.136 (0.443)	−0.289 (0.097)	−0.173 (0.329)	−0.135 (0.446)
Oxygen pulse at peak exercise	0.368* (0.032)	−0.039 (0.826)	0.001 (0.995)	−0.059 (0.739)	0.163 (0.357)
HR at rest	−0.258 (0.141)	−0.301 (0.307)	−0.190 (0.281)	−0.143 (0.420)	−0.390* (0.022)
HR at AT	−0.076 (0.699)	−0.425* (0.024)	−0.200 (0.307)	−0.158 (0.422)	−0.400* (0.035)
HR peak exercise	0.096 (0.589)	−0.410* (0.016)	−0.075 (0.672)	−0.036 (0.840)	−0.192 (0.277)
SatO2 at rest	0.561† (0.001)	0.224 (0.203)	0.100 (0.573)	0.215 (0.222)	0.492* (0.003)
SatO2 at AT	0.523† (0.006)	0.034 (0.869)	−0.001 (0.998)	0.498* (0.010)	0.342 (0.087)
SatO2 peak exercise	0.624† (<0.001)	0.080 (0.672)	0.013 (0.944)	0.058 (0.763)	0.332 (0.073)

Spearman's correlation, *P* values in parentheses

FVC forced vital capacity, *% pred* percent of predicted value, *FEV1* forced expiratory volume in one second, *MVV* maximum expiratory ventilation, *VO2peak* maximal oxygen consumption, *VEpeak* minute ventilation at peak exercise, *RER* respiratory exchange ratio, *AT* anaerobic threshold, *HR* heart rate, *SatO2* oxygen saturation

* $0.5 \geq$ Spearman's rho > 0.3 † Spearman's rho > 0.5

Table 5 Correlation between scores of the CRQ, SGRQ, and the SF-36

	CRQ scores				
	Dyspnea	Fatigue	Emotion	Mastery	Total
SGRQ					
Symptoms	−0.123 (0.455)	−0.025 (0.882)	−0.077 (0.643)	−0.167 (0.310)	−.0102 (0.535)
Activities	−0.518†(<0.001)	−0.356* (0.026)	−0.356* (0.026)	−0.212 (0.196)	−0.483* (0.002)
Impact	−0.374* (0.019)	−0.324* (0.045)	−0.426* (0.007)	−0.411* (0.009)	−0.521† (0.001)
Total scores	−0.480* (0.002)	−0.347* (0.030)	−0.417* (0.008)	−0.374 * (0.019)	−0.548† (<0.001)
SF-36					
Physical functioning	0.377 * (0.017)	0.265 (0.098)	0.223 (0.167)	0.389 * (0.013)	0.402* (0.010)
Role physical	0.321* (0.044)	0.243 (0.131)	0.184 (0.256)	0.206 (0.202)	0.347* (0.028)
Bodily pain	−0.117 (0.472)	0.205 (0.203)	0.285 (0.075)	0.076 (0.643)	0.137 (0.399)
General health	0.219 (0.175)	0.399 * (0.011)	0.293 (0.066)	0.259 (0.107)	0.445* (0.004)
Vitality	0.361* (0.022)	0.524† (<0.001)	0.231 (0.152)	0.236 (0.143)	0.497* (0.001)
Social functioning	0.268 (0.094)	0.329* (0.038)	0.340* (0.032)	0.404* (0.010)	0.442* (0.004)
Role emotional	0.063 (0.698)	0.208 (0.197)	0.404* (0.010)	0.153 (0.346)	0.288 (0.072)
Mental health	−0.135 (0.405)	0.252 (0.117)	0.538† (<0.001)	0.178 (0.273)	0.288 (0.071)

Spearman's correlation, *P* values in parentheses

* $0.5 \geq$ Spearman's rho > 0.3 † Spearman's rho > 0.5

as well as concurrent, convergent, and discriminant validity. The degree of internal consistency of the dyspnea domain was relatively low, similar to that observed in previous studies (6, 11). The five items of the dyspnea domain are "individualized." Thus, our patients identified 37 different activities that made them dyspneic. This might contribute to lower internal consistency. In contrast to those of previous studies (6, 11), our data showed low internal consistency of the mastery domain. Several of our patients indicated that although they seldom felt confident in coping with their disease, they almost never felt fear or panic. These major score discrepancies between items 7 and 19 and items 10 and 13 lowered the internal consistency of the mastery domain.

All the CRQ domains and total score exhibited moderate-to-strong correlation with the activities, impact, and total scores of the SGRQ, except for the mastery domain, which exhibited weak correlation with the SGRQ activity score. The correlations between all the CRQ scores and the SGRQ symptoms score were weak, similar to those observed in some previous studies (14). The eight questions of the SGRQ symptoms score include two questions inquiring about wheezing status—one about sputum and another about coughing. Thus, half of the questions do not specifically inquire about the dyspnea status of the patient, which might explain the weak correlations. The dyspnea and fatigue domain scores that convey *physical* information correlated well with the *physical* subscales of the SF-36: PF, RP (correlated with dyspnea), VT (with dyspnea and fatigue), and GH (with fatigue). They exhibited poor correlation with the social-emotional subscales of the SF-36. The emotional domain of the CRQ correlated with all the *social-emotional* subscales of the SF-36 (RE, MH, and SF), but not with the physical subscales. The mastery domain correlated with the PF and SF subscales. These results support the construct and concurrent validity of the CRQ.

The current study also showed that the scores of the CRQ correlated with several physiological measures, including FVC%pred, FEV1%pred, SatO2 at rest, AT and peak exercise (correlated with the dyspnea domain), maximum VE/MVV%pred during the exercise test (negatively correlated with fatigue and total score), and maximum VE%pred (negatively correlated with emotion score), which indicate the severity of the disease. The results suggest that the CRQ can discriminate among patients with different disease severities.

This study did not include a longitudinal survey to determine whether changes in HQOL, induced either by treatment or by a complication of the disease, could be readily picked up by the questionnaire. Further study is required to measure this aspect of discriminating validity.

Conclusions

The Taiwan (Mandarin Chinese) version of the CRQ shows good internal consistency, test–retest reliability, as well as good convergent, discriminant, and concurrent validity.

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References

1. Goldstein, R. S., Gort, E. H., Stubbing, D., Avendano, M. A., & Guyatt, G. H. (1994). Randomised controlled trial of respiratory rehabilitation. *Lancet, 344*(8934), 1394–1397.
2. Lacasse, Y., Wong, E., Guyatt, G. H., King, D., Cook, D. J., & Goldstein, R. (1996). Meta-analysis of respiratory rehabilitation in chronic obstructive pulmonary disease. *Lancet, 348*(9035), 1115–1119.
3. Alexander, M. R., Dull, W. L., & Kasik, J. E. (1980). Treatment of chronic obstructive pulmonary disease with orally administered theophylline. A double-blind controlled study. *Journal of American Medical Association, 244*(20), 2286–2290.
4. Eaton, M. L., MacDonald, F. M., Church, T. R., & Niewoehner, D. E. (1982). Effects of theophyllin on breathlessness and exercise tolerance in patients with chronic airflow obstruction. *Chest, 82*(5), 538–542.
5. Griffiths, T. L., Burr, M. L., Campell, I. A., Lewis-Jenkins, V., Mullins, J., Shiels, K., et al. (2000). Results at 1 year of outpatient multidisciplinary pulmonary rehabilitation: A randomized controlled trial. *Lancet, 355*(9201), 362–368.
6. Wijkstra, P. J., TenVergert, E. M., Van Altena, R., Otten, V., Kraan, J., & Postma, D. S., et al. (1994).Relation of lung function, maximal inspiratory pressure, dyspnea, and quality of life with exercise capacity in patients with chronic obstructive pulmonary disease. *Thorax*, *49*(5), 468–472.
7. Berry, M. J., Rejeski, W. J., Adair, N. E., & Zaccaro, D. (1999). Exercise rehabilitation and chronic obstructive pulmonary disease stage. *American Journal of Respiratory and Critical Care Medicine, 160*(4), 1248–1253.
8. Rabe, K. F., Hurd, S., Anzueto, A., Barnes, P. J., Buist, S. A., Calverley, P., et al. (2007). Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease. GOLD executive summary. *American Journal of Respiratory and Critical Care Medicine, 176*(6), 532–555.
9. Guyatt, G. H., Berman, L. B., Townsend, M., Pugsley, S. O., & Chambers, L. W. (1987). A measure of quality of life for clinical trials in chronic lung diseases. *Thorax, 42*(10), 773–778.
10. Guell, R., Casan, P., Sangenis, M., Morante, F., Belda, J., & Guyatt, G. H. (1998). Quality of life in patients with chronic respiratory disease: The Spanish version of the chronic respiratory questionnaire (CRQ). *European Respiratory Journal, 11*(1), 55–60.
11. Wijkstra, P. J., TenVergert, E. M., Van Altena, R., Otten, V., Postma, D. S., Kraan, J., et al. (1994). Reliability and validity of the chronic respiratory questionnaire. *Thorax, 49*(5), 465–467.
12. Martin, L. L. (1994). Validity and reliability of a quality-of-life instrument. The chronic respiratory disease questionnaire. *Clinical Nursing Research, 3*(2), 146–156.
13. Morgan, L. (1991). Experience of using the chronic respiratory questionnaire. *Respiratory Medicine, 85*(suppl B), 23–24.

14. Singh, S. J., Sodergren, S. C., Hyland, M. E., Williams, J., & Morgan, L. (2001). A comparison of three disease-specific and two generic health-status measures to evaluate the outcome of pulmonary rehabilitation in COPD. *Respiratory Medicine, 95*(1), 71–77.
15. Guyatt, G. H., King, D. R., Feeny, D. H., Stubbing, S., & Goldstein, R. S. (1999). Generic and specific measurement of health-related quality of life in a clinical trial of respiratory rehabilitation. *Journal of Clinical Epidemiology, 52*(3), 187–192.
16. Jenkinson, C., Layte, R., Wright, L., & Coulter, A. (1996). *The UK SF-36: An analysis and interpretation manual*. Oxford: Health Services Research Unit.
17. New England Medical Center Hospital. (1996). *IQOLA SF-36 Taiwan standard version 1.0*. Boston, MA: The Health Institute, New England Medical Center.
18. Lu, J. R., Tseng, H. M., & Tsai, Y. J. (2003). Assessment of health-related quality of life in Taiwan, I: Development and psychometric testing of SF-36 Taiwan version. *Taiwan Journal of Public Health, 22*(6), 501–511.
19. Jones, P. W., Quirk, F. H., Baveystock, C. M., & Littlejohns, P. (1992). A self-complete mearure of health status for chronic airflow limitation. The St. George respiratory questionnaire. *American Review of Respiratory Disease, 145*(6), 1321–1327.
20. Wang, K. Y., Chiang, C. H., Maa, S. H., Shau, W. Y., & Tarn, Y. H. (2001). Psychometric assessment of the Chinese language version of the St. George's respiratory questionnaire in Taiwanese patients with bronchial asthma. *Journal of Formosan Medical Association, 100*(7), 455–460.
21. The American Thoracic Society (ATS) and the American College of Chest Physicians (ACCP) (2003). ATS/ACCP statement on cardiopulmonary exercise testing. *American Journal of Respiratory and Critical Care Medicine*, *167*(2), 211–277.
22. Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd edn) (pp. 79–81, 532). New Jersey: Lawrence Erlbaum.