Recruitment of the diaphragm and sternocleidomastoid muscle during loaded inspiration on varying sitting support in healthy adults

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Objectives

(1) To investigate the relationship between diaphragm thickening friction with 4 different sitting conditions during loaded inspection among healthy adults

(2) To investigate the relationship between SCM activity with 4 different sitting conditions during loaded inspiration among healthy adults

Method

Ethical committee approval

Ethical committee approval was granted by the Research Ethics Committee of Hong Kong Metropolitan University (ethics approval number: HE-OT2023/13).

Sample size calculation

Sample size calculations are based on a repeated-measures analysis of variance (ANOVA). With an estimated effect size of 0.2 based on pilot data, an alpha level of 0.05, and a power of 0.8, the estimated sample size will be 36. To account for possible attrition, an additional 20% was incorporated, the final required sample size would be at least 45.

Participants

Participants included who are healthy, 18-35 years old without recent thoracic surgery, history of chronic respiratory illness. Exclusion involved (1) with known cardiovascular, pulmonary or musculoskeletal disorders that would limit their functional capacity (E.g. Asthma, COPD); (2) presence with respiratory symptoms over past 2 weeks; (3) pregnancy; (4) malignancy; (5) presence of neurological disorders (e.g. ALS, stroke); (6) PCS/ MCS in SF-12 scores below 50; (7) Findings in spirometry suggesting presence of obstructive or restrictive disorders.

Procedure

Participants have to complete the consent form after reading the information sheets. SF-12 will access the participants' health-related quality of life. Eligible participants will undertake a standard spirometry test. The maximum inspiratory pressure (MIP) will be determined with a threshold device (POWERbreathe, K5). Each participant will be instructed to use the device to perform, 15 breaths at 50% MIP with diaphragmatic instruction, with a rest period of 5 mins between sets, in random order, sitting on a chair (S1), sitting on a soft pad with feet supported on the ground (S2), sitting on a soft pad with feet supported by two soft pads (S3), and sitting on a soft pad with both feet supported by one soft pad (S4). Simultaneous surface electromyographic (sEMG) recording of the right sternocleidomastoid muscle and ultrasound of right diaphragmatic thickness will be conducted during each breath.

Measurements

Quality of life

The Physical Component Summary (PCS) and the Mental Component Summary (MCS) will be measured to quantify physical and mental wellbeing.

Spirometry respiratory function

Forced vital capacity, forced expiratory volume in 1 second, and MIP will be measured

following the American Thoracic Society guideline protocol.

Diaphragm thickness

Thickness of the right diaphragm at the end of each end-tidal inspiration, end-tidal expiration, and voluntary maximum inspiration will be evaluated by a high-resolution ultrasonography (Mindray M9) The recorded thickness over each set of last 10 breaths will be averaged. The diaphragmatic contraction will be reflected by the DTf, which will be calculated as the mean difference between the diaphragm thickness at the end of each loaded inspiratory condition and end-tidal expiration, divided by the diaphragm thickness at the end-tidal expiration.

Activity of the sternocleidomastoid muscle (SCM)

A Noraxon Ultium wireless sEMG system (Noraxon USA, Inc., Scottsdale, AZ, USA) will be used to detect the muscle recruitment activity of the right sternocleidomastoid muscle. On the 2 days of data collection, sEMG data over each set of 10 breaths will be averaged for data analysis.

Borg's scale

The Borg scale will be used to evaluate self-perceived exertion level at the end of each 10-breath set at each inspiratory pressure

Statistical analysis

All data will be analysed using the IBM SPSS Statistics for Windows, Version 25.0 (Armonk, NY: IBM Corp).
Change in DTf, muscle activity of sternocleidomastoid muscle and Borg's scale during each inspiratory protocol will be analysed using repeated-measure ANOVA.