TUGAS AKHIR KARDIOPULMONAL
(RESUM JURNAL)

Disusun Oleh :

NAMA : FIRDONA ADI PUTRA

NIM : 1810601185

KLAS : 6C

PROGRAM STUDI FISIOTERAPI

FAKULTAS ILMU KESEHATAN

UNIVERSITAS 'AISYIYAH YOGYAKARTA

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Resume jurnal 1

Fisioterapi Dada Dan Batuk Efektif Sebagai Penatalaksanaan Ketidakefektifan Bersihan Jalan Nafas Pada Pasien TB Paru Di RSUD Kota Kendari.

Latar belakang

Tuberkulosis (TB) merupakan penyakit menular yang menyebabkan kematian tertinggi kedua di dunia setelah HIV/AIDS. Penyakit TB paru ditularkan melalui airborne yaitu inhalasi droplet yang kuman mycobacterium tuberculosis. Pasien TB paru akan mengeluh batuk yang disertai dahak dan atau batuk berdarah, sesak napas, nyeri pada daerah dada, keringat pada malam hari, penurunan nafsu makan. Ketidakefektifan bersihan jalan nafas adalah ketidakmampuan membersihkan sekresi atau penyumbatan pada saluran nafas untuk mempertahankan bersihan jalan nafas. Obstruksi saluran napas disebabkan oleh menumpuknya sputum pada jalan napas yang akan mengakibatkan ventilasi menjadi tidak adekuat. Untuk itu perlu dilakukan tindakan memobilisasi pengeluaran sputum agar proses pernapasan dapat berjalan dengan baik guna mencukupi kebutuhan oksigen tubuh. Intervensi keperawatan yang bisa diterapkan untuk membersihkan sputum pada jalan napas adalah fisioterapi dada dan batuk efektif.

Metode

1. Jenis penelitian : jenis penelitian ini adalah penelitian deskriptif dengan pendekatan observational
2. Lokasi dan waktu : Studi kasus berlokasi di Ruang Lavender RSUD Kota Kendari.
3. Studi kasus dilaksanakan mulai bulan Maret – April 2019.
4. Populasi dan sampel : Sampel dalam studi kasus ini berfokus pada satu orang pasien yang menjalani perawatan di RSUD Kota Kendari dengan diagnosa medis TB paru dan diagnosa keperawatan ketidakefektifan bersihan jalan napas dengan kriteria yaitu pasien dengan diagnosa medis TB paru tanpa disertai hemaptoe, kesadaran komposmentis, tidak mengalami gangguan pada thorax danpunggung atau tulang belakang.

5. Pengumpulan data : Data dalam studi kasus ini dibagi menjadi dua, yaitu data primer dan data sekunder. Data primer diperoleh dari pengkajian, observasi dan wawancara dengan pasien. Data sekunder diperoleh dari rekam medis dan wawancara dengan keluarga yang mendampingi pasien selama menjalani perawatan.

Hasil

Hasil pengkajian didapatkan identitas pasien berinisial Tn. D umur 36 tahun, suku Tolaki, beragama Islam, pekerjaan Wirasuasta, pendidikan terakhir SMA, alamat Desa Lalonggombu Kecamatan Lainea Kabupaten Kobawe Selatan. Keluhan utama saat masuk RS adalah demam, batuk berlendir disertai bercak darah, sesak nafas, nafsu makan menurun, ronchi, wajah nampak pucat, mukosa bibir kering, TD 100/70 mmhg, Nadi 82x/menit, pernapasan tidak teratur dengan frekuensi (RR)27x/menit. Penerapan fisioterapi dada dan batuk efektif dilaksanakan selama 3 hari, dengan frekuensi latihan 2x dalam sehari pada pagi (P) dan sore (S) hari.

Pembahasan

Subjek studi kasus dalam hal ini adalah pasien TB paru mengalami masalah keperawatan ketidakefektifan bersihan jalan napas. Berdasarkan Nursing Intervention Clasification (NIC), salah satu intervensi mandiri yang dapat dilakukan perawat untuk mengatasi masalah tersebut adalah fisioterapi dada dan mengajarkan teknik batuk efektif (Bulechek, & Butcher, 2013). Sedangkan keberhasilan intervensi ini dinilai berdasarkan kepatenan jalan napas yang terdiri dari empat kriteria hasil yaitu frekuensi napas, irama napas, suara napas tambahan, dan kemampuan mengeluarkan sputum.

Kesimpulan

Kesimpulan dari studi kasus ini adalah fisioterapi dada dan batuk efektif dapat digunakan sebagai penatalaksanaan ketidakefektifan bersihan jalan nafas pada pasien TB paru dengan kriteria hasil kepatenan jalan napas yang ditandai dengan frekuensi napas normal, irama napas teratur, tidak ada suara napas tambahan, pasien mampu mengeluarkan sputum.

Resume Jurnal 2

The Effect of Pulmonary Rehabilitation in Mountain Environment on Exercise Capacity and Quality of Life in Patients with Chronic Obstructive Pulmonary Disease (COPD) and Chronic Bronchitis

Latar Belakang

Penyakit paru-paru khususnya penyakit paru obstruksi kronis (PPOK) dalam bahasa inggris disingkat COPD menjadi penyebab kematian terbesar ke 3 didunia. Terjadinya penyakit tersebut sering disebabkan oleh pola hidup tidak sehat seprti merokok, terpapar polusi udara, usia, dan lainnya. Banyak terapi yang dilakukan untuk mengurangi keparahan dari penyakit tersebut salah satunya dengan Climatotherapy. Terapi ini dilakukan diketinggian tertentu dan pada area yang sejuk seperti pegunungan.

Tujuan

Untuk mengetahui efektifitas climatotherapy terhadap penyakit pulmonal seperti PPOK dan bronkitis kronis

Metode

pasien yang terlibat sebanyak 90 orang dengan PPOK dan 38 orang penderita CB (chronic bronchitis). Pasien PPOK diperiksa menggunakan spirometri dan pasien CB diperiksa sesuai dengan gejala yang dialami seperti pemeriksaan sputum dll.

Intervensi

terapi dilakukan didaerah Slovak, pada suatu resort dipegunungan dengan ketinggian 760-1067 meter diatas permukaan laut. Dilakukan selama 3 minggu oleh pengawasan fisioterapi, psikolog, dan tenaga medis lain. Latihan yang dilakukan diantaranya adalah strength training, respiratory physiotherapy (breathing exercise, purse lip breathing dll), physical therapy (massage, relaxation dll), hydrotherapy, dan climatotherapy. Latihan dengan frekuensi 5x/minggu. Tidak lupa pasien diberikan edukasi untuk tetap menjalankan latihan setelah penelitian ini, menjaga pola makan sehat, dan menjaga berat badan agar tetap stabil.

Alat ukur

spirometry (FEV1 and FEV1/FVC), 6MWT, Borg scale of dyspnea, depression, anxiety, dan QoL assessment.

Hasil

Terjadi penurunan kecemasan atau anxiety lebih signifikan pada pasien CB daripada pasien PPOK/COPD. Kualitas hidup juga meningkat pada kedua pasien tersebur diukur menggunakan QoL measurement. Terapi dipegunungan atau climatetherapy berpotensi untuk meninhkatkan pulmonary function (FEV1) dan 6MWT. Tetapi, kualitas sesak nafas dan jarak berjalan harus diperhatikan khususnya pada pasien COPD karena beberapa dari mereka rawan mengalami sesak setelah latihan.

Disisi lain menurut Karagiannidis et al. Climatetherapy dapat mengurangi gejala asma dan juga menurunkan tingkat inflamasi pada traktus respirasi (saluran pernafasan). Pada pasien COPD juga ditemukan penurunan obstruksi paru setelah dilakukan treatment climatetherapy.

Kesimpulan

Climate treatment cukup efektif dalam mengurangi keparahan pasien COPD dan CB. Dibuktikan dengan peningkatan FEV, 6MWT, penurunan kecemasan, dan peningkatan kualitas hidup mereka diukur dengan indeks QoL.

Resume jurnal 3

Effects of physical therapy on lung function in children with asthma: Study protocol for a systematic review and meta-analysis

Latar Belakang

Morbiditas penyakit asma pada anak semakin meningkat yang secara signifikan mempengaruhi kualitas hidup anak. Meskipun terapi pengobatan, terapi fisik, termasuk latihan pernapasan, pelatihan otot inspirasi, dan pelatihan fisik, secara luas digunakan untuk memperbaiki kondisi anak-anak. Namun, efektivitas terapi fisik masih belum jelas. Tinjauan sistematis ini dan meta-analisis bertujuan untuk mengevaluasi efek terapi fisik pada fungsi paru-paru pada anak-anak dengan asma dan untuk menilai yang mana terapi fisik lebih efektif. Terapi obat telah digunakan untuk mengontrol asma sejak lama waktu. Terlepas dari pengobatannya, terapi fisik adalah hal lain pengobatan penting untuk anak penderita asma dan banyak digunakan pada dunia. Terapi fisik utama untuk asma adalah pernapasan latihan, pelatihan otot inspirasi, dan pelatihan fisik.

Metode

Jenis studi.

Hanya RCTs yang akan disertakan. Studi tersebut harus diterbitkan dalam bahasa Inggris sebelum atau pada 31 Maret 2019. Kami akan mengecualikan studi yang tidak ditulisdalam bahasa Inggris karena bias bahasa.

Jenis peserta

Populasi yang termasuk harus berusia kurang dari 18 tahun tanpa batasan gender atau etnis. Kami akan mengecualikan studi dengan peserta berusia ≥ 18 tahun. Diagnosis asmaharus didefinisikan dengan jelas pada semua peserta dalam studi yang disertakan.

Jenis intervensi

Intervensi fisioterapi untuk asma meliputi pelatihan fisik, latihan pernapasan, dan pelatihan otot inspiratory (IMT). Kami tidak akan mempertimbangkan studi dengan intervensi mengenai farmakologi, psikolo- gy, atau perilaku. Fisioterapi harus dilakukan selama ≥ 2 minggu.

Jenis langkah-langkah hasil

QoL akan dibandingkan antara kelompok eksperimental dan kelompok kontrol. Untuk mengevaluasi kualitas hidup, Pediatric Asthma Quality of Life Questionnaire (PAQLQ) harus digunakan dalam studi dan skor harus dilaporkan. PAQLQ terdiri dari 3 domain, termasuk gejala, keterbatasan aktivitas, dan fungsi emosional.

PubMed, Embase, dan Cochrane Library dicari sejak awal hingga 31 Maret 2019 untuk uji coba terkontrol acak (RCTs) yang diterbitkan dalam bahasa Inggris, yang menyelidiki efektivitas fisioterapi pada QoL pada anak-anak dengan asma. Selain itu, studi tambahan akan dicari dengan memindai daftar referensi studi dan tinjauan sistematis yang relevan. Dua penulis akan memilih studi, mengekstrak data, dan menilai risiko bias secara independen. Sintesis data dan analisis statistik akan dilakukan di Manajer ulasan 5.3. Stata 14.0 akan digunakan untukmenilai bias pelaporan. Kualitas bukti akan dievaluasi berdasarkan sistem Penilaian, Pengembangan, dan Evaluasi Rekomendasi (GRADE).

Hasil

Fisioterapi seperti pelatihan fisik telah terbukti bermanfaat bagi anak-anak yang sehat dengan meningkatkan kesehatan muskuloskeletal dan kesehatan mental mereka. Namun, efek fisioterapi pada anak-anak asma tetap tidak pasti. Publikasi sebelumnya telah melaporkan efek fisioterapi pada pasien dengan asma, tetapi penelitian ini termasuk anak-anak dan orang dewasa, atau orang dewasa saja. Meskipun beberapa ulasan sistematis tidak termasuk orang dewasa, mereka hanya menyelidiki efek dari satu jenis fisioterapi. Dengan demikian, kita akan memasukkan berbagai jenis fisioterapi dan anak-anak asma hanya untuk melakukan tinjauan sistematis dan meta-analisis. Tinjauan sistematis ini akan mengkalsinasi efektivitas fisioterapi

pada QoL pada anak-anak asma dan menunjukkan terapi fisio mana yang lebih membantu. Ini akan memberikan bukti langsung kepada dokter untuk membuat pilihan pada pengobatan asma.

Kesimpulan

Beberapa meta analisis hanya melibatkan anak-anak, mereka hanya memeriksa efeknya dari satu jenis terapi fisik pada anak-anak dengan asma tapi tidak termasuk semua 3 terapi utama. Oleh karena itu, memang demikian diperlukan untuk melakukan tinjauan sistematis dan meta-analisis untuk menyelidiki efek terapi fisik pada fungsi paru-paru di anak-anak dengan asma dan menunjukkan terapi fisik yang mana lebih efektif. Studi ini akan membantu dokter yang merawat asma pada anak-anak dan memberikan beberapa informasi yang berguna kapan mereka membuat pilihan untuk jenis terapi fisik yang mana digunakan.

Sumber :

Kubincová, Anna, dkk. 2018. *The Effect of Pulmonary Rehabilitation in Mountain Environment on Exercise Capacity and Quality of Life in Patients with Chronic Obstructive Pulmonary Disease (COPD) and Chronic Bronchitis* https://pubmed.ncbi.nlm.nih.gov/30206201/ . April 15, 2021.

Tahir, Rusna, dkk. 2019. *Fisioterapi Dada dan Batuk Efektif sebagai Penatalaksanaan Ketidakefektifan Bersihan Jalan Nafas pada Pasien TB Paru di RSUD Kota Kendari*. https://www.neliti.com/id/publications/296596/fisioterapi-dada-dan-batuk-efektif-sebagai-penatalaksanaan-ketidakefektifan-bers . April 15, 2021.

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Fisioterapi Dada Dan Batuk Efektif Sebagai Penatalaksanaan Ketidakefektifan Bersihan Jalan Nafas Pada Pasien TB Paru Di RSUD Kota Kendari

Rusna Tahir [1], Dhea Sry Ayu Imalia S [2], Siti Muhsinah[3]
[123]Jurusan Keperawatan Poltekkes Kemenkes Kendari

ABSTRACT

Backgorund: Pulmonary tuberculosis is an infection disease with the highest prevalence in the world and being the third largest in Indonesia with 1.02 million cases. The core problem of pulmonary tuberculosis patient is ineffective airway clearance characterized by dyspnea, ronchi, excessive sputum, ineffective cough. Nursing intervention to manage the problem is chest physiotherapy and effective coughing. **Objective:** This study aims to obtain an overview of the application of chest physiotherapy and effective coughing as ineffective airway clearance management on pulmonary tuberculosis patient. **Method:** Method used descriptive case study with structured interview, studies document and observations. Participants in this study is pulmonary tuberculosis patient which is given three days and twice a day session of chest physiotherapy and effective coughing. **Results:** Patency of the airway is improve after chest physiotherapy and effective coughing which characterized by normal respiratory frequencies, normal respiratory rythms, no ronchi and able to remove sputum from airway. **Conclusion:** Chest physiotherapy and effective coughing is applicable as ineffective airway clearance management on pulmonary tuberculosis patient.

Keywords : *pulmonary tuberculosis, ineffective clearance airway, chest physiotherapy and effective coughing*

PENDAHULUAN

Latar Belakang

Tuberkulosis (TB) merupakan penyakit menular yang menyebabkan kematian tertinggi kedua di dunia setelah HIV/AIDS (WHO, 2015). *World Health Organization* (WHO) menunjukkan peningkatan prevalensi kasus TB dari 9,6 juta menjadi 10,4 juta pada tahun 2016. Indonesia menduduki peringkat kedua dunia dengan penyakit TB terbanyak yaitu 1,2 juta kasus dengan angka kematian 100.000 jiwa setiap tahun (*Global Tuberculosis Report*, 2016).

Kejadian TB di Sulawesi Tenggara bukan yang tertinggi di Indonesia, akan tetapi mengalami peningkatan jumlah setiap tahun. Pada Tahun 2017 tercatat sebanyak 2.587 kasus baru BTA positif, yang tersebar pada empat Kabupaten dengan penderita terbanyak yakni Kota Kendari, Kabupaten Konawe, Kolaka, dan Bau-Bau. Di RSUD Kota Kendari sebagai salah satu RS rujukan Provinsi, tercatat 545 penderita TB dalam rekam medis pernah menjalani perawatan di 2017 (Rekam Medik RSUD Kota Kendari, 2018). Angka ini diperkirakan terus mengalami lonjakan seiring dengan bertambahnya populasi masyarakat yang tinggal di Kota Kendari.

Penyakit TB paru ditularkan melalui *airborne* yaitu inhalasi droplet yang mengandung kuman *mycobacterium tuberculosis.* Pasien TB paru akan mengeluh batuk yang disertai dahak dan atau batuk berdarah, sesak napas, nyeri pada daerah dada, keringat pada malam hari, penurunan nafsu makan. Pemeriksaan fisik menunjukkan tanda-tanda berupa peningkatan frekuensi napas, irama nafas tidak teratur, dan ronchi (Ardiansyah, 2012). Merujuk pada manifestasi tersebut, masalah keperawatan yang umum terjadi pada pasien TB paru adalah ketidakefektifan bersihan jalan napas (Herdman, 2018).

Ketidakefektifan bersihan jalan nafas adalah ketidakmampuan membersihkan sekresi atau penyumbatan pada saluran nafas untuk mempertahankan bersihan jalan nafas (Herdman, 2018). Obstruksi saluran napas disebabkan oleh menumpuknya sputum pada jalan napas yang akan mengakibatkan ventilasi menjadi tidak adekuat. Untuk itu perlu dilakukan tindakan memobilisasi pengeluaran sputum agar proses pernapasan dapat berjalan dengan baik guna mencukupi kebutuhan oksigen tubuh (Endrawati, Aminingsih S, & Ariasti D, 2014).

Salah satu intervensi keperawatan yang bisa diterapkan untuk membersihkan sputum pada jalan napas adalah fisioterapi dada dan batuk efektif. Banyak penelitian yang telah

membuktikan fisioterapi dada dan dan batuk efektif dapat membantu pasien mengeluarkan sputum (Nugroho, 2011 ; Kapuk, 2012 ; Endrawati, Aminingsih S, & Ariasti D, 2014 ; Maidartati, 2014). Fisioterapi dada dan batuk efektif dinilai efektif karena bisa dilakukan oleh keluarga, mudah dan bisa dilakukan kapan saja.

Rumusan Masalah

Berdasarkan uraian latar belakang diatas, maka rumusan masalah pada studi kasus ini adalah bagaimana penerapan fisioterapi dada dan batuk efektif sebagai penatalaksanaan ketidakefektifan bersihan jalan nafas pada pasien TB paru?

Tujuan

Tujuan pelaksanaan studi kasus ini adalah untuk mengetahui gambaran penerapan fisioterapi dada dan batuk efektif sebagai penatalaksanaan ketidakefektifan bersihan jalan nafas pada pasien TB paru di RSUD Kota Kendari.

METODE

Jenis Penelitian

Jenis penelitian ini adalah deskiftif dengan pendekatan observasional melalui studi kasus untuk memperoleh gambaran penerapan fisioterapi dada dan batuk efektif pada pasien TB paru.

Lokasi dan Waktu Penelitian

Studi kasus berlokasi di Ruang Lavender RSUD Kota Kendari. Studi kasus dilaksanakan mulai bulan Maret – April 2019.

Populasi dan Sampel

Sampel dalam studi kasus ini berfokus pada satu orang pasien yang menjalani perawatan di RSUD Kota Kendari dengan diagnosa medis TB paru dan diagnosa keperawatan ketidakefektifan bersihan jalan napas dengan kriteria yaitu pasien dengan diagnosa medis TB paru tanpa disertai hemaptoe, kesadaran komposmentis, tidak mengalami gangguan pada thorax dan punggung atau tulang belakang.

Pengumpulan Data

Data dalam studi kasus ini dibagi menjadi dua, yaitu data primer dan data sekunder. Data primer diperoleh dari pengkajian, observasi dan wawancara dengan pasien. Data sekunder diperoleh dari rekam medis dan wawancara dengan keluarga yang mendampingi pasien selama menjalani perawatan.

Pengkajian menggunakan format pengkajian kebutuhan oksigenasi. Alat ukur yang digunakan sebagai evaluasi tindakan adalah lembar observasi yang berisi SOP serta lembar observasi penilaian merujuk pada *Nursing Outcome Clasification* (NOC) serta buku Standar Luaran Keperawatan Indonesia (SLKI) untuk menilai kepatenan jalan napas yang ditandai dengan frekuensi napas (16-20x/menit), irama napas reguler, kemampuan mengeluarkan sputum, tidak ada suara napas tambahan.

Kepatenan jalan napas dievaluasi dua kali dalam sehari (pagi dan sore) selama tiga hari berturut-turut setelah tindakan fisioterapi dada dan batuk efektif (Tarwoto dan Wartonah, 2015 ; Kasanah, 2015 ; Laukhil, 2016). Fisioterapi dada dan batuk efektif dilakukan sebelum pasien minum obat untuk mengurangi bias dalam studi kasus.

Pengolahan, Analisis Data, Penyajian Data

Data diperoleh dari hasil pengkajian, observasi, wawancara dan serta studi dokumen berupa rekam medik. Data ditampilkan secara tekstural atau narasi disertai dengan ungkapan verbal dan respon dari subjek studi kasus yang merupakan data pendukung penelitian. Data menerangkan beragam aspek dari pasien kemudian dibandingkan dengan data normal sesuai rujukan referensi. Hasil analisa data-data ditampilkan dalam bentuk tabel.

HASIL

Hasil pengkajian didapatkan identitas pasien berinisial Tn. D umur 36 tahun, suku Tolaki, beragama Islam, pekerjaan Wirasuasta, pendidikan terakhir SMA, alamat Desa Lalonggombu Kecamatan Lainea Kabupaten Kobawe Selatan. Keluhan utama saat masuk RS adalah demam, batuk berlendir disertai bercak darah, sesak nafas, nafsu makan menurun, ronchi, wajah nampak pucat, mukosa bibir kering, TD 100/70 mmhg, Nadi 82x/menit, pernapasan tidak teratur dengan frekuensi (RR) 27x/menit.

Penerapan fisioterapi dada dan batuk efektif dilaksanakan selama 3 hari, dengan frekuensi latihan 2x dalam sehari pada pagi (P)

dan sore (S) hari. Hasil yang diperoleh sebagai berikut :

a. Frekuensi pernapasan

Tabel 1. Frekuensi Pernafasaan Sebelum Dan Setelah Fisioterapi Dada Dan Batuk Efektif

No	Hari Latihan	Frekuensi Nafas (Kali/Menit)			
		Sebelum (P)	Setelah (P)	Sebelum (S)	Setelah (S)
1	Hari 1	27x/menit	27x/menit	27x/menit	27x/menit
2	Hari 2	27x/menit	26x/menit	26x/menit	25x/menit
3	Hari 3	25x/menit	24x/menit	24x/menit	24x/menit

Dari tabel diatas dapat dilihat bahwa setelah dilakukan tindakan fisioterapi dada dan batuk efektif terjadi penurunan RR dari 27x/menit menjadi 26x/menit pada hari kedua sesi pagi dan dari 26x/menit menjadi 25x/menit pada sesi sore. Terjadi penurunan dari 25x/menit menjadi 24x/menit (RR normal) pada hari ketiga pada sesi pagi dan sore hari.

b. Suara napas tambahan

Tabel 2. Suara Napas Tambahan Sebelum Dan Setelah Fisioterapi Dada Dan Batuk Efektif

No	Hari Latihan	Suara Nafas tambahan			
		Sebelum (P)	Setelah (P)	Sebelum (S)	Setelah (S)
1	Hari 1	Ada(ronchi)	Ada(ronchi)	Ada(ronchi)	Ada(ronchi)
2	Hari 2	Ada(ronchi)	Ada(ronchi)	Ada(tonchi)	Tidak ada
3	Hari 3	Tidak ada	Tidak ada	Tidak ada	Tidak ada

Dari tabel diatas dapat dilihat bahwa setelah dilakukan tindakan fisioterapi dada dan batuk efektif suara napas tambahan (ronchi) tidak terdengar lagi pada hari kedua sesi sore sampai pada hari ketiga baik pada sesi pagi maupun sore.

c. Irama napas

Tabel 3. Irama Pernapasan Sebelum Dan Setelah Fisioterapi Dada Dan Batuk Efektif

No	Hari Latihan	Irama Pernapasan			
		Sebelum (P)	Setelah (P)	Sebelum (S)	Setelah (S)
1	Hari 1	Tidak teratur	Tidak Teratur	Tidak teratur	Tidak Teratur
2	Hari 2	Tidak teratur	Tidak steratur	Tidak teratur	Teratur
3	Hari 3	Teratur	Teratur	Teratur	Teratur

Dari tabel diatas dapat dilihat bahwa setelah dilakukan tindakan fisioterapi dada dan batuk efektif terjadi perubahan irama napas dari tidak teratur menjadi teratur pada hari kedua sesi sore. Selanjutnya pada hari ketiga irama napas normal baik pada sesi pagi maupun sore.

d. Kemampuan mengeluarkan sputum

Tabel 3. Kemampuan Mengeluarkan Sputum Sebelum Dan Setelah Fisioterapi Dada Dan Batuk Efektif

No	Hari Latihan	Kemampuan mengeluarkan sputum			
		Sebelum (P)	Setelah (P)	Sebelum (S)	Setelah (S)
1	Hari 1	Tidak Mampu	Mampu	Mampu	Mampu
2	Hari 2	Mampu	Mampu	Mampu	Mampu
3	Hari 3	Mampu	Mampu	Mampu	Mampu

Dari tabel diatas dapat dilihat bahwa setelah dilakukan tindakan fisioterapi dada dan batuk efektif pasien mampu (M) mengeluarkan sputum pada hari pertama sesi pagi sampai hari ketiga.

e. Kepatenan jalan napas

Tabel 4. Kepatenan Jalan Napas Sebelum Dan Setelah Fisioterapi Dada Dan Batuk Efektif

Hari	KEPATENAN JALAN NAFAS									
	RR (kali/menit)		Irama Pernafasan		Suara Nafas Tambahan		Kemampuan Mengeluaran Sekret		Kriteria	
	S.1	S.2	S.1	S.2	S1	S2	S.1	S.2	S.1	S.2
1	27	27	TT	TT	Ada	Ada	M	M	TP	TP
2	26	25	TT	T	Ada	Tidak ada	M	M	TP	P
3	24	24	T	T	Tidak ada	Tidak ada	M	M	P	P

Dari tabel diatas dapat dilihat bahwa setelah dilakukan tindakan fisioterapi dada dan batuk efektif terjadi perubahan kepatenan jalan napas pada hari kedua sesi sore hari yang ditandai dengan RR normal (24x/menit), irama napas teratur, tidak ada ronchi, serta pasien mampu mengeluarkan sputum. Kepatenan jalan napad dapat dipertahankan sampai hari ketiga.

PEMBAHASAN

Subjek studi kasus dalam hal ini adalah pasien TB paru mengalami masalah keperawatan ketidakefektifan bersihan jalan napas. Berdasarkan *Nursing Intervention Clasification* (NIC), salah satu intervensi mandiri yang dapat dilakukan perawat untuk mengatasi masalah tersebut adalah fisioterapi dada dan mengajarkan teknik batuk efektif (Bulechek, & Butcher, 2013). Sedangkan keberhasilan intervensi ini dinilai berdasarkan kepatenan jalan napas yang terdiri dari empat kriteria hasil yaitu frekuensi napas, irama napas, suara napas tambahan, dan kemampuan mengeluarkan sputum (Moorhead, S & Johnson, M, 2013). Pembahasan masing-masing kriteria hasil sebagai berikut :

a. Frekuensi Pernapasan

Pada hari pertama pelaksanaan tindakan fisioterasi dada dan batuk efektif, hasil yang diperoleh yaitu terjadi penurunan RR pada hari kedua yaitu 26x/menit dan hari ketiga menjadi normal (24x/menit). Hasil ini sejalan dengan penelitian Sitorus, Lubis dan Kristiani (2018) pada pasien TB paru dengan hasil yaitu suara

nafas normal/vesikuler, RR 24x/menit, TD 100/70mmHg, N 89x/menit, S 37^{o}C. Juga didukung oleh penelitian Tarwoto dan Wartonah (2015) melalui evaluasi pasien selama 3 hari setelah tindakan fisioterapi dada yaitu penurunan RR dari 27x/menit menjadi 22x/menit. Penelitian sebelumnya membuktikan bahwa adanya kesesuaian terhadap hasil yang dicapai yaitu frekuensi napas menjadi normal.

Mobilisasi sputum dari saluran napas setelah fisioterapi dada akan membuat rongga alveoli menjadi lebih lebar sehingga tekanannya mengecil mengakibatkan pengembangan alveoli lebih maksimal. Pengembangan alveoli secara maksimal akan mendukung ventilasi yang adekuat untuk dapat meningkatkan asupan oksigen yang lebih banyak keparu sehingga mengurangi keluhan sesak napas pada pasien (Khotimah, 2013).

b. Suara Napas Tambahan

Hasil penelitian menunjukkan bahwa setelah dilakukan latihan fisioterapi dada dan batuk efektif suara napas tambahan (ronchi) tidak terdengar lagi pada hari kedua sesi sore sampai pada hari ketiga baik pada sesi pagi maupun sore. Bunyi ronchi disebabkan karena aliran udara melalui saluran nafas yang berisi sputum atau eksudat. Sputum dijalan nafas dapat dimobilisasi keluar melalui fisioterapi dada dan batuk efektif (Kusuma, 2015).

Keluarnya sputum membuat saluran nafas bebas dari sputum sehingga tidak terdengar lagi ronchi. Hal ini ditunjang dengan teori yang menyebutkan bahwa batuk efektif akan membantu proses pengeluaran sekret yang menumpuk pada jalan nafas sehingga tidak ada lagi perlengketan pada jalan nafas sehingga jalan nafas paten dan sesak nafas berkurang (Nugroho, 2011).

c. Irama Pernapasan

Hasil penelitian menunjukkan bahwa setelah tindakan fisioterapi dada dan batuk efektif terjadi perubahan irama napas dari tidak teratur menjadi teratur pada hari kedua sesi sore. Selanjutnya pada hari ketiga irama napas normal baik pada sesi pagi maupun sore. Perubahan irama napas terjadi seiring dengan normalnya frekuensi pernapasan.

Frekuensi nafas yang normal dan keteraturan irama pernafasan terjadi kerena kecukupan suplai oksigen dalam paru yang akan didistibusikan ke suluruh tubuh. Saluran napas yang bebas dari sekret yang menumpuk akan memudahkan transport oksigen dari saluran pernapasan menuju paru-paru. Kecukupan suplay oksigen dalam tubuh ditandai dengan AGD dalam batas normal (McPhee & Ganong, 2010).

d. Kemampuan Mengeluarkan Sputum

Kemampuan mengeluarkan sekret pasien ditunjukkan pada hari pertama sampai hari terakhir pemberian tindakan fisioterapi dada dan batuk efektif. Kemampuan mengeluarkan sekret berkaitan dengan kemampuan pasien melakukan batuk efektif. Batuk yang efektif dapat mendorong sekret yang menumpuk pada jalan nafas untuk keluar. Setelah dilakukan latihan fisioterapi dada dan batuk efektif selama 3 hari maka didapatkan hasil bahwa pasien mampu mengeluarkan sekret karena bisa melakukan batuk dengan efektif.

Hal ini ditunjang dengan teori yang menyebutkan bahwa dengan dilakukan batuk efektif akan membantu proses pengeluaran sekret yang menumpuk pada jalan nafas sehingga tidak ada lagi perlengketan pada jalan nafas sehingga jalan nafas paten dan sesak nafas berkurang (Nugroho, 2011).

e. Kepatenan Jalan Napas

Hasil penelitian menunjukkan bahwa setelah dilakukan tindakan fisioterapi dada dan batuk efektif terjadi perubahan kepatenan jalan napas pada hari kedua sesi sore hari yang ditandai dengan RR normal (24x/menit), irama napas teratur, tidak ada ronchi, serta pasien mampu mengeluarkan sputum. Kepatenan jalan napad dapat dipertahankan sampai hari ketiga.

Indikator dari kepatenan jalan napas adalah RR normal, irama napas teratur, tidak ada suara napas tambahan, serta pasien mampu mengeluarkan sputum dari jalan napas. Kepatenan jalan napas dapat dicapai melaui tindakan fisoterapi dada dan batuk efektif karena tindakan ini dapat memobilisasi secret di saluran napas yang meningkatkan fungsi respirasi (Maidartati, 2014 ; Laukhil, 2016). Jalan napas yang paten merupakan target luaran atau kriteria hasil dari diagnosa ketidakefektifan bersihan jalan napas (Herdman, 2018).

Berdasarkan hasil penelitian yang dilakukan oleh peneliti dengan ditunjang oleh teori dan hasil-hasil penelitian sebelumnya maka peneliti berasumsi bahwa fisioterapi dada dan batuk efektif dapat digunakan sebagai

penatalaksanaan ketidakefektifan bersihan jalan nafas pada pasien TB paru (Apriyadi, 2013 ; Mardiono, 2013 ;)

KESIMPULAN DAN SARAN

Kesimpulan dari studi kasus ini adalah fisioterapi dada dan batuk efektif dapat digunakan sebagai penatalaksanaan ketidakefektifan bersihan jalan nafas pada pasien TB paru dengan kriteria hasil kepatenan jalan napas yang ditandai dengan frekuensi napas normal, irama napas teratur, tidak ada suara napas tambahan, pasien mampu mengeluarkan sputum.

Peneliti berharap bahwa tenaga perawat lebih banyak lagi menerapkan intervensi mandiri seperti fisioterapi dada dan batuk efektif karena sudah terbukti secara empiris (*evidence based*) bisa mengatasi masalah ketidakefektifan bersihan jalan napas khususnya pada pasien TB paru.

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The Effect of Pulmonary Rehabilitation in Mountain Environment on Exercise Capacity and Quality of Life in Patients with Chronic Obstructive Pulmonary Disease (COPD) and Chronic Bronchitis

Authors' Contribution:
Study Design A
Data Collection B
Statistical Analysis C
Data Interpretation D
Manuscript Preparation E
Literature Search F
Funds Collection G

ACDEFG 1 Anna Kubincová
ACDEF 1 Peter Takáč
ABEFG 2 Lucia Kendrová
ADEF 3 Pavol Joppa
BFG 2 Wioletta Mikuľáková

1 Department of Physical Medicine, Balneology and Medical Rehabilitation, Medical Faculty of P. J. Šafárik University and L. Pasteur University Hospital in Košice, Košice, Slovak Republic
2 Department of Physiotherapy, Faculty of Health Care, University of Prešov, Prešov, Slovak Republic
3 Department of Pneumology and Phtiseology, Medical Faculty of P. J. Šafárik University and L. Pasteur University Hospital in Košice, Košice, Slovak Republic

Corresponding Author: Lucia Kendrová, e-mail: lucia.kendrova@unipo.sk
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Background: We aimed to test the effectiveness of the pulmonary rehabilitation in a mountain environment on the pulmonary function, physical performance, dyspnea, affective factors, and quality of life (QoL) in patients with chronic obstructive pulmonary disease (COPD) and chronic bronchitis (CB), as well as to determine predictors of clinical improvement.

Material/Methods: 128 consecutive patients (90 diagnosed with COPD and 38 diagnosed with CB) underwent comprehensive pulmonary rehabilitation for a duration of 3 weeks in one of 3 mountain health resorts in the High Tatras. The examination included spirometry (FEV_1 and FEV_1/FVC), 6-minute walk test (6MWT), Borg scale of dyspnea, and assessment of depression (Zung score), anxiety (Beck score), and QoL using the SF-36 scales.

Results: After the study intervention, all patients in both monitored groups demonstrated significant improvements in objective measurements in which large treatment effect was achieved (for FEV_1 η^2=0.218, for 6MWT η^2=0.771). Similarly, in subjective measurements a large effect was achieved (for the Beck score: η^2=0.599, for the Zung score: η^2=0.536). QoL improved after the intervention in all the monitored SF-36 scales in both groups (P<0.001 for all). In patients with COPD, the improvement of exercise capacity was positively correlated with baseline 6MWT and FEV_1, and negatively with the Beck anxiety score and the Borg dyspnea score, whereas, only improvement in the mental summary component of QoL was negatively correlated with baseline 6MWT and FEV_1 (P<0.05 for all).

Conclusions: Rehabilitation in a mountain environment has proven to be effective in both the reported diagnoses of COPD and CB. Improvements in both functional and subjective indicators were observed. These findings support the use of this treatment modality.

MeSH Keywords: Bronchitis, Chronic • Climatotherapy • Pulmonary Disease, Chronic Obstructive • Quality of Life

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Background

Worldwide, chronic obstructive pulmonary disease (COPD) is the third leading cause of death. According to estimates from the Global Burden of Disease Study, COPD was prevalent in more than 300 million people in 2013. The disease burden and its financial impact is predicted to increase, mainly due to population aging. Several studies have reported on the prevalence of COPD. In European adult populations over 40 years of age, the prevalence of COPD ranges between 15% and 20% [1].

In 2015 in Slovakia, according to the National Health Information Center, there were 83 341 followed patients with COPD (1 535.9/100 000 inhabitants) and 24 817 patients with chronic bronchitis (CB) [2].

According to ATS/ERS (American Thoracic Society/European Respiratory Society), pulmonary rehabilitation is a multidisciplinary and comprehensive intervention for patients with chronic lung diseases in which symptoms predominate and often restrict daily activities. The stabilizing or reversing of the systemic manifestations of the disease are part of the individual patient's treatment and are designed to optimize their functional status, improve participation in physical and social activities, improve quality of life (QoL), and reduce health care costs [3]. Nici et al. [4] report that according to the ATS/ERS, pulmonary rehabilitation is an integral part of the clinical management and the maintenance of the health of patients with chronic pulmonary disease who are experiencing symptoms or whose functions are reduced despite standard medical treatment.

Several studies have indicated a worsening in QoL due to the occurrence of dyspnea, anxiety, and depression, which are often present in COPD patients and associated with poor physical condition, functional impairment, and comorbidities [5,6]. The incidence of depression ranges from 7% to 80% and anxiety from 2% to 80% in patients with COPD [7]. Therefore, according to the study by Cullen et al. [8], early screening is necessary because higher levels of anxiety and depression may lead to poorer results after pulmonary rehabilitation (PR) in 6MWT (6-minute walk test). The presence of these symptoms results in a vicious circle resulting in deconditioning and inactivity, which are key predictors of mortality in COPD patients [9,10]. The key intervention in these pathomechanisms is considered to be the pulmonary rehabilitation treatment [11].

Health Resort Medicine and Climatology as a separate medical unit is not fully recognized internationally partially due to a lack of scientific evidence, the fact that Health Resort Medicine and Climatology is not used in all countries, and that it is focused only on independent methods that do not have a comprehensive concept. Other reservations are related to the fact that this treatment can only be performed in a specific environment [12]. Eberlein at al. [13,14] recognized the influence of the Alpine Mountain Climate on allergic diseases and COPD. The benefits of the Health Resort Medicine and Climatology are therefore still under discussion [14].

Health Resort Medicine includes "all medical activities originated and derived in health resorts based on scientific evidence aiming at health promotion, prevention, therapy and rehabilitation". Core elements of interventions in health resorts are balneotherapy, hydrotherapy, and climatotherapy [12]. Climatotherapy involves the use of climatic conditions in the treatment of chronic diseases. Mountain and sea climates are used to treat chronic pulmonary diseases [13]. Climatotherapy is considered a part of the comprehensive treatment of respiratory diseases in many European countries, including Slovakia [15,16]. The tradition of Slovak climatotherapy is directly linked to the treatment of chronic pulmonary diseases in the Alps, i.e., high altitude climate therapy (HACT, also known as "alpine" therapy). A meta-analysis of asthma climatotherapy (i.e., HACT) that included studies from 1972 to 2015 concluded that climatotherapy may be effective in improving pulmonary function, however, the authors highlighted the need of further research [15,17]. The climatotherapy of pulmonary diseases in the High Tatras (Slovakia) was introduced in the 19th century by Dr. Szontag. According to climatic stratification [18], the territory of the High Tatras is integrated into an area with very cold temperatures and cold mountain climate. Health resorts in which we provided the climatotherapy-rehabilitation intervention were included in the category of Stimulation Level 1, which has moderate stimulating climatic effects on the human body as categorized by Climatic Classification of Altitudes according to the Physical-Meteorological Observatory in Davos and the Swiss Meteorological Institute [19]. We assume that knowledge from Slovakia could be applicable in other regions as well.

The objective of this study was to test the following hypotheses: 1) whether pulmonary rehabilitation in a mountain environment (i.e., climatotherapy-rehabilitation) is effective in improving pulmonary function, physical performance, dyspnea, affective factors (anxiety, depression), and QoL in patients with COPD and CB; 2) to determine the degree of the improvement, depending on the diagnosis; 3) to analyze correlations between baseline measures of physical and mental functioning status and improvement in the exercise capacity; and 4) to analyze correlations between baseline measures of physical functioning status and improvements in QoL.

Material and Methods

This study involved patients with COPD diagnosis and patients with CB diagnosis who were referred for pulmonary

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rehabilitation in a mountain environment. Our prospective study, which was conducted from August 2014 to December 2014, involved 128 consecutive patients, with 90 of these patients diagnosed with COPD and 38 of these patients diagnosed with CB. The diagnosis of COPD was based on postbronchodilator forced expiratory volume (FEV) in 1 sec to forced vital capacity (FVC) ratio (FEV_1/FVC) being <0.7 [11]. The diagnosis of CB was based on the presence of chronic symptoms (cough, sputum, and/or dyspnea) and normal spirometry, according to the previously published definition used separate stage 0 for COPD [20]. Patients with acute exacerbations, respiratory insufficiency, and coronary artery disease (all stages according to the New York Heart Association), and patients with a history of previous myocardial infarction or stroke were excluded. Exclusion criteria also included non-cooperation or non-consent of the patient. The research was approved by the ethics committee of the treatment facility. All patients signed an informed consent.

Intervention

All patients underwent comprehensive pulmonary rehabilitation in one of 3 health resorts in the High Tatras, which form a part of the Carpathian Mountains.

Characteristics of treatment

The research itself was carried out in 3 spa facilities located in the Slovak part of the High Tatras: in the Sanatorium Tatranská Kotlina (760 a.s.l.), the Sanatorium Dr. Guhr Tatranská Polianka (1067 a.s.l.), and the Nová Polianka Specialized Institute for Pulmonary Diseases (1040 a.s.l.). The health resorts are located at an altitude between 760 and 1067 meters above sea level, which corresponds with a mountain altitude. The climatotherapy-rehabilitation treatment lasted for 3 weeks and included a standard climatotherapy-rehabilitation set of procedures. This set consisted of exercise training set up according to international recommendations [3,21], moreover, it also included strength training, respiratory physiotherapy, physical therapy, hydrotherapy, and climatotherapy. Patients completed the daily program 5 days a week. Exercise prescription was based on the outcome of initial exercise assessment and was increased throughout the program as tolerated (see Supplementary Table 1 for details).

The overall training intensity was set at a dyspnea rating scale of 3 according to the Borg dyspnea scale.

Programs were multidisciplinary with an educational component covering issues including exercise (which was recommended during the program and was to continue after its completion), medication use, diet, and coping strategies.

Measurements

Patients were examined at the beginning and end of the climatotherapy-rehabilitation intervention. The examination included spirometry (FEV_1 and FEV_1/FVC), 6MWT, Borg scale of dyspnea, depression, anxiety, and QoL assessment.

We used the 6MWT to assess exercise capacity. This test has been broadly used to assess the effects of treatment for people with a variety of cardiovascular and lung diseases, including COPD. The 6MWT was performed indoors along the corridor (25 meters) in accordance with international recommendations [22]. The subjective dyspnea score was evaluated using a modified scale according to Borg [23,24]. We evaluated QoL with the general QoL questionnaire SF-36. It consists of 36 items and is divided into 8 subscales: physical functioning (PF), role physical (RP), bodily pain (BP), general health (GH), vitality (VT), social functioning (SF), role emotional (RE), mental health (MH); 2 summary scales (the physical component summary (PCS) and the mental component summary (MCS). The SF-36 overall QoL index is used in the evaluation of QoL (Perceived Health Status or PHS) [25,26].

The Beck Anxiety Inventory was used to evaluate anxiety. The overall score ranges from 0 to 63, and Zung's self-assessment depression scale, resulting in the SDS index (SDS – Zung's Self-Rating Depression Scale) [27,28].

The minimal clinically important difference (MCID) has been used to characterize patients benefiting from pulmonary rehabilitation [29]. This parameter allows the comparison of results between programs that have different starting clinical measurements. The MCID for different test variables was defined according to cited publications. For the 6MWT it is defined as an increase of more than 30 meters [30]. The MCID of the SF-36 QoL in COPD was defined according to Wyrwich et al. [31]. The MCID was set to 10 points for summary scores PCS and MCS of the SF-36 [32].

Statistical analysis

The evaluation was performed by comparing 2 groups of patients (patients with COPD and patients with CB) before initiation of the treatment with baseline measurements, and again after the intervention of 3 weeks of pulmonary rehabilitation in a mountain environment.

Descriptive statistics were used for data processing; baseline differences between COPD and CB were evaluated by an unpaired *t*-test, and before and after intervention with a paired *t*-test. The effectiveness of the 3-week intervention program was evaluated using the GLM (General Linear Model) test through the ANOVA mixed design. Partial Eta^2 (η^2) was used

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to measure the effect size. Interpretation of the effect size according to Cohen [33] for the ANOVA analysis was 0.00–0.003 as no effect; 0.010–0.039 as small effect; 0.060–0.110 as intermediate effect; and more than 0.140 as large effect. Pearson's correlation coefficients were calculated between improvement in exercise capacity (distance in the 6MWT) after the pulmonary rehabilitation in COPD patients and in CB patients, and baseline measurements of physical and mental functioning status, with subsequent partial correlation analyses controlling for age, gender, and body mass index (BMI); the same procedure was also applied between improvements in the SF-36 QoL summary scales and baseline values of FEV_1 and 6MWT (all controlling for age, gender, and BMI).

The statistical analysis was performed using the IBM SPSS 19 software. Data are presented as mean ±1 standard deviation (SD) or as percentages. The level of statistical significance was set at $P<0.05$.

Results

In total, 90 patients with COPD and 38 patients with CB underwent complex pulmonary rehabilitation in the health resorts in the High Tatras. The COPD group consisted of 64 men (71%) and 26 women (29%) with an average age of 65.7±11.9 years; the group with CB consisted of 23 men (61%) and 15 women (39%) with an average age of 60.2±8.9 years. According to GOLD (Global Initiative for Chronic Obstructive Lung Disease) [11], patients with COPD were classified according to the severity of decline in stage in pulmonary function as follows: 14 patients (16%) at stage I, 45 patients (50%) at stage II, 27 patients (30%) at stage III, and 4 patients (4%) at stage IV. In the personal interview, we also recorded whether respondents smoke or smoked in the past and how many cigarettes a day. Among respondents with COPD, there were 46 (51%) non-smokers, 34 (38%) ex-smokers, and 10 (11%) current smokers. Among respondents with CB, there were 17 (45%) non-smokers, 15 (39%) ex-smokers, and 6 (16%) current smokers. There was no difference in gender between the 2 groups ($P=0.244$). Table 1 displays baseline characteristics between the 2 groups of studied patients according to diagnosis. COPD patients were older, had worse pulmonary function, achieved a lower distance in the 6MWT, and experienced more severe dyspnea both at rest and after a 6MWT compared to CB patients. When comparing the monitored QoL domains, COPD patients had lower baseline scores, and thus had worse prospects in GH, PF, RP, and PCS than CB patients.

The effect of the pulmonary rehabilitation in patients with CB and COPD

After completing the intervention of climatotherapy-rehabilitation treatment, all patients in both monitored groups demonstrated statistically significant improvements in objective measurements, i.e., FEV_1 and 6MWT, ($P<0.001$ for both parameters) and for which a large treatment effect was achieved (for FEV_1 $\eta^2=0.218$, for 6MWT $\eta^2=0.771$). In subjective measurements, there was a statistically significant improvement in the Beck anxiety score, as well as in the Zung depression score ($P<0.001$ for both parameters) with large treatment effects observed (for the Beck score: $\eta^2=0.599$, for the Zung score: $\eta^2=0.536$). In anxiety, the interaction between the intervention at the defined time and diagnosis was statistically significant ($P=0.040$): patients with CB showed larger improvement compared to patients with COPD. In the case of dyspnea, we noticed a small intervention effect in the improvement of dyspnea at rest ($\eta^2=0.016$), which did not achieve statistical significance ($P=0.153$) for the entire cohort; we also noticed intermediate effect of treatment on the improvement of dyspnea after completing the 6MWT ($\eta^2=0.066$, $P=0.003$) in all patients. However, there was a statistically significant interaction between intervention at the defined time and diagnosis, in which dyspnea before and after the walk ($P=0.004$ and $P=0.001$, respectively) was reduced by intervention in COPD patients, whereas in CB patients, it was not influenced (Table 2).

In the QoL measurements, according to SF-36, there was a statistically significant improvement after the intervention in all the monitored subscales and summative scores in both CB patients and COPD patients ($P<0.001$ for all, Table 3). We observed a large effect of the intervention on the subscales of the GH, PF, RP, BP, VT, SF, MH, and intermediate effect in RE (η^2 Table 3). In the summary dimensions, a large effect was achieved for all the dimensions of PCS, MCS, and PHS (η^2 Table 3). The interactions between intervention at the defined time and diagnosis in none of the monitored subscales and summative scores was statistically significant (Table 3).

Correlation analysis between improvement in exercise capacity and baseline measures of physical and mental functioning status

A clinically important improvement in the distance achieved in the 6MWT (an increase of at least 30 meters in length) was achieved by 20 patients with CB (52.6%) and 33 patients with COPD (36.7%).

In patients with COPD, the improvement of exercise capacity (i.e., an increase in the distance walked in the 6MWT) was positively correlated with baseline 6MWT and FEV_1 values, and negatively correlated with the Beck anxiety score and the Borg dyspnea score both before and after exercise. All observed correlations remained statistically significant after controlling for age, gender, and BMI. In patients with CB, only an inverse relationship with the Beck anxiety score remained statistically significant after controlling for age, gender, and BMI (Table 4).

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Table 1. Comparison of baseline characteristics between CB and COPD patients.

Parameters	Group	Mean (SD)	t	p
BMI	COPD	27.0±5.0	–1.146	0.254
	CB	28.2±6.9		
Age (years)	COPD	65.7±11.9	2.589	0.011
	CB	60.2±8.9		
FEV1 (% predicted)	COPD	61.0±22.6	–5.150	0.000
	CB	82.4±18.5		
FEV1 (ml)	COPD	1626±574	–6.120	0.000
	CB	2323±622		
FEV1/FVC (%)	COPD	52.6±11.0	–14.607	0.000
	CB	80.1±5.6		
Beck score	COPD	14.8±8.3	–2.770	0.006
	CB	19.8±11.7		
Zung score	COPD	53.2±10.2	1.424	0.157
	CB	50.1±12.5		
6 MWT (m)	COPD	258±108	–4.484	0.000
	CB	346±82		
Borg score before walking	COPD	1.34±1.13	2.221	0.028
	CB	0.87±1.04		
Borg score after walking	COPD	3.64±1.90	3.039	0.003
	CB	2.60±1.39		
General Health	COPD	39.3±17.6	–2.158	0.033
	CB	47.2±21.7		
Physical Functioning	COPD	44.7±24.1	–2.010	0.047
	CB	54.2±25.2		
Role Physical	COPD	28.3±31.8	–2.913	0.004
	CB	47.4±38.0		
Bodily Pain	COPD	56.6±24.1	0.097	0.923
	CB	56.1±21.4		
Vitality	COPD	57.6±18.2	0.460	0.646
	CB	55.9±20.8		
Social Functioning	COPD	62.9±23.5	0.680	0.498
	CB	59.9±22.4		
Role Emotional	COPD	42.6±39.7	–0.968	0.335
	CB	50.0±39.3		
Mental Health	COPD	62.2±20.7	0.261	0.794
	CB	61.2±21.8		
PCS	COPD	42.2±17.4	–2.505	0.014
	CB	51.2±21.1		
MCS	COPD	56.3±18.4	–0.107	0.915
	CB	56.7±21.6		
Perceived health status	COPD	49.3±15.8	–1.409	0.161
	CB	54.0±20.3		

PCS – physical component summary; MCS – mental component summary.

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Table 2. The average values and statistical comparison of CB and COPD patients before and after the 3-week pulmonary rehabilitation in objective and subjective parameters.

Parameters	Group	Average values ±SD before PR	Average values ±SD after PR	Comparison before and after treatment				Interaction		
				F value	P Couple	η^2	Inter-pretation	F value	P between	η^2
FEV_1 (% predicted)	CB	82.4±18.5	86.2±19.4	35.038	**0.000**	0.218	Large effect	0.137	0.712	0.001
	COPD	61.0±22.6	64.3±22.9							
FEV1 (ml)	CB	2323±622	2439±691	35.038	**0.000**	0.218	Large effect	0.137	0.712	0.001
	COPD	1626±574	1710±577							
6MWT (m)	CB	346±82	371±85	423.413	**0.000**	0.771	Large effect	0.132	0.717	0.001
	COPD	258±108	282±112							
Beck score	CB	19.8±11.7	12.3±6.6	188.219	**0.000**	0.599	Large effect	4.327	0.040	0.033
	COPD	14.8±8.3	9.3±5.9							
Zung score	CB	50.1±12.5	45.0±9.7	139.745	**0.000**	0.536	Large effect	0.311	0.578	0.003
	COPD	53.2±10.2	47.6±7.7							
Borg score before walking	CB	0.87±1.04	0.95±1.09	2.065	0.153	0.016	Small effect	8.448	0.004	0.063
	COPD	1.34±1.13	1.11±0.97							
Borg score after walking	CB	2.60±1.37	2.63±1.40	8.922	**0.003**	0.066	Inter-mediate effect	10.82	0.001	0.079
	COPD	3.64±1.90	3.10±1.45							

PR – pulmonary rehabilitation.

Correlation analysis between improvements in the SF-36 QoL and baseline measures of physical functioning status (FEV_1 and 6MWD)

An improvement in the MCS summary score was negatively correlated with the baseline distance achieved during the 6MWT after controlling for age, gender, and BMI in patients with COPD (Table 5).

Discussion

Pulmonary rehabilitation is an important aspect of COPD management to improve symptoms, physical activity, daily life, social functions, and QoL. According to the study by Sundh et al. [34], many patients do not receive rehabilitation treatment, mainly due to insufficient use of rehabilitation options. In our opinion, one of the possibilities for increasing the availability of pulmonary rehabilitation is the use of available facilities for climatotherapy. There is still a lack of research focused on mountain climate therapy. Eberlein et al. [13] found that rehabilitation treatment at specialized facilities in the Bavarian Mountains had a beneficial effect on patients with asthma and COPD, with the potential to improve pulmonary function (FEV_1) and 6MWT. The effectiveness of health resort therapy and climate therapy has been discussed at the international level [12]. In many European countries, health resort therapy is fully recognized as a medical field. Since discussions are still ongoing, we have decided to verify the effects of climatotherapy-rehabilitation treatment on parameters of physical functioning, symptoms, and QoL in patients with chronic non-allergic pulmonary disease in mountain resorts of the High Tatras.

After completing the pulmonary rehabilitation in a mountain environment in both CB patients and COPD patients, we observed improvements in the majority of the monitored objective and subjective functional parameters except for dyspnea at rest, and improvements in the scores were observed for all the monitored SF-36 QoL dimensions. Of note, statistically significant differences were found between the subgroups of patients according to the diagnosis in the baseline descriptive parameters: compared to patients with CB, patients with COPD had by definition worse pulmonary function and performance in the 6MWT, higher intensity of perceived anxiety, as well as dyspnea before and after walking, and had a worse score in the subscales of QoL of GH, PF, RP, and summary scores PCS. To take these differences into account, the mixed design ANOVA statistical model was used to describe the potentially different intervention effects between the subgroups according to the diagnosis (interaction between intervention at the defined time and diagnosis), according to which there was a greater intervention effect on the dyspnea COPD patients before walking exercise (P=0.004 versus CB) and after walking exercise (P=0.001 versus CB). On the contrary, patients with

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Table 3. The average values and statistical comparison of CB and COPD patients before and after the 3-week pulmonary rehabilitation in SF 36 QoL.

SF 36 score (subscales and summary scales)	Group	Average values ±SD before PR	Average values ±SD after PR	Comparison before and after treatment				Interaction		
				F value	P Couple	η^2	Inter-pretation	F value	P between	η^2
General Health	CB	47.2±21.7	57.8±15.0	125.718	**0.000**	0.499	Large effect	0.812	0.369	0.006
	COPD	39.3±17.6	51.7±14.6							
Physical Functioning	CB	54.2±25.2	62.9±24.1	86.059	**0.000**	0.406	Large effect	0.041	0.840	0.000
	COPD	44.7±24.1	53.8±21.3							
Role Physical	CB	47.4±38.0	57.2±33.8	30.842	**0.000**	0.197	Large effect	0.509	0.477	0.004
	COPD	28.3±31.8	41.1±32.3							
Bodily Pain	CB	56.1±21.4	73.4±16.1	191.637	**0.000**	0.603	Large effect	1.758	0.187	0.014
	COPD	56.6±24.1	70.8±19.1							
Vitality	CB	55.9±20.8	80.1±20.8	487.434	**0.000**	0.795	Large effect	0.657	0.419	0.005
	COPD	57.6±18.2	83.7±19.8							
Social Functioning	CB	59.9±22.4	73.7±19.2	79.484	**0.000**	0.387	Large effect	3.253	0.074	0.025
	COPD	62.9±23.5	72.1±21.5							
Role Emotional	CB	50.0±39.3	58.8±39.1	18.304	**0.000**	0.127	Inter-mediate effect	0.186	0.667	0.001
	COPD	42.6±39.7	53.3±36.3							
Mental Health	CB	61.2±21.8	83.0±19.2	417.734	**0.000**	0.768	Large effect	0.030	0.863	0.000
	COPD	62.2±20.7	83.6±19.9							
PCS	CB	51.2±21.1	62.8±17.2	190.968	**0.000**	0.602	Large effect	0.095	0.759	0.001
	COPD	42.2±17.4	54.4±16.1							
MCS	CB	56.7±21.6	73.9±18.7	349.117	**0.000**	0.735	Large effect	0.027	0.869	0.000
	COPD	56.3±18.4	73.2±18.4							
Perceived Health	CB	54.0±20.3	68.4±17.3	336.784	**0.000**	0.728	Large effect	0.005	0.942	0.000
	COPD	49.3±15.8	63.8±15.7							

PCS – physical component summary; MCS – mental component summary; PR – pulmonary rehabilitation.

CB achieve somewhat greater benefits in reducing anxiety (*P*=0.040 versus COPD). In the remaining monitored parameters, the improvements were comparable between the subgroups according to the diagnosis.

In the study by Eberlein et al. [13], similar to our study, improvements were observed in spirometry parameters (FEV_1) and exercise capacity (6MWT) but only observed in some domains (RP, BP, PH, SF, and RE) in the SF-36 QoL. However, this aforementioned study was focused largely on patients diagnosed with bronchial asthma.

Karagiannidis et al. [35] reported that climatic treatment improved clinical symptoms of asthma and reduced local inflammation of the respiratory tract. In addition to the mountain climate, Dramsdahl [36] presented the use of the Dead Sea climato-therapy as an integrated adjunct therapeutic modality in a complex pulmonary rehabilitation program for patients with COPD, asthma, and cystic fibrosis, which improved clinical parameters and QoL.

In a recent meta-analysis, Vinnikov et al. [15] evaluated the effectiveness of the mountain climate on the asthma of 907 patients. In 93% of patients, high-altitude climatotherapy was found to be an effective intervention to improve pulmonary functional parameters. In the aforementioned mountain climate studies, more attention was paid to patients with asthma and allergic diseases of the respiratory system, whereas in our research we focused on patients with non-allergic chronic inflammatory diseases of the respiratory tract. In addition to the objective parameters and QoL, in our study we also studied the effect of treatment on subjective perceived dyspnea, anxiety, and depression in COPD patients and CB patients.

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Table 4. Pearson's and partial correlation analysis between improvement in exercise capacity (distance in the 6MWT) after the pulmonary rehabilitation in COPD and CB patients and baseline measures of physical and mental functioning status.

Parameter at baseline		Δ 6MWT			
		R		Partial correlation	
6MWT (m)	COPD	0.265	(0.012)	**0.241**	**(0.029)**
	CB	0.318	(0.052)	0.354	(0.037)
FEV1	COPD	**0.448**	**(0.000)**	**0.420**	**(0.000)**
	CB	0.076	(0.651)	–0.050	(0.774)
Beck	COPD	**–0.289**	**(0.006)**	**–0.295**	**(0.007)**
	CB	**–0.354**	**(0.029)**	**–0.456**	**(0.006)**
Zung	COPD	–0.046	(0.675)	–0.071	(0.524)
	CB	–0.098	(0.558)	–0.087	(0.621)
Borg before walking	COPD	**–0.254**	**(0.016)**	**–0.296**	**(0.007)**
	CB	**–0.327**	**(0.045)**	–0.300	(0.080)
Borg after walking	COPD	**–0.278**	**(0.008)**	**–0.316**	**(0.004)**
	CB	**–0.341**	**(0.036)**	–0.332	(0.052)

R – Pearson's correlation coefficient; Bold-numbers are statistically significant results with p<0.05 (p value in parentheses); Partial correlation adjusted for age, gender, BMI.

Table 5. Pearson's and partial correlation analysis between improvement in the SF 36 quality of life summary scales after the pulmonary rehabilitation in COPD and CB patients and baseline values of FEV1 and 6MWT.

SF 36 score		FEV_1				6MWT			
		R		Partial correlation		R		Partial correlation	
Δ PCS	COPD	0.146	(0.170)	0.079	(0.466)	–0.130	(0.222)	–0.132	(0.223)
	CB	–0.118	(0.481)	–0.148	(0.396)	–0.100	(0.552)	–0.161	(0.356)
Δ MCS	COPD	–0.050	(0.642)	–0.083	(0.443)	**–0.254**	**(0.016)**	**–0.248**	**(0.020)**
	CB	0.047	(0.779)	–0.025	(0.888)	–0.062	(0.712)	–0.160	(0.359)

R – Pearson's correlation coefficient; Bold-numbers are statistically significant results with p<0.05 (p value in parentheses); Partial correlation adjusted for age, gender, BMI.

Dyspnea is a major symptom of COPD, causing significant reductions in performance and QoL and is often associated with comorbid anxiety and depression. Dyspnea is usually experienced as highly aversive and threatening [37]. As a result, many patients avoid situations related with dyspnea, which is in mainly physical activity, leading to progressive decline of physical condition, ultimately increasing dyspnea in low activity levels and contributing to the progression of disease [7]. Moreover, the loss of control over the disease itself and the loss of ability to engage in personal and social activities are frustrating and anxiety-inducing. The detection and recognition of these symptoms is of the utmost importance because they are related to the progression of disease and they may be approached by medical treatment and rehabilitation [38–40]. The meta-analysis of McCarthy et al. [9] demonstrated that PR relieved dyspnea and fatigue, improved emotional function, and enhanced the sense of control that individuals had over their condition. These improvements were moderately large and clinically significant. The results of our work extend this knowledge even further: pulmonary rehabilitation is an effective tool for influencing dyspnea in COPD patients, with the observed improvement being greater than in patients with CB and normal pulmonary function.

In clinical practice, another frequently used tool for assessing the effect of intervention is the MCID concept, which has

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recently been used to evaluate improvement in exercise capacity and QoL after pulmonary rehabilitation. Boutou et al. [29] and McCarthy et al. [9] presented the results of randomized controlled trials according to which the MCID for 6MWT is 30 meters. Based on this value, in our study more than half of patients with COPD and more than one-third of CB patients (who had better baseline values) achieved a clinically important improvement in the 6MWT after completing the climatotherapy-rehabilitation treatment. The work by Boutou et al. [29] demonstrated an improvement in exercise capacity in 68% of COPD patients from those who completed rehabilitation, which is a higher rate compared to our results, but in their work only 57% of patients completed the rehabilitation treatment and, moreover, their research did not include patients with CB.

In patients with both diagnoses, the intensity of anxiety was negatively correlated with achieved improvements in exercise capacity. In a population-based study by Leivseth et al. [41] found that anxiety was present in 15.6% of patients with CB, anxiety and dyspnea were related to each other, and dyspnea may affect anxiety or vice versa. In the study by Amiri et al. [42] in which the prevalence of anxiety in COPD patients was evaluated, values ranged considerably from 2% to 96%. In patients with COPD and anxiety, the health outcomes were worse, including the exercise capacity (6MWT) [43] and patients had a higher number of exacerbations [44]. In our group, 72.2% of patients with COPD and 84.2% of patients with CB suffered from anxiety. Depression often occurs together with anxiety, and both co-morbidities are usually evaluated at the same time. There are various approaches for the treatment of depression and anxiety. Comprehensive PR procedures that included exercise training with or without psychological and medical interventions have been shown to have the greatest effect on exercise capacity, anxiety, depression, and dyspnea, while at the same time positively affecting the QoL [38–40].

Within the subgroup of COPD patients, baseline parameters were lower degree of bronchial obstruction, lower perceived intensity of dyspnea at rest and after exertion, and a better baseline performance in the 6MWT identified as positively correlated with the achieved improvements in exercise capacity. On the contrary, the predictor of the achieved MCID in the exercise capacity in the study by Boutou et al. [29] was a lower baseline 6MWT level, nevertheless the patients in their study were older and had worse spirometric features, more pronounced dyspnea, and more severe symptoms.

Many studies have reported that improving the QoL should be considered the primary result of pulmonary rehabilitation [9,29,45,46]. Interestingly, in our study, we observed that lower baseline distance in the 6MWT was related to an improvement in the MCS summary score in patients with COPD. Predictors of the MCID in improving the QoL as assessed by the CAT (COPD Assessment Test) in the study by Boutou et al. [29] were younger age and fewer symptoms. Notwithstanding, their study used a different questionnaire than we used in our study.

Study strengths and limitations

As one of the strengths of this research, we consider evaluating the effect of pulmonary rehabilitation treatment in a mountain environment. We have studied the additive effect of pulmonary rehabilitation and climatotherapy, while many of the cited studies [9,29,47] only followed the effect of pulmonary rehabilitation without studying the effect of climatotherapy.

This effect was monitored in 3 High Tatras mountain resorts within the same climatic zone and accordingly with the same level of bioclimatic stimulation. Location of health resorts at 3 different altitude levels ranging between 760 and 1067 meters above sea level could be viewed as a limitation of the study. Nevertheless, in our study we adhered to the Swiss climatic classification of altitudes according to the Physical-Meteorological Observatory in Davos and the Swiss Meteorological Institute [19] based on altitude treatment stimulation intensity. This classification has been used in several countries in Europe. According to this classification, all mountain health resorts engaged in our study were located within the Level 1 of Stimulation ranging from 500–1100 meters above sea level [48] and thus our study group can be viewed as homogenous in terms of delivered intervention. Notwithstanding, this classification also has some disadvantages as it does not take into account all the local climatic specifics or the individual patient needs.

Another strength of our study was the implementation of a wide range of objective and subjective functional parameters along with a multidimensional evaluation of perceived QoL before and after a defined intervention in a representative set of patients with the 2 most commonly occurring chronic non-allergic inflammatory pulmonary diseases, which in practice are referred for this type of treatment. We used sophisticated statistical models (mixed design ANOVA and multivariate logistic regression models with the implementation of the MCID achievement concept).

Limitations of this study imply the impossibility of separating the effect of rehabilitation procedures from the effect of the mountain climate alone, but this is of less practical significance, because both effects intentionally act together. It is not possible to exclude the referral bias: the fact that patients with milder COPD stages are referred to mountain sanatoriums (in our group two-thirds of the COPD patients had first and second degree of severity of airflow obstruction according to GOLD) [11], so the results of our observations should be interpreted with caution in patients with severe airflow

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limitation in COPD (only 4 patients with FEV_1 less than 30% were participants in our study population).

Conclusions

In our study, we demonstrated the effectiveness of the complex climatotherapy-rehabilitation treatment in a mountain environment in patients with CB and COPD, as reflected by the improvements in almost all of the studied subjective and objective parameters. Both groups of patients experienced a statistically important improvement in exercise capacity and a large treatment effect was observed in improving the majority of the dimensions of QoL. Among the monitored groups according to the diagnosis, the effects of the intervention were comparable except for the effect on dyspnea which was greater in favor of patients with COPD, in whom the baseline values were worse. We further found that the intensity of anxiety negatively affected expectable improvements in exercise capacity in both patient groups. Additionally, in the COPD group, patients with better baseline FEV_1 and 6MWT distance as well as with less pre-and post-exercise dyspnea had better prospects for clinically important improvement in exercise capacity.

To summary, the climatotherapy-rehabilitation has been shown to be effective in both reported diagnoses as well as throughout the entire spectrum of functional status, although individual patients may benefit in different ways depending on the diagnosis and disease severity. As the correlation analyses revealed relationships between baseline functional and mental status and achieved improvements in exercise capacity and in QoL, further research is warranted to identify possible predictors of clinically important improvements. In our opinion, this knowledge should serve as a motivation for specialists for patients with lung diseases to become more involved in climate and rehabilitation treatment as part of their comprehensive treatment.

Statement

The research was carried out in 3 health resorts in a mountain environment of the High Tatras, which form a part of the Carpathian Mountains in Sanatorium Tatranská Kotlina, Sanatorium Dr. Guhr Tatranská Polianka and the Nová Polianka Specialized Institute for Pulmonary Diseases.

Conflicts of interest

None.

Supplementary Table

Supplementary Table 1. Rehabilitation protocol for pulmonary patient.

	Mode	Intensity	Protocol	Duration	Frequency, provider
Lower limb 1) endurance training Ground walking	Walking training Ground-based	80% average speed on 6MWT Dyspnoea rating of 3 (moderate)	Continuous	30 minutes	5 times a week supervised sessions, physioterapeutist
2) strength training	Strength training without weights: Squats. Straight leg raise. Step-ups or stair climbing. Sit-to-stand from progressively lower chairs	10 RM (repetition maximum)		10 repetitions (1 set)	5 times a week, physioterapeutist
Upper limb 1) endurance training	Exercises Elastic bands.	Determine the weight that the patient can only lift 15 times Dyspnoea rating of 2 or 3 (slight or moderate)		15 repetitions (1 set)	5 times a week supervised sessions. physioterapeutist

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	Mode	Intensity	Protocol	Duration	Frequency, provider
2) strength training	Exercises Asking the patient to lift their arms alternately overhead 15 times holding a light weight (e.g. 1–2 kg)	10 RM (repetition maximum)		10 repetitions (1 set)	5 times a week supervised sessions, physioterapeutist
Respiratory physiotherapy	Pursed-lip breathing Posture techniques Diaphragmatic breathing, Flutter	Warming up phase 5 min., Breathing techniques 10–15 min., Relaxation exercises 5–10 min.		30 min.	5 times a week supervised sessions, repiratory physioterapeutist
Physical therapy	Manual massage or soft tissue techniques			10-15 min	5 times a week, repiratory physioterapeutist
Hydrotherapy	Whirlpool (upper or lower limb)			5-10min.	5 times a week
Climatotherapy	3 Health resorts in High Tatras	Stimulation level 1 – with moderate stimulating climatic effects	daily	5 hours	21 days
Educational component	Exercise education Lecture			5-10 min. 60 min.	5 times a week, physioterapeutist repiratory physioterapeutist once in 3 weeks, physiatrist
Disease education	Lecture	Smoking cessation, nutritional interventions, exercise, and health promotion, oxygen therapy, inhalation techniques		60 min.	once in 3 weeks, physiatrist, physician
Coping strategies	Lecture	Symptom management, psychological interventions, anxiety,depresion management		60 min.	Once in 3 weeks, psychologist

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Study Protocol Systematic Review

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Effects of physical therapy on lung function in children with asthma

Study protocol for a systematic review and meta-analysis

Qiu Wang, MD[a], Weijian Zhang, MD[a], Lilong Liu, MM[b], Wenhao Yang, MM[a], Hanmin Liu, MD[a,*]

Abstract

Background: Morbidity of asthma in children is increasing, which is significantly affecting children's life quality. Despite the medication therapy, physical therapies, including breathing exercises, inspiratory muscle training and physical training, are widely used to improve children's condition. However, the effectiveness of physical therapy remains unclear. This systematic review and meta-analysis is aiming to evaluate the effects of physical therapy on lung function in children with asthma and to assess which physical therapy is more effective.

Methods: Three main databases (PubMed, Embase, and the Cochrane Library) will be searched from inception to November 30, 2018 for randomized controlled trials investigating the effects of physical therapy on lung function in children (age < 18 years old) with asthma published in English. In addition, a manual search of the references of relevant published studies in English will also be considered.

Two independent reviewers will conduct studies selection, data extraction, and risk of bias assessment. Outcome measures will be the Peak Expiratory Flow (PEF), the Forced Expiratory Volume in the first second (FEV1), and the Forced Vital Capacity (FVC). Subgroup analyses will be performed according to the physical therapy (breathing exercises, inspiratory muscle training, and physical training) and the outcome (PEF, FEV1, FVC).

Results: The results will provide useful information about the effect of physical therapy on lung function in children with asthma and demonstrate which physical therapy is more effective.

Conclusion: The findings of this study will be published in a peer-reviewed journal.

Prospero registration number: CRD42019121627

Abbreviations: CI = confidence interval, FEV1 = forced expiratory volume in the first second, FVC = forced vital capacity, GRADE = grading of recommendations, assessment development and evaluation, MD = mean difference, PEF = peak expiratory flow, PRISMA = preferred reporting items for systematic reviews and meta-analyses, RCTs = randomized controlled trials, SMD = standardized mean difference.

Keywords: asthma, children, lung function, physical therapy

1. Introduction

Asthma is one of the most common chronic respiratory diseases in children all over the world, significantly affecting children's health and life quality.[1] Although the prevalence of asthma in children among some high-income countries started to decrease, many low- and middle-income countries with large populations showed increases in prevalence, leading to a great significant burden on worldwide healthcare system.[2] Etiology of asthma is still not clear, but the causes are often discussed on genetic factors and environmental factors.[3] Well-known environment factors include virus infection,[4,5] smoke exposure,[6,7] particulate matter exposure,[8,9] and ozone exposure[10,11] etc. Although GATA3, KIAA1109, and MUC5AC were identified as significant with asthma,[12] the specific genetic factor remains to be clarified.

Medication therapy has been used to control asthma for a long time.[13–15] Despite the medication, physical therapy is another important treatment for children with asthma and widely used in the globe. The main physical therapies for asthma are breathing exercises, inspiratory muscle training, and physical training.[16–18]

QW and WJZ are co-first authors who contributed equally to this study.

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No ethical statement will be required for this study because there is no direct involvement of human.

The authors have no conflicts of interest to disclose.

[a] Department of Pediatrics, West China Second University Hospital, Sichuan University, Chengdu, [b] Department of Gastrointestinal Surgery, People's Hospital of Deyang City, Deyang, Sichuan, China.

[*] Correspondence: Hanmin Liu, MD, Department of Pediatrics, West China Second University Hospital, Sichuan University, Chengdu 610041, Sichuan, China (e-mail: liuhm@scu.edu.cn).

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Table 1

Preliminary search strategy in PubMed.

Search	Query
1	"Asthma"[Mesh] OR asthma*[Title/Abstract]
2	"Child"[Mesh] OR children[Title/Abstract] OR school age[Title/Abstract] OR "Adolescent"[Mesh] OR adolescen*[Title/Abstract] OR teen*[Title/Abstract] OR youth*[Title/Abstract]
3	**#1 AND #2**
4	physiotherapy[Title/Abstract] OR physical therapy[Title/Abstract] OR physical intervention[Title/Abstract] OR physical rehabilitation[Title/Abstract] OR pulmonary therapy[Title/Abstract] OR pulmonary intervention[Title/Abstract] OR pulmonary rehabilitation[Title/Abstract] OR respiratory therapy[Title/Abstract] OR respiratory intervention[Title/Abstract] OR respiratory rehabilitation[Title/Abstract]
5	(breath*[Title/Abstract]) AND (exercise*[Title/Abstract] OR train*[Title/Abstract] OR retrain*[Title/Abstract] OR educat*[Title/Abstract] OR re-educat*[Title/Abstract] OR physiotherap*[Title/Abstract] OR physical therap*[Title/Abstract] OR respiratory therap*[Title/Abstract] OR buteyko[Title/Abstract])
6	IMT[Title/Abstract] OR inspiratory muscle train*[Title/Abstract] OR inspiratory muscle strength[Title/Abstract] OR inspiratory muscle endurance[Title/Abstract] OR respiratory muscle train*[Title/Abstract] OR respiratory muscle strength[Title/Abstract] OR respiratory muscle endurance[Title/Abstract]
7	physical training[Title/Abstract] OR physical activity[Title/Abstract] OR rehabilitat*[Title/Abstract] OR exercis*[Title/Abstract] OR fitness*[Title/Abstract] OR train*[Title/Abstract] OR aerobic[Title/Abstract] OR swim*[Title/Abstract] OR bik*[Title/Abstract] OR joy*[Title/Abstract] OR walk*[Title/Abstract] OR run*[Title/Abstract] OR sport*[Title/Abstract] OR danc*[Title/Abstract] OR motor[Title/Abstract]
8	#**4 OR** #5 **OR** #6 **OR #7**
9	(((((((randomized controlled trial [pt]) OR controlled clinical trial [pt]) OR randomized [tiab]) OR placebo [tiab]) OR groups [tiab]) OR randomly [tiab]) OR trial [tiab])
10	#3 AND #8 AND #9

However, whether the physical therapy improves the lung function in children with asthma is still unclear. Furthermore, there is no systematic review and meta-analysis including all these 3 main physical therapies to evaluate the lung function in children with asthma. In this study, we are aiming to perform a systematic review and meta-analysis to investigate the effects of physical therapy on lung function in children with asthma and demonstrate which physical therapy is more effective.

2. Methods

2.1. Registration

This study protocol has been registered in the PROSPERO and the registration number is CRD42019121627. The *Cochrane Handbook for Systematic Reviews of Interventions* will be used as a guideline[19] and the software RevMan 5.3 will be used to construct the meta-analysis. We will report this study in accordance with the PRISMA statement also.[20] No ethical statement will be required for this study because there is no direct involvement of human.

2.2. Eligibility criteria

2.2.1. Types of studies. Randomized controlled trials (RCTs) published in English up to November 30, 2018 will be included. Trials without well-described randomization methods or those with quasi-random allocation will be excluded.

2.2.2. Types of participants. We will include participants aged <18 years old irrespective of gender and ethnicity. Those including participants aged ≥18 years old will be excluded. All participants must be diagnosed as asthmas by clearly defined or internationally recognized criteria.

2.2.3. Types of interventions. Intervention with physical therapy for asthma could be breathing exercises, inspiratory muscle training or physical training. Those reported with pharmacological, psychological, or behavioral interventions will not be considered. Intervention should be performed with a minimum duration of 2 weeks.

2.2.4. Types of outcome measures. Lung function will be compared between the group with intervention and the group with no intervention. To measure lung function, one of the following outcomes should be reported: the Peak Expiratory Flow (PEF), the Forced Expiratory Volume in the first second (FEV1), and the Forced Vital Capacity (FVC).

2.3. Search methods

We will search the three main databases from their inception to November 30, 2018: PubMed, Embase, and the Cochrane Library. The search strategy will involve terms including *child*, *asthma*, *physical therapy*, and *RCT*. A preliminary search strategy in PubMed is described in Table 1. Same search strategy will be used in Embase and the Cochrane Library based on different specific requirements. We will also scan the reference lists of studies and relevant systematic reviews for additional trials.

2.4. Study selection and data extraction

2.4.1. Study selection. Study selection will be performed by two authors independently. The search results from three electronic databases and additional trials from other resources will be sent to Endnote. We will screen the records after duplicates removed following the two steps: (1) by reading the title and abstract, (2) by reading the full texts. Whether a study will be included is based on the eligibility criteria mentioned above. The reason for studies excluded on full text should be noted. Any different opinions between two authors should consent with the help of a third author. The process of study selection is summarized in a PRISMA flow diagram (Fig. 1).

2.4.2. Data extraction. Two authors will also perform data extraction independently by using a standardized form. The contents will include: generation information of the study (title, author, year, country, etc.), population (number, baseline characteristics, diagnosis criteria, etc.), intervention (type of physical therapy, duration, etc.), outcomes (PEF, FEV1, FEC), study characteristics (design, randomization method, blinding, etc.). When extraction finished, data will be checked with each other by the two authors. Any dispute should be solved with the

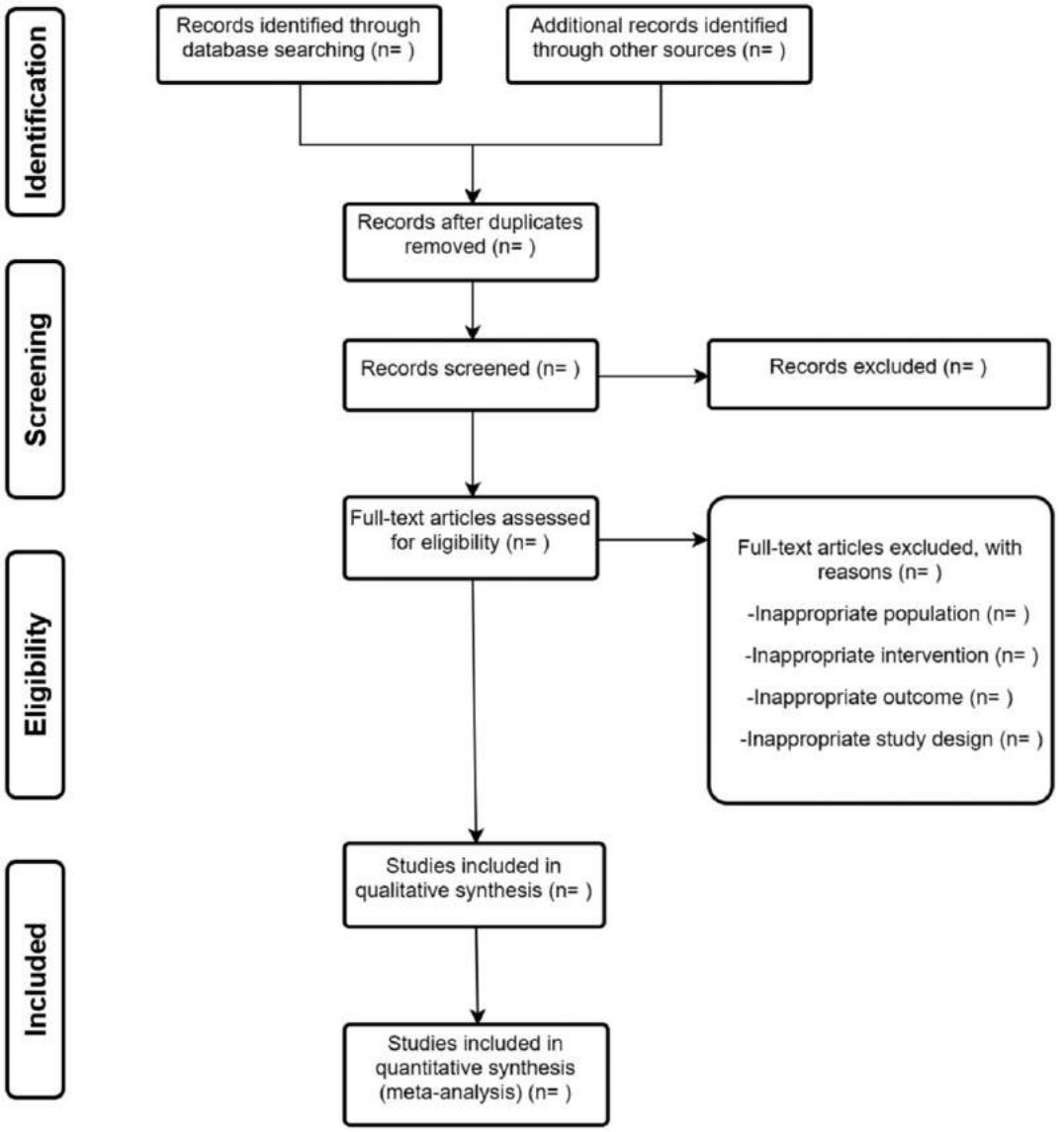

Figure 1. Flow diagram of study selection.

help of a third author. If the data is not complete, it is necessary to contact the original author. If data cannot be obtained still, we should transform the existing data or exclude the study.

2.5. Risk of bias assessment

Two authors will assess the methodological quality of all included studies independently based on the Cochrane Collaboration's tool.[21] The following contents will be evaluated: random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective reporting and other biases. Each domain will be judged by the level of risk of bias: high level, low level, or unclear level. Any disagreements will be solved by discussion or with the help of a third author.

2.6. Data synthesis and statistical analysis

2.6.1. Data synthesis. The software RevMan 5.3 will be used to construct the meta-analysis. To express the effects of physical therapy on lung function, it is necessary to extract the data change from the studies. The mean difference (MD) and the 95% confidence interval (CI) will be calculated for the continuous variable with a consistent unit. The standardized mean difference (SMD) and 95% CI will be calculated for the continuous variable with different units. $P < .05$ will be considered to be statistically significant.

2.6.2. Assessment of heterogeneity. Heterogeneity will be assessed by the χ^2 test and the I^2 test. If $P > .10$ and $I^2 < 50\%$, the heterogeneity is acceptable and a fixed effect model will be used for data analysis. If $P < .10$ and $I^2 > 50\%$, we will search for the reasons for the high heterogeneity and use a random effects model for data analysis.

2.6.3. Subgroup analysis. Subgroup analyses will investigate the effects of physical therapy according to the type of physical therapy (breathing exercises, inspiratory muscle training, and physical training), and the type of outcome measures on lung function (PEF, FEV1, FEC).

2.6.4. Sensitivity analysis. Sensitivity analysis will be carried out based on the sample size, the missing data result and the methodological quality of the included study. If necessary, we will exclude a low-quality study and repeat the meta-analysis to test the stability of the pooled results.

2.7. Assessment of reporting bias

If more than 10 studied are included, a funnel plot will be used to examine the reporting bias. The results will be calcified based on the Cochrane Handbook for Systematic Reviews of Interventions.

2.8. Confidence in cumulative evidence

The quality of evidence will be assessed based on the Grading of Recommendations Assessment, Development, and Evaluation (GRADE) system. The evidence will be adjusted to 4 levels: high, moderate, low, or very low.

3. Discussion

Physical therapy is widely applied to improve lung function in children with asthma globally. However, the effects of physical therapy are still not certain, especially in children. To the best of our knowledge, the published review has examined the effects of physical training in people with asthma involving both children and adults, but not children only.[22] Although some meta-analysis involved children only, they only examined the effects of one kind of physical therapies on children with asthma but not included all the 3 main therapies.[23–25] Therefore, it is necessary to perform a systematic review and meta-analysis to investigate the effects of physical therapy on lung function in children with asthma and demonstrate which physical therapy is more effective. This study will be helpful to doctors treating asthma in children and provide some useful information when they are making the choice on which kind of physical therapy to be used.

However, this study will have some limitations. Language bias may exist because only studies published in English will be considered due to language barriers.

Author contributions

Q Wang put forward the concept of this study. WJ Zhang drafted the preliminary version of this protocol. WJ Zhang and WH Yang will contribute to the study search, study selection, data extraction, and risk of bias assessment. WJ Zhang and LL Liu will complete the data analysis. Q Wang and HM Liu will help to solve any disagreement and ensure the quality of this study. Q Wang and WJ Zhang are co-first authors who contributed equally to this study. All authors critically reviewed, revised and approved the final manuscript.

Conceptualization: Qiu Wang.
Data curation: Weijian Zhang, Lilong Liu, Wenhao Yang.
Methodology: Weijian Zhang, Lilong Liu.
Project administration: Qiu Wang.
Supervision: Hanmin Liu.
Writing – original draft: Weijian Zhang.
Writing – review & editing: Qiu Wang, Hanmin Liu.

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