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Research

Inspiratory muscle training improves respiratory muscle strength, functional capacity and quality of life in patients with chronic kidney disease: a systematic review

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KEY WORDS

Chronic renal insufficiency
Haemodialysis
Breathing exercises
Respiratory muscle training
Physical therapy

ABSTRACT

Questions: Does inspiratory muscle training improve respiratory muscle strength, functional capacity, lung function and quality of life of patients with chronic kidney disease? Does inspiratory muscle training improve these outcomes more than breathing exercises? **Design**: Systematic review and meta-analysis of randomised trials. **Participants**: People with chronic kidney disease undergoing dialysis treatment. **Intervention**: Inspiratory muscle training versus sham or no inspiratory muscle training, and inspiratory muscle training versus breathing exercises. **Outcome measures**: The primary outcomes were: maximal inspiratory pressure, maximal expiratory pressure, and distance covered on the 6-minute walk test. The secondary outcomes were: forced vital capacity, forced expiratory volume in the first second (FEV_1), and quality of life. **Results**: The search identified four eligible studies. The sample consisted of 110 participants. The inspiratory muscle training used a Threshold® or PowerBreathe® device, with a load ranging from 30 to 60% of the maximal inspiratory pressure and lasting from 6 weeks to 6 months. The studies showed moderate to high risk of bias, and the quality of the evidence was rated low or very low, due to the studies' methodological limitations. The meta-analysis showed that inspiratory muscle training significantly improved maximal inspiratory pressure (MD 23 cmH_2O, 95% CI 16 to 29) and the 6-minute walk test distance (MD 80 m, 95% CI 41 to 119) when compared with controls. Significant benefits in lung function and quality of life were also identified. When compared to breathing exercises, significant benefits were identified in maximal expiratory pressure (MD 6 cmH_2O, 95% CI 2 to 10) and FEV_1 (MD 0.24 litres 95% CI 0.14 to 0.34), but not maximal inspiratory pressure or forced vital capacity. **Conclusion**: In patients with chronic renal failure on dialysis, inspiratory muscle training with a fixed load significantly improves respiratory muscle strength, functional capacity, lung function and quality of life. The evidence for these benefits may be influenced by some sources of bias. **Registration**: PROSPERO CRD42015029986. **[de Medeiros AIC, Fuzari HKB, Rattes C, Brandão DC, de Melo Marinho PÉ (2017) Inspiratory muscle training improves respiratory muscle strength, functional capacity and quality of life in patients with chronic kidney disease: a systematic review. *Journal of Physiotherapy* 63: 76–83]**

Introduction

Chronic kidney disease is characterised by changes in kidney structure or function that are present for > 3 months and classified into different stages that take into account the cause, the glomerular filtration rate and albuminuria.[1] In end-stage kidney disease, renal replacement therapy is required to maintain homeostasis of metabolic function. The most common method of renal replacement is haemodialysis, which is used in the management of over two million people with kidney disease worldwide.[2,3]

People with chronic kidney disease commonly develop uraemic syndrome, which affects multiple systems, including the respiratory system, with complications such as pleural effusion, pulmonary hypertension, calcification of lung parenchyma and respiratory impairment.[4,5] Also as a result of uraemia, myopathy and loss of muscle mass are frequent, due to protein-energy wasting, which affects up to 75% of dialysis patients.[6] An in-vitro study[7] showed decreased strength of the soleus and diaphragm muscles after uraemia induction and an in-vivo study[8] illustrated delay in latency of the phrenic nerve in patients with chronic kidney disease. Thus, people with chronic kidney disease have reduced respiratory and peripheral muscle strength, and low cardiorespiratory conditioning; these complications limit participation in activities of daily living and increase mortality.[9,10]

In order to improve the performance of the respiratory muscles, inspiratory muscle training has been suggested for people with chronic kidney disease.[11] Inspiratory muscle training is helpful in several other patient populations, including: pulmonary and heart disease,[12,13] cardiac surgery,[14] thoracic surgery,[15] multiple sclerosis[16] and stroke.[17] Inspiratory muscle training improves respiratory performance by loading the respiratory system beyond its usual

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level of work.[18] People with chronic obstructive pulmonary disease increase the percentage of type I fibres and size of type II fibres in respiratory muscles after performing inspiratory muscle training.[19]

In people with chronic kidney disease, the benefits of aerobic and resistance exercise are well established in systematic reviews.[20,21] Some individual clinical trials of inspiratory muscle training in haemodialysis patients have identified favourable effects on conditioning and strength of respiratory muscles and a reduction in complications.[10,22] However, no systematic reviews have estimated the effects of inspiratory muscle training on respiratory muscle strength, functional capacity, lung function and quality of life in people with chronic kidney disease.

Therefore, the research questions for this systematic review were:

1. Does inspiratory muscle training improve respiratory muscle strength, functional capacity, lung function and quality of life of patients with chronic kidney disease?
2. Does inspiratory muscle training improve these outcomes more than breathing exercises?

Method

Identification and selection of studies

A search was performed in the databases PubMed, CINAHL, CENTRAL, Web of Science, Scopus, LILACS and PEDro. The IBICT bank of theses and dissertations was also searched. No search restrictions were applied regarding year or language of publication. The trial register ClinicalTrials.gov was also accessed to search for relevant studies. The following key words were used: 'Renal Insufficiency; Chronic', 'Kidney disease', 'Hemodialysis', 'Breathing Exercises', 'Inspiratory Muscle Training', 'Respiratory Muscle Training' and 'Clinical Trial', in different combinations (see Appendix 1 on the eAddenda for the full search strategy).

Two independent reviewers evaluated the titles and abstracts of articles found in the searches against the eligibility criteria (Box 1). If there were disagreements between reviewers, a third reviewer arbitrated. All articles that were considered potentially eligible on review of the title and abstract were obtained in full text. Each article that was considered eligible for inclusion in the review had its reference list searched for further eligible publications. Duplicate articles were removed during the assessment of the studies' characteristics.

Assessment of characteristics of studies

Quality

The included studies were assessed using the Cochrane Risk of Bias Tool, which classifies the risk of bias as high, low or unclear.

Box 1. Inclusion criteria.

Design
- Randomised trial

Participants
- Adults (>18 years old)
- Receiving haemodialysis
- Haemodynamically stable

Intervention
- Inspiratory muscle training using linear load

Outcomes
- Primary: pulmonary function, functional capacity
- Secondary: respiratory muscle strength, quality of life

Comparisons
- Inspiratory muscle training versus no or sham intervention
- Inspiratory muscle training versus breathing exercises

Risk of bias was considered: high if a methodological procedure was not described, unclear if the description was unclear, and low if the procedure was described in detail.

The Grading of Recommendations Assessment, Developing and Evaluation (GRADE)[23] tool was used to analyse the quality of the evidence. The GRADE tool considers study limitations, consistency, targeting, precision and publication bias. The assessment of these criteria guides the classification of the evidence into one of four quality levels: high, moderate, low and very low.

Participants

Studies were included if the participants: were > 18 years old, had chronic kidney disease stage 5, and were receiving regular haemodialysis. The data extracted about the participants were age and gender.

Intervention

The experimental intervention of this research was inspiratory muscle training with devices[a,b] that provide a linear load, used in either the intradialytic or interdialytic phase. The data extracted about the intervention were the device used, the load used, and the duration and frequency of training. The control intervention was either no training or sham training. The comparison intervention was another breathing exercise.

Outcome measures

The primary outcome measures in this systematic review were respiratory muscle strength and functional capacity. The measures of respiratory muscle strength were inspiratory and expiratory muscle strength, each assessed using manovacuometry and expressed in cmH_2O. The measure of functional capacity was the distance walked in the 6-minute walk test and expressed in metres.

The secondary outcome measures were lung function and quality of life. The measures of lung function were: forced vital capacity (FVC) and forced expiratory volume in the first second (FEV_1); each was assessed by spirometry and expressed in litres. The measure of quality of life was the Kidney Disease Quality of Life Instrument Short Form questionnaire, which is scored from 0 to 100.

Data analysis

Two reviewers used standard forms to extract data about the characteristics of studies. Data for continuous variables were extracted, pooled using meta-analysis, and expressed as mean difference with a 95% confidence interval. The meta-analyses were performed with standard software[c] and using random effects models.

Results

Identification and selection of studies

The search resulted in 169 potentially relevant articles. After removal of duplicates, 96 articles were screened by title and abstract, of which 90 were excluded and six were assessed in the full-text version. Among the articles obtained in full text, one was excluded due to its ineligible study design and another due to an ineligible intervention (ie, inspiratory muscle training without linear load). The remaining four studies were included in the systematic review (Figure 1).

Characteristics of the included studies

The characteristics of the study are presented in Table 1. The risk of bias analysis is presented in Figure 2.