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Title of the PhD Thesis: Effect of the addition of balance training to pulmonary rehabilitation for patients with chronic obstructive pulmonary disease

ABSTRACT

The purpose of this PhD thesis was in twofold. Firstly, to develop the cross-cultural adaptation of activities specific balance scale and test the measurement properties of Hindi adapted version of activities-specific balance scale (ABC-H), to establish the measurement properties hand held dynamometer and static and dynamic balance indices measured by HUMAC balance board. Study 1, 2 and 3 was undertaken to achieve the main objective, which was a prerequisite to accomplish the main aim. Secondly, to investigate the efficacy of balance training programme along with pulmonary rehabilitation (PR) program on functional capacity, pulmonary function, quality of life musculoskeletal and balance parameters in balance impaired moderate to severe stable COPD patients. Main study (study 4) was undertaken to achieve this second objective.

Study 1: Cross-cultural Adaptation Study

One hundred community-dwelling older adults participated in the study. ABC-H was developed through a standard cross-cultural adaptation procedure. Eight items from the original ABC scale were modified. A subsample of 50 subjects was re-assessed for test-retest reliability, standard error of measurement (SEM), minimum detectable change (MDC), and concurrent validity, using the fall efficacy scale (FES-I) to analyze the psychometric properties. The normative value of ABC-H total score observed in the Indian older population (n = 100) was 71%, ranging from 41.25 to 95.63. In the subsample of 50 subjects, test-retest reliability was excellent (ICC = 0.97). All 16 items had excellent to good internal consistency (Cronbach's α = 0.97 - 0.88); SEM was 2.45, $MDC_{95\%}$ was 6.9%, with excellent concurrent validity ($r = -0.85$, $p < 0.0001$).

Study 2: Predictive Validity Study

A total of 125 community-dwelling older adults completed the ABC-H scale. The occurrence of falls over the follow-up period of 12 months was recorded. Discriminative validity was analyzed by comparing the total ABC-H scale scores between the faller and non-faller groups. A receiver operating characteristic curve analysis and a logistic regression analysis was used to examine the predictive accuracy of the ABC-H scale. The optimal cut-off value for distinguishing faller and non-faller adults was $\leq$ 58.13%. The sensitivity, specificity, area under the curve and positive and negative likelihood ratios of the cut-off score were 86.3%, 87.3%, 0.91 ($p = 0.001$), 6.84, and 0.16, respectively. The percentage test accuracy and false-positive and false-negative rates were 86.87%, 12.2%, and 13.6%, respectively. A dichotomized total ABC-H scale score of $\leq$ 58.13% was significantly related with future falls.

Study 3: Reliability Study

Nineteen COPD patients with balance impairment participated in the study. Static (mCTSIB) and dynamic (LoS) balance was measured though HUMAC balance board, and maximal isometric strength of 6 lower-extremity muscle was measured with a Lafayette's hand held dynamometer. All the measurements were tested initially, after 48 hours after completion of 8-week pulmonary rehabilitation. Relative reliability ($ICC_{2,1}$) for all four test conditions which ranged for eye open firm surface (EOFS) (ICC = 0.81-0.98), eye close firm surface (ECFS) (ICC = 0.96-0.98), eye open compliant surface (EOCS) (ICC = 0.98-0.99) and eye closed foam surface (ECCS) (ICC = 0.82-0.96) for all balance indices (SI, OSI, MLSI, APSI). The SEM and $MDC_{95\%}$ was found lower ranged from 0.02 - 0.20 and 0.05 - 0.55 respectively across the four mCTSIB conditions. The test-retest reliability of the percentage directional control composite score (overall) resulted in an $ICC_{2,1}$ of 0.94. Test-retest reliability ($ICC_{2,1}$) for test duration of each direction ranged between 0.66 (for anterior left) to 0.88 (for posterior right). Excellent reliability was observed (0.93 to 0.98) for isometric muscle strength measured by HHD. The standard error of measurement (SEM) was ranged between 0.64 - 0.93, suggesting all these measures demonstrated high absolute reliability. The minimum detectable changes ($MDC_{95\%}$) for all the six muscle groups were ranged between 1.9 - 2.8 Kg. Responsiveness was demonstrated with a standardized response mean (SRM) ranged between 0.91- 2.27 and effect size of 0.91 to 2.21 for all six muscle groups.

Study 4: Main Study

Patients recruited for this 8-week study were medically diagnosed COPD. Total 57 COPD subjects randomly allocated into experimental group (n= 29) and control group (n= 28). The experimental group received balance training concurrent with pulmonary rehabilitation; however, the control group received only balance training 3- days/ week for 8- weeks. Overall results from this study demonstrated that in balance impaired COPD patients, 8-weeks of balance training concurrent with PR is well tolerated, improved postural balance measured by both clinical (BBS,TUG,FRT and ABC-H) and laboratory (mCTSIB, LoS) balance measures. Physical function, body composition, lower limb muscle strength improved from in both the group from baseline and there was no between group difference.

In conclusion this study demonstrated Hindi adapted version of ABC scale is valid and reliable measure to assess the balance confidence in older adults. This study established the use of ABC-H scale as a predictive tool for correctly identifying elderly individuals more susceptible to fall. The result of this study revealed that static and dynamic balance indices (mCTSIB, and LoS) measured by HUMAC balance board are reliable and responsive measures following pulmonary rehabilitation in COPD patients. Muscle strengths measured by HHD were also found to be reliable and responsive measure to assess muscle strength in COPD patients. The findings from our main study indicated that 8-weeks of balance training concurrent with pulmonary rehabilitation program had improved measures of clinical (BBS,TUG,FRT and ABC-H) as well quantitatively measures(mCTSIB, LoS) of postural balance and balance performance in comparison with PR only group. A significant improvement in lower limb muscle strength and body composition, functional capacity, health related quality of life was observed in both groups but it was not different from PR only group. No significant change was found in pulmonary function tests.

Abbreviation: mCTSIB: modified clinical test of sensory interaction on balance; LoS: limits of stability; COPD: chronic obstructive pulmonary disease