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Adaptation and validation of the Chinese version of Dyspnoea-12 scale in individuals with chronic obstructive pulmonary disease

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Abstract

Introduction: Dyspnoea-12 scale is a validated assessment tool, capturing the perception of dyspnoea and its physical and affective effects in individuals with chronic obstructive pulmonary disease (COPD). A validated version for the Chinese-speaking population has been unavailable.

Objective: To develop a Chinese version of D-12 (D-12-C) scale and evaluate its validity and reliability.

Methods: D-12 was translated from English to traditional Chinese in collaboration with a physician and a linguist. Back translation was adopted to ensure accuracy of the translation. A total of 155 COPD patients were recruited to test the reliability and validity of the D-12-C scale. Internal reliability and test-retest reliability were measured with Cronbach's alpha coefficient and intra-class correlation coefficient, respectively. Construct validity was assessed through exploratory factor analysis (EFA). Concurrent validity was assessed by the correlation of D-12-C total score and sub-scores and the Chinese version of Saint George's Respiratory Questionnaire (SGRQ), 36-Item Short Form Health Survey (SF-36), COPD Assessment Test (CAT) and Hospital Anxiety and Depression Scale (HADS) total score and sub-scores.

Results: The two-factor structure of D-12-C was confirmed by EFA. D-12-C and its sub-scores demonstrated high level of internal reliability (Cronbach's alpha = 0.88) and moderate level of test-retest reliability. D-12-C total score, physical and affective sub-scores were significantly correlated to SGRQ total score ($r_s = 0.59$, $p < 0.001$) and activity sub-score ($r_s = 0.38$, $p = 0.006$), SF-36 mental health sub-score ($r_s = -0.36$, $p < 0.001$), CAT ($r_s = 0.56$, $p < 0.001$), HADS anxiety ($r_s = 0.51$, $p < 0.001$) and depression sub-scores ($r_s = 0.44$, $p < 0.001$).

Conclusion: D-12-C scale was developed, which demonstrated satisfactory reliability and validity in measuring dyspnoea among COPD patients.

KEYWORDS

assessment tool, chronic obstructive pulmonary disease, dyspnoea

1 | INTRODUCTION

Dyspnoea is one of the most frequently reported and distressing symptoms in individuals with chronic obstructive pulmonary disease (COPD). It is a perceptual experience of difficult or uncomfortable breathing originating from a complex intrinsic interaction between physiological and psychological factors.[1–3]

Evidence indicates that dyspnoea significantly correlates with health-related quality of life, mortality rate and hospital re-admission rate.[4,5] In individuals with COPD, dyspnoea contributes to the low compliance to exercise and it is a better predictor of 5-year survival compared to spirometry.[6] Hence, dyspnoea management is a major clinical objective for individuals with COPD.[7,8]

1.1 | Assessment of dyspnoea

Dyspnoea can be assessed in either direct or indirect approaches. The most frequently used direct assessment tools are the Visual Analogue Scale (VAS) and the Borg scale. However, these scales only measure monodimensional information which does not reflect the multi-dimensional nature of the symptom.[2] On the other hand, indirect assessment tools of dyspnoea such as Medical Research Council (MRC) Dyspnoea Scale, Hospital Anxiety and Depression Score (HADS) and Saint George's Respiratory Questionnaires (SGRQ) measure levels of functional disability, physical activities and/or health-related quality of life.[2,9] However, available assessment questionnaires do not adequately capture the perception of dyspnoea and its physical and affective dimension.

1.2 | Dyspnoea-12

The Dyspnoea-12 (D-12) scale was developed using 81 identified dyspnoea descriptors reported by patients and then reduced to 12 descriptors by hierarchical methods and Rasch analysis.[2] It is a brief, self-reported, convenient and multidimensional assessment tool with an aim to supplement the deficiency of traditional dyspnoea assessment tools. The 12 descriptors address both 'physical' (seven items) and 'affective' (five items) components. Satisfactory correlation has been reported with SGRQ, MRC Dyspnoea Scale, HADS, COPD Assessment Test (CAT) as well as the Six-Minute Walking Distance (6MWD).[2,10–12]

D-12 has already been validated with acceptable reliability in different clinical situations such as interstitial lung disease, COPD, bronchiectasis, post-tuberculosis destroyed lung, asthma, lung cancer and pulmonary arterial hypertension.[9,11–16] It is currently available in different languages including English (original), Italian, Korean, Arabic, Swedish and Portuguese.[5,9–12,17] A validated version for the Chinese-speaking population is yet to be developed.

The purposes of this study were to develop a Chinese version of D-12 (D-12-C) scale and to evaluate its validity and reliability.

2 | MATERIALS AND METHODS

2.1 | Translation process

The standard 'forward-backward' procedure was adopted to translate the original English version of D-12 to Chinese commonly used in Hong Kong (spoken in Cantonese, written in traditional Chinese) to ensure accuracy of meaning and cultural acceptability.[18]

The forward translation of the instrument was performed in close collaboration with a physician and a linguist. The instrument was translated from English to Chinese, including the introductory paragraph, 12 descriptors and response options.

A bilingual native English speaker, naïve to the original English version of D-12, then blindly back-translated the Chinese version to English. The original English version was compared with the back-translated English version afterwards. To ensure content validity of the D-12-C, linguistic validation report was obtained. There were no inconsistencies, mistranslated sentences, vague words, irrelevant and inappropriate issues identified.

Pilot testing with 10 Chinese speaking patients with COPD was conducted to test the clarity and applicability of the D-12-C. The group of patients reported that all items in D-12-C were clear, understandable and applicable. It showed that there was no need to modify the scale. After the completion of final formatting and proofreading, final D-12-C version was endorsed.

2.2 | Subject recruitment

A convenience sampling technique was adopted. Patients with confirmed diagnosis of COPD, breathlessness experience and the ability to read and understand Chinese were recruited from a weekly COPD clinic in a public hospital in Hong Kong. Those with heart failure, malignant neoplasm, cognitive impairment, history of myocardial infarction within six months, severe liver disease and severe psychiatric disease were excluded from the study.

The purposes and procedures of the study were explained to the recruited individuals. Written consents were obtained from all participants.

2.3 | Sample size

Sample size of this study was determined with reference to the previous literature. It had been shown that there was correlation between the Arabic version of D-12 and Arabic version of HADS ($r = 0.498$, $p < 0.05$).[11] To achieve a similar correlation model between D-12 and Chinese version of HADS, an alpha level of 0.05 and statistical power of 0.8 was set and a minimum sample size of 29 was required.

Correlation between D-12 and 6MWD had also been found to be significant ($r = -0.38$, $p < 0.05$).[12] The correlation effect size between D-12-C and 6MWD was expected to be similar. If an alpha level of 0.05 and statistical power of 0.8 was set, a minimum sample size of 41 was required. For this study, to account for 10% dropout rate, the target sample size was therefore 46.

2.4 | Data collection

Prior to the study, demographic characteristics of the subjects with COPD including age, gender, MRC Dyspnoea Scale, 6MWD, lung function, use of long-term oxygen therapy and Body-Mass Index, Airflow Obstruction, Dyspnea, and Exercise Capacity (BODE) Index were collected. The subjects were subsequently asked to complete the following instruments (Table 1).

2.4.1 | Chinese version of Dyspnoea-12 (D-12-C)

The D-12-C, similar to the original English version, consists of 12 items that assess breathlessness using descriptors on a 4-point scale from none (score 0), mild (score 1), moderate (score 2) to severe (score 3). Total score therefore ranged from 0 to 36 with a higher score indicating a higher level of breathlessness. The D-12-C total score can also be divided into two components: the physical score for items 1–7 (score range of 0–21) and the emotional score for items 8–12 (score range of 0–15).

2.4.2 | Chinese version of Saint George's Respiratory Questionnaire (SGRQ)

The SGRQ is a specific tool to measure the impact of overall health and perceived well-being in COPD patients. It consists of 50 items that assess patients in three domains (symptoms, activity and impact). The total scores range from 0 to 100 with higher scores indicating more limitations. The Chinese version of SGRQ has also been well validated.[19]

TABLE 1 Demographic characteristics of patients and their results of D-12-C, SGRQ, SF-36, CAT and HADS instruments

Characteristics	Participants (n = 155)
Age, mean (SD), years	71.1 (10.7)
Female sex, number (%)	33.0 (21.3)
FEV_1% of predicted	30.0 (27.6)
Long term oxygen therapy user, number (%)	8.0 (5.2)
Six-Minute Walking Distance, mean (SD), m	259.4 (110.6)
MRC Dyspnoea Scale	
Grade 0, n (%)	4.0 (2.6)
Grade 1, n (%)	35.0 (22.6)
Grade 2, n (%)	75.0 (48.4)
Grade 3, n (%)	24.0 (15.5)
Grade 4, n (%)	11.0 (7.1)
BODE Index, median (IQR)	4 (4)
D-12-C total score, median (IQR)	4 (9)
D-12-C physical sub-score, median (IQR)	3 (6)
D-12-C affective sub-score, median (IQR)	0 (3)
SGRQ total score, mean (SD)	35.9 (20.7)
SGRQ symptoms sub-score, mean (SD)	35.5 (25.3)
SGRQ activity sub-score, mean (SD)	57.6 (26.2)
SGRQ impact sub-score, mean (SD)	35.8 (26.0)
SF-36 total score, mean (SD)	57.6 (22.8)
SF-36 mental health sub-score, mean (SD)	59.3 (27.0)
SF-36 physical health sub-score, mean (SD)	54.6 (22.9)
CAT score, median (IQR)	6 (11)
HADS total score, median (IQR)	5 (8)
HADS anxiety sub-score, median (IQR)	1 (3)
HADS depression sub-score, median (IQR)	4 (5)

Abbreviations: BODE Index, Body-Mass Index, Airflow Obstruction, Dyspnea, and Exercise Capacity (BODE) Index; CAT, COPD Assessment Test; D-12-C, Chinese version of Dyspnoea-12; FEV1% of predicted, forced expiratory volume in 1 s in percentage of predicted value; HADS, Hospital Anxiety and Depression Scale; IQR, interquartile range; MRC Dyspnoea Scale, Medical Research Council Dysnoea Scale; SD, standard deviation; SF-36, 36-Item Short Form Health Survey; SGRQ, Saint George's Respiratory Questionnaire.

2.4.3 | Chinese version of 36-item Short Form Health Survey (SF-36)

The SF-36 is a 36-item self-report measure of health-related quality of life (HRQOL). The Chinese version of SF-36 has been well validated and commonly used in different settings.[20] There are eight subscales measuring different domains of HRQOL: physical functioning (PF), role-physical (RP), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), role-emotional (RE), and mental health (MH). Two component scores are derived from the eight subscales: a physical health component score and a

mental health component score. The higher the scores, the better are the health and functioning.

2.4.4 | Chinese version of COPD Assessment Test (CAT)

Chinese version of CAT consists of eight items.[21] Each item has a score that ranged from 0 to 5, making a total score ranging from 0 to 40. The higher the scores, the worse the symptoms were. The Chinese version of CAT has been well validated and commonly used clinically.

2.4.5 | Chinese version of Hospital Anxiety and Depression Scale (HADS)

The HADS is a validated and widely used assessment tool used for screening anxiety and depression in the general population. The Chinese version of HADS has been well validated and is popular in clinical setting.[22] It is a self-report questionnaire of 14 items on a 4-point Likert scale that ranged from 0 to 3. Anxiety and depression were each scored using seven items. Total score for each component ranged from 0 to 21. The higher the scores, the more severe was the distress.

2.5 | Statistical analysis

The IBM SPSS Statistics for Windows, version 21.0 (IBM Corporation, Armonk, NY) was utilized for data analysis. Level of statistical significance was set at $p \leq 0.05$. Patients' demographic data and the floor and ceiling effects of D-12-C were summarized in percentages, mean values and standard deviation or median and inter-quartile range depending on data types and normality of data distribution, tested by Shapiro–Wilk test.

Internal consistency of the D-12-C was estimated by Cronbach's alpha coefficient and an alpha score of 0.7 or above was considered satisfactory (Table 2). Test-retest reliability was assessed by comparing two scores obtained within 7 days, by intraclass correlation coefficient (ICC) estimates under a mean-rating ($k = 2$) under absolute-agreement, two-way mixed-effects model. To assess concurrent validity, correlations between D-12-C and 6MWD, MRC Dyspnoea Scale, BODE Index, SGRQ, SF-36, CAT and HADS were assessed (Table 3). Either Pearson's correlation coefficient (r) or Spearman's correlation coefficient (r_s) was used, depending on the normality of data distribution (Table 4). Construct validity was assessed by exploratory factor analysis (EFA) using maximum likelihood estimation (Table 5). Varimax rotation was used to facilitate interpretation of factor loadings. Factors with an eigenvalue larger than one were retained. Items with factor loading exceeding 0.5 were considered relevant.

TABLE 2 Internal consistency of the D-12-C total score and sub-scores

Scale variable	Number of items	Reliability D-12-C in Cronbach's α
D-12-C total	12	0.93
D-12-C physical	7	0.88
D-12-C affective	5	0.91

3 | RESULTS

Data from 155 participants were analysed. The mean age of the patients was 71.05 ± 10.68 years with the majority being male (78.71%). The mean forced expiratory volume in one second in percentage of predicted value was 30.03 ± 27.62 and 5.16% of them were long term oxygen therapy users. The average 6MWD of the patients was 259.40 ± 110.60 m. Nearly half of participants reported their breathlessness as MRC grade 2, while 23% and 15% of participants recorded Grade 1 and Grade 3, respectively. The median of their BODE Index, which was used to predict patients' long-term outcomes, was 4.

The mean D-12-C total score was 5.85 ± 7.06. Mean physical sub-score was 3.90 ± 4.40 while mean affective sub-score was 1.95 ± 4.21. No patient (0%) achieved the highest score (36/36) while forty patients (26%) attained the lowest score (0/36).

TABLE 3 Cronbach's alpha if each question was deleted

Item number	Cronbach's alpha if item deleted
Physical sub-score	
1	0.87
2	0.86
3	0.87
4	0.87
5	0.86
6	0.86
7	0.87
Affective sub-score	
8	0.88
9	0.89
10	0.91
11	0.86
12	0.86

TABLE 4 Spearman's correlation coefficients between D-12-C and 6MWD, MRC Dyspnoea Scale, BODE Index, SGRQ, SF36, CAT and HADS

Scale/Sub-score	D-12-C total	D-12-C physical	D-12-C affective
6MWD	−0.17*	−0.22**	−0.02
MRC Dyspnoea Scale	0.22**	0.25**	0.11
BODE index	0.22**	0.25**	0.07
SGRQ total	0.59**	0.57**	0.44**
SGRQ symptoms	0.26**	0.28**	0.17
SGRQ activity	0.35**	0.38**	0.16
SGRQ impact	0.29**	0.26**	0.22*
SF-36 total	−0.31**	−0.28**	−0.27**
SF-36 mental heath	−0.34**	−0.28**	−0.36**
SF-36 physical health	−0.24**	−0.22*	−0.168
CAT	0.56**	0.56**	0.41**
HADS total	0.46**	0.41**	0.51**
HADS anxiety	0.45**	0.38**	0.51**
HADS depression	0.41**	0.37**	0.44**

Abbreviations: 6MWD, Six-Minute Walking Distance; BODE Index, Body-Mass Index, Airflow Obstruction, Dyspnea, and Exercise Capacity (BODE) Index; CAT, COPD Assessment Test; D-12-C, Chinese version of Dyspnoea-12; HADS, Hospital Anxiety and Depression Scale; MRC Dyspnoea Scale, Medical Research Council Dysnoea Scale; SF-36, 36-Item Short Form Health Survey; SGRQ, Saint George Respiratory Questionnaire.

*Correlation is significant at the 0.05 level (2-tailed).; **Correlation is significant at the 0.01 level (2-tailed).

3.1 | Internal reliability

The D-12-C physical sub-score demonstrated high level of internal consistency with a Cronbach's alpha of 0.88. The item-total correlations were moderately strong, ranging from 0.37 to 0.65. Cronbach's alpha ranged from 0.86 to 0.87 if any item was deleted.

The D-12-C affective sub-score also demonstrated excellent level of internal consistency with a Cronbach's alpha of 0.91. Item-total correlation ranged from 0.55 to 0.87. Cronbach's alpha ranged from 0.86 to 0.91 if any item was deleted.

3.2 | Test-retest reliability

Twenty-eight participants were called back to have their D-12-C score retested two weeks after the baseline data collection. They reported unchanged level of breathlessness during the retest. D-12-C total score demonstrated a moderate test-retest reliability (ICC = 0.57, 95%CI: 0.28 to 0.78). Similarly, moderate test-retest reliabilities were found in D-12-C affective sub-score (ICC = 0.55, 95%CI: 0.23 to 0.76) and physical sub-score (ICC = 0.57, 95%CI: 0.26 to 0.77). As there was only one-fifth of the total participants who were available for the retest, it could be one of the reasons explaining why repeatability in current study is only moderate compared with Sundh J et al's (2019) study in which the Swedish version of D-12 was validated (two weeks follow up, ICC = 0.75-0.81).

TABLE 5 Summary of exploratory factor analysis results for D-12-C using maximum likelihood estimation

	Factor loadings	
Question number	Affective	Physical
1	0.185	**0.762**
2	0.399	**0.672**
3	0.154	**0.804**
4	0.345	**0.673**
5	0.274	**0.739**
6	**0.502**	**0.625**
7	**0.636**	0.448
8	**0.797**	0.316
9	**0.819**	0.172
10	**0.620**	0.405
11	**0.849**	0.291
12	**0.875**	0.239

Note: Factor loadings over 0.50 appears in bold.

3.3 | Concurrent validity

The D-12-C total score demonstrated a strong correlation with the SGRQ total score ($r_s = 0.59$, $p < 0.001$) and a weak correlation with the 6MWD ($r_s = -0.17$, $p < 0.05$). The D-12-C physical sub-score is significantly correlated with SGRQ activity sub-score ($r_s = 0.38$, $p = 0.006$) and CAT ($r_s = 0.56$, $p < 0.001$). The D-12-C affective sub-score was found to have weak to moderate correlation with SF-36 mental health sub-score ($r_s = -0.36$, $p < 0.001$), HADS anxiety sub-score ($r_s = 0.51$, $p < 0.001$) and depression sub-score ($r_s = 0.44$, $p < 0.001$). Scatterplots of the above comparisons are presented in Supporting Graph 2A–G.

3.4 | Construct validity

Through exploratory factor analysis, two factors were found to have eigenvalues of one or higher. Items 6 to 12 demonstrated moderately high loadings to factor 1, which ranged from 0.50 to 0.88. Items 1 to 6 demonstrated moderately high loadings to factor 2, which ranged from 0.63 to 0.80.

4 | DISCUSSION

4.1 | Main findings of this study

The present study developed a Chinese version of D-12 (D-12-C) which was clear and culturally appropriate to native speakers. It demonstrated satisfactory reliability and validity in measuring dyspnoea severity and impact in individuals with COPD. The D-12-C total and its sub-scores showed high to excellent level of internal consistency and moderate test-retest reliabilities. Low to moderate levels of correlations between D-12-C and the 6MWD, MRC Dyspnoea Scale, BODE Index, SGRQ, SF-36, CAT, and HADS scores were found.

Moderate-to-strong associations were reported between the original D-12 score (English version), SGRQ total score (Pearson's $r = 0.79$) and 6MWD (Pearson's $r = -0.51$). Similarly, moderate correlations were observed between the Korean version of D-12 score, CAT score (Pearson's $r = 0.72$) and SGRQ total score (Pearson's $r = 0.67$).[23] In comparison, the D-12-C demonstrated significant but weaker associations with these measurements. This may be explained by the high proportion of participants reporting a score of 0 in D-12-C. It has been previously reported that Chinese population tend to under-report physical symptom and psychological distress, out of concern for the disturbances on group harmony and social stigmas.[24]

4.2 | Implications of this study

Dyspnoea and psychological distresses are ubiquitous among individuals with COPD. However, it has been reported that existing measurement tools fail to accurately measure their specific experiences. With an aim to supplement the deficiency of the traditional dyspnoea assessment tools, D-12 was developed using identified dyspnoea descriptors reported by patients that incorporates both physical and affective domains. It allows clinicians to identify the main origin of dyspnoea which could originate from physical or affective aspect, to formulate appropriate management. This simple and convenient assessment tool has been validated and proven to be reliable to measure both physical and affective components of dyspnoea.

D-12 has been translated to different languages and routinely used clinically in many different countries. However, in Chinese speaking populations, a translated Chinese version is not yet available. The need for a Chinese version is imminent as COPD poses a major public health concern in China with an estimated prevalence of 13.6%.[25]

D-12-C allows health care professionals to identify whether the dyspnoea experienced by Chinese speaking individuals were caused by physical or affective component. Thus, appropriate management including patient education, early detection of deterioration, treatment plan and progress monitoring could be tailor-made while resource allocation could be optimized.

4.3 | Limitations

D-12-C was translated from English to Cantonese, the commonest form of spoken Chinese used by Hong Kong population. Since the language of expressing breathlessness is influenced by cultural factors, further research would be needed to test the applicability of D-12-C to other Chinese-speaking communities of the world.

Although this Chinese translation has been validated in patients with COPD, potential use of this tool would include the dyspnoea assessment of Chinese-speaking patients with other cardiorespiratory diseases.

5 | CONCLUSION

A validated Chinese version of the Dyspnoea-12 scale is now available for clinical measurement of multi-dimensional component of dyspnoea with the purpose of improving assessment and management of dyspnoea in patients with COPD.

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ETHICAL CONSIDERATION

Ethics approval was obtained from The Joint Chinese University of Hong Kong – New Territories East Cluster Clinical Research Ethics Committee (reference number: 2016.699). Recruited subjects were provided with written and verbal information about the study by the investigators.

CONFLICT OF INTEREST

Tiffany Ching Man Choi, Lloyd Long Yu Chan, Hin Cheung Tsang, Yee Ping Vong, Yui Kwan Cheng, Yuk Ling To, Kah Lin Choo, Janelle Yorke declare that they have no conflict of interest.

AUTHOR CONTRIBUTIONS

Tiffany Ching Man Choi carried out the study design, manuscript drafting and paper submission. Lloyd Long Yu Chan carried out the study design, data collection and data analysis. Hin Cheung Tsang participated in the study design and manuscript drafting. Yee Ping Vong and Yui Kwan Cheng participated in the study design and data collection. Yuk Ling

To and Kah Lin Choo carried out overall study supervision. Janelle Yorke contributed expert opinion in study design and manuscript writing. All authors read and approved the final manuscript.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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SUPPORTING INFORMATION

Additional Supporting Information may be found online in the Supporting Information section.

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