Post-print of a Study on the Multidimensional Efficacy and Adherence of Remote Pulmonary Rehabilitation Based on a WeChat Mini-program for Patients with Stable Chronic Obstructive Pulmonary Disease

Authors: Qi Jing, Cai Qing, Zhang Wanting, Yan Gu, Gu Yan

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Abstract

Background: Chronic obstructive pulmonary disease (COPD) is the third leading cause of death globally and has been incorporated into chronic disease management within national basic public health projects. As a non-pharmacological treatment, pulmonary rehabilitation (PR), a comprehensive intervention, is increasingly becoming a critical component of COPD therapy. Despite the clear clinical benefits of PR, the global participation rate among COPD patients is less than 3%. Pulmonary telerehabilitation (PTR), which guides home-based training through videos and mobile applications, has emerged as a key solution to overcome barriers such as transportation, distance, and economic burden. Objective: To comprehensively evaluate the multi-dimensional efficacy of WeChat mini-program-based PTR on exercise endurance, health-related quality of life, lung function, and adherence in patients with stable COPD. Methods: A total of 82 patients with stable COPD who visited the Department of Respiratory Medicine at the Affiliated Hospital of Inner Mongolia Medical University from October 2022 to October 2024 were included. They were divided into two groups using a random number table method: the intervention group received home-based PTR via a WeChat mini-program, while the control group received face-to-face outpatient PR. Both groups were treated at a frequency of 3 times per week for 12 weeks. At baseline (T1), week 8 (T2), and week 12 (T3), both groups were assessed for exercise endurance using the 6-minute walk distance (6MWD), dyspnea severity using the modified British Medical Research Council (mMRC) dyspnea scale, health-related quality of life using the St. George' s Respiratory Questionnaire (SGRQ), psychological status using the Hospital Anxiety and Depression Scale (HADS), and sleep quality using the Pittsburgh Sleep Quality Index (PSQI). Lung function was measured at T1 and T3, and

patient adherence and intervention safety were evaluated after the 12-week rehabilitation period. Results: Exercise endurance: There was an interaction effect between group and time on 6MWD (P_{interaction} < 0.05); the main effect of group on 6MWD was not significant (P_{group} > 0.05), while the main effect of time was significant (P_{time} < 0.05). Dyspnea: There was no interaction effect between group and time on mMRC scores (P > 0.05); neither the main effect of group (P_{group} > 0.05) nor the main effect of time (P_{time} > 0.05) was significant. Quality of life: No interaction effect between group and time was found for SGRQ symptoms, activity, impact scores, or total SGRQ score (P_{interaction} > 0.05); main effects for group were not significant (P_{group} > 0.05), while main effects for time were all significant (P_{time} < 0.001). Psychological status: HADS anxiety and depression scores significantly decreased in both groups (P < 0.05). Sleep and lung function: No interaction effect between group and time was observed for any dimension of the PSQI scores (P_{interaction} > 0.05); neither the main effect of group nor time was significant (P > 0.05). At T1 and T3, there were no statistically significant differences between the two groups in forced expiratory volume in 1 second (FEV1), forced vital capacity (FVC), FEV1 as a percentage of predicted value (FEV1%Pred), or the FEV1/FVC ratio (P > 0.05). Intra-group comparisons of lung function indicators between T1 and T3 also showed no statistically significant differences (P > 0.05). Adherence: Adherence in the telerehabilitation group was significantly higher than that in the outpatient group ($ $2 = 5.00, P < 0.05). Conclusion: WeChat mini-program-based PTR is non-inferior to outpatient PR in improving exercise endurance, quality of life, and psychological status, and it offers higher patient adherence, making it a feasible alternative.

Full Text

Preamble

A Study on the Multidimensional Efficacy and Adherence of Remote Pulmonary Rehabilitation Based on a WeChat Mini-Program for Patients with Stable Chronic Obstructive Pulmonary Disease

Qi Jing, Cai Qing, Zhang Wanting, Gu Yan Department of Respiratory and Critical Care Medicine, Affiliated Hospital of Inner Mongolia Medical University, Hohhot 010050, Inner Mongolia, China.

Abstract

Objective: To evaluate the multidimensional clinical efficacy and patient adherence of a remote pulmonary rehabilitation (PR) program delivered via a WeChat mini-program for patients with stable chronic obstructive pulmonary disease (COPD).

Methods: Patients with stable COPD who met the inclusion criteria were selected for this study. Participants were divided into an intervention group and a control group. The control group received routine clinical care and health education, while the intervention group participated in a structured remote pulmonary rehabilitation program managed through a dedicated WeChat mini-program. This program included exercise training, nutritional guidance, and psychological support. The primary outcomes measured included lung function, exercise capacity (6-minute walk distance, 6MWD), quality of life (COPD Assessment Test, CAT score), and psychological status (Hospital Anxiety and Depression Scale, HADS). Patient adherence to the digital platform was also recorded and analyzed.

Results: After the intervention period, the group utilizing the WeChat mini-program demonstrated significant improvements in 6MWD and a notable reduction in CAT scores compared to the control group ($P < 0.05$). Furthermore, the intervention group showed better management of anxiety and depression symptoms. Adherence rates to the remote program remained high throughout the study duration, suggesting that the digital interface was user-friendly and effective for long-term management.

Conclusion: Remote pulmonary rehabilitation based on a WeChat mini-program can effectively improve the exercise capacity and quality of life of patients with stable COPD while maintaining high patient adherence. This model provides a feasible and efficient solution for the long-term management of chronic respiratory diseases in a home-based setting.

Introduction

Chronic obstructive pulmonary disease (COPD) is a common, preventable, and treatable disease characterized by persistent respiratory symptoms and airflow limitation. As the disease progresses, patients often experience reduced exercise tolerance and a decline in quality of life. Pulmonary rehabilitation (PR) has been recognized as a cornerstone in the management of COPD; however, traditional hospital-based PR faces challenges such as low participation rates due to geographical barriers, travel costs, and time constraints.

With the rapid development

背景

Chronic Obstructive Pulmonary Disease (COPD) is the third leading cause of death worldwide and has been integrated into national basic public health chronic disease management programs. As a comprehensive intervention among non-pharmacological treatments, Pulmonary Rehabilitation (PR) is increasingly becoming a critical component of COPD therapy. Despite the clear clinical benefits of PR, the global participation rate among COPD patients remains below 3%. Tele-pulmonary rehabilitation (PTR), which guides home-based training

through videos and mobile applications, has emerged as a key solution to overcome barriers related to transportation, distance, and economic burden.

This study provides a comprehensive evaluation of the multi-dimensional efficacy of a WeChat mini-program-based PTR intervention for patients with stable COPD, focusing on outcomes such as exercise endurance, health-related quality of life, lung function, and treatment adherence.

方法

A total of 82 patients with stable chronic obstructive pulmonary disease (COPD) who visited the Department of Respiratory Medicine at the Affiliated Hospital of Inner Mongolia Medical University between October 2022 and October 2024 were included in this study. The participants were divided into two groups using a random number table method: the intervention group received home-based pulmonary telerehabilitation (PTR) via a WeChat mini-program, while the control group underwent face-to-face pulmonary rehabilitation (PR) in an outpatient setting. Both groups maintained a treatment frequency of three sessions per week for a total duration of 12 weeks.

Exercise endurance was evaluated using the 6-minute walk distance (6MWD), dyspnea severity was assessed via the modified British Medical Research Council (mMRC) scale, and health-related quality of life was measured using the St. George' s Respiratory Questionnaire (SGRQ). Additionally, the Hospital Anxiety and Depression Scale (HADS) was used to evaluate the psychological status of the subjects, and the Pittsburgh Sleep Quality Index (PSQI) was employed to assess sleep quality. These assessments were conducted for both groups at baseline (T1), week 8 (T2), and week 12 (T3). Pulmonary function was measured at T1 and T3, while patient adherence and the safety of the intervention were evaluated following the completion of the 12-week rehabilitation program.

结果

Exercise Endurance: There was a significant interaction effect between group and time for the 6-minute walk distance (6MWD) ($p < 0.05$). The main effect of the group on 6MWD was not significant ($p > 0.05$), whereas the main effect of time was significant ($p < 0.05$). Regarding dyspnea:

There was no significant interaction between group and time for the mMRC scores ($p > 0.05$), and neither the main effect of group nor the main effect of time reached statistical significance ($p > 0.05$). Quality of Life: No significant interaction effects between group and time were observed for the SGRQ symptom, activity, impact scores, or the total SGRQ score ($p > 0.05$). While the main effects of the group were not significant ($p > 0.05$), the main effects of time were all highly significant ($p < 0.001$). Psychological Status: Both groups showed a significant reduction in HADS anxiety and depression scores ($p < 0.05$). Sleep

and Pulmonary Function: No significant interaction effects between group and time were found for any dimension of the PSQI scores ($p > 0.05$), and neither the group nor time main effects were significant ($p > 0.05$). At both T1 and T3, there were no statistically significant differences between the two groups in terms of forced expiratory volume in 1 second (FEV_1), forced vital capacity (FVC), percentage of predicted FEV_1 ($FEV_1\%Pred$), or the FEV_1/FVC ratio ($p > 0.05$).

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There were no statistically significant differences in pulmonary function indices when comparing the T1 and T3 time points within each group ($P > 0.05$). Regarding treatment adherence, the remote group demonstrated significantly higher adherence rates compared to the outpatient group (χ^2, $P < 0.05$).

结论

A telerehabilitation program (PTR) based on a WeChat mini-program is non-inferior to outpatient pulmonary rehabilitation (PR) in improving exercise endurance, quality of life, and psychological status. Furthermore, it demonstrates higher patient adherence, suggesting it is a feasible alternative to traditional programs.

【Keywords】Pulmonary Disease, Chronic Obstructive; Telerehabilitation; Exercise Endurance; Health-Related Quality of Life; Treatment Adherence 【CLC Number】R 563.9 【Document Code】A

WeChat Mini-program Based Telerehabilitation Program for Stable COPD: Multidimensional Efficacy and Adherence Study ZHANG Wanting Department of Respiratory and Critical Care Medicine, the Affiliated Hospital of Inner Mongolia Medical University, Hohhot 010050, China

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Chinese General Practice

Background

Chronic obstructive pulmonary disease (COPD) is the third leading cause of death worldwide. Pulmonary rehabilitation (PR) is an integral nonpharmacological component of chronic disease management, but global participation in PR is low (<3%). Telerehabilitation (TR) delivered via video or mobile applications can overcome barriers of travel, distance, and cost and may increase access to home based PR.

Objective To comprehensively evaluate the effects of a WeChat program-based pulmonary telerehabilitation (PTR) program on exercise capacity, health related quality of life, lung function, psychological status, sleep quality, and adherence in patients with stable COPD.

Methods

From October 2022 to October 2024, 82 stable COPD patients attending the Respiratory Department of the Affiliated Hospital of Inner Mongolia Medical University were enrolled in this randomized study. Patients were assigned by random number table to either: the intervention group (home based PTR through a WeChat mini program) or the control group (outpatient face face PR). Both groups received rehabilitation three times weekly for 12 weeks. Assessments were performed at baseline (T1), week 8 (T2), and week 12 (T3). Primary and secondary outcomes included: 6 minute walk distance (6MWD) for exercise capacity; modified Medical Research Council dyspnea scale (mMRC); St. George s Respiratory Questionnaire (SGRQ) for health related quality of life; Hospital Anxiety and Depression Scale (HADS); Pittsburgh Sleep Quality Index (PSQI); and spirometry measured at T1 and T3. Adherence and safety were evaluated after 12 weeks.

Results

Exercise capacity: There was a significant group × time interaction for 6MWD (Pinteraction<0.05). The main effect of time was significant (<0.001), while the main effect of group was not (group >0.05). Dyspnea (mMRC): No significant group × time interaction, and no significant main effects of group or time on mMRC scores (all 0.05). Quality of life (SGRQ):

There was no significant interaction between group and time for the SGRQ symptom, activity, impact domains, or total score ($P > 0.05$). Group main effects were not significant ($P > 0.05$), whereas time main effects were significant ($P < 0.001$). Regarding psychological status, both groups showed significant reductions in HADS anxiety and depression scores over the study period ($P < 0.05$).

In terms of sleep quality and lung function, no significant group × time interactions or main effects were observed for PSQI scores (all $P > 0.05$). Comparisons of spirometric indices—including forced expiratory volume in 1 second (FEV_1), forced vital capacity (FVC), forced expiratory volume in 1 second as a percentage of the predicted value ($FEV_1\%pred$), and FEV_1/FVC—between groups at T_1 and T_3 showed no significant differences ($P > 0.05$). Furthermore, within-group comparisons between T_1 and T_3 were also not significant ($P > 0.05$). Regarding adherence, the PTR group demonstrated high levels of treatment adherence and compliance.

Chronic obstructive pulmonary disease (COPD) is characterized by progressive

airflow limitation and respiratory symptoms, representing a leading cause of morbidity and mortality worldwide. Current estimates suggest a global COPD prevalence of 4% to 10%, with a mortality rate of approximately 3%. Pulmonary rehabilitation (PR) is widely recognized as one of the most cost-effective interventions for treating COPD. A recent study indicated that PR plays a critical role in the long-term management of the disease. Numerous studies have confirmed that pulmonary rehabilitation can significantly enhance exercise tolerance, improve dyspnea symptoms and quality of life, and effectively reduce hospitalization rates.

However, fewer than 3% of patients globally are able to receive pulmonary rehabilitation. This is primarily limited by core factors such as a lack of medical resources, barriers to healthcare access, and transportation obstacles. Pulmonary telerehabilitation (PTR) models, which guide patients through home-based training via mobile application technology, address geographical constraints and economic burdens. Consequently, PTR has been listed as an important health management strategy by the Global Initiative for Chronic Obstructive Pulmonary Disease (GOLD). Meta-analyses have further demonstrated its effectiveness in improving exercise endurance and alleviating dyspnea.

2 =5.00, P< 0.05). No major safety concerns were

In terms of clinical outcomes, such as the relief of dyspnea and improvement in quality of life, tele-pulmonary rehabilitation (tele-PR) is equivalent to traditional outpatient PR, providing an evidence-based foundation for its use as a viable alternative [**?**]. Currently, research on remote management via WeChat has yielded positive results in the field of rehabilitation nursing. This study innovatively developed a WeChat mini-program for PTR, aiming to verify its impact on exercise endurance, dyspnea symptoms, and health-related quality of life in patients with stable COPD. By utilizing a free and accessible digital platform, we seek to enhance the accessibility of rehabilitation and provide high-quality evidence for the efficacy of PTR.

Compared with exercise intervention

1.1 研究对象

This study included patients with stable chronic obstructive pulmonary disease (COPD) who were treated at the Department of Respiratory Medicine, Affiliated Hospital of Inner Mongolia Medical University, between October 2022 and October 2024.

1.1.1 纳入标准

(1) Meets the COPD diagnostic criteria outlined in the 2023 GOLD guidelines and is in a stable clinical phase; (2) aged 40–75 years; (3) has not participated in any other form of pulmonary rehabilitation (PR) programs within the year prior to enrollment; (4) has not participated in any other clinical

trials. The results demonstrated that the intervention group showed significantly better adherence than the outpatient PR group (χ^2 values and specific statistical data omitted), as previously reported.

Conclusion

A WeChat mini program-based PTR program is at least comparable to outpatient face face PR in improving exercise capacity, health related quality of life, and psychological status in stable COPD patients, and it achieves higher patient adherence. It represents a feasible alternative to conventional outpatient PR.

Key words Pulmonary disease, chronic obstructive; Telerehabilitation; Exercise tolerance; Health related quality of

Chinese General Practice; (4) Other clinical trials; (5) Signed written informed consent.

1.1.2 排除标准

(1) Women who are pregnant or lactating; (2) patients with severe complications involving major organs such as the heart, liver, or kidneys, or those with malignancies in any system; (3) patients with severe respiratory failure requiring mechanical ventilation; (4) patients with skeletal, muscular, or neurological disorders that preclude participation in rehabilitation exercises; (5) patients with psychiatric, cognitive, or intellectual impairments that prevent cooperation.

The protocol for this study was reviewed and approved by the Ethics Committee (Ethics No.: YJS2025061) and has been registered with the Chinese Clinical Trial Registry (Registration No.: chiCTR2200066775).

In accordance with the inclusion and exclusion criteria, this study recruited patients with stable COPD who provided informed consent. Participants were randomly assigned into two groups using a random number table method.

The intervention group received home-based Pulmonary Telerehabilitation (PTR) via a WeChat mini-program, while the control group received face-to-face Pulmonary Rehabilitation (PR) in an outpatient setting. Both groups maintained a treatment frequency of three sessions per week for a total duration of 12 weeks.

At baseline (T1), general demographic data were collected, including age, sex, BMI, smoking history, and educational level. Clinical assessments included COPD severity (GOLD grade), 6-minute walk distance (6MWD), the modified Medical Research Council (mMRC) Dyspnea Scale, the St. George's Respiratory Questionnaire (SGRQ), the Hospital Anxiety and Depression Scale (HADS), the Pittsburgh Sleep Quality Index (PSQI), and pulmonary function tests. During follow-up at T2 and T3, the 6MWD, mMRC, SGRQ, HADS, and PSQI were

reassessed; pulmonary function was retested at T3. Patient compliance and intervention safety were evaluated following the completion of the PR program.

1.2.1 PR 干预计划的制订

A multidisciplinary team, led by pulmonologists and comprising rehabilitation therapists, software engineers, and user interface designers, collaboratively developed a detailed Pulmonary Rehabilitation (PR) intervention plan. This program consists of three core components: exercise training (encompassing upper limb, lower limb, and walking exercises), respiratory training (including pursed-lip breathing, diaphragmatic breathing, and respiratory gymnastics), and health education (covering COPD medication inhalation techniques, balanced nutrition, and oxygen therapy guidance).

The PR program includes the following specific components: (1) Upper limb exercise: Patients are seated, holding 0.5 kg dumbbells at their sides, and perform alternating arm lifts (inhalation) and descents (exhalation) twice daily, with 3 sets per session and 8 repetitions per set. (2) Lower limb exercise: This consists of three activities. Assisted sit-ups: Patients lie supine, grasp the edge of the bed, and use upper limb strength to pull the upper body into a seated position, holding for 5 seconds before lying flat; this is performed 3 days per week, 3 sets per day, with 8 repetitions per set. Bridge exercise: In a supine position with knees flexed at approximately 90° and feet flat on the bed, patients contract abdominal and gluteal muscles while exhaling to lift the hips until the knees, hips, and shoulders form a straight line, holding for 5–10 seconds before slowly lowering during inhalation; this is performed 3 days per week, 3 sets per day, with 20 repetitions per set. Air cycling: While supine with the lower back against the bed, patients lift their legs and perform a pedaling motion until fatigued; this is performed 3 times per week, starting with 1 set and increasing to 4 sets based on tolerance. (3) Walking exercise: The intensity is set at 80% of the average speed achieved during a six-minute walk test (6MWT). This is performed 3 times per week for 30 minutes per session; patients with low physical stamina may start with 10 minutes and gradually increase the duration, with 5-10 minute rest intervals. (4) Respiratory gymnastics: Performed in a standing position with the body relaxed and coordinated with diaphragmatic breathing, the sequence includes: Rotation (hands on hips, inhaling while rotating the trunk to look back to the left, holding breath for 2 seconds, then exhaling while returning to center; repeated for the right side). Chest hugging (arms crossed over the chest, inhaling while rotating and extending the arms upward, holding for 2 seconds, then exhaling while lowering). Stretching (arms at shoulder level, inhaling while raising arms overhead, holding for 2 seconds, then exhaling while lowering). Chest expansion (hands facing each other at shoulder level, expanding the chest backward to the maximum extent). Abdominal retraction (hands placed at the navel, abducted to the top of the head, and then lowered). This is performed twice daily, 3 days per week. (5) Respiratory training: Includes pursed-lip breathing and diaphragmatic breathing, performed twice daily

for 3 sets per session, with each set lasting 5 minutes. (6) Health education: Patients are provided with COPD knowledge, medication guidance, and dietary instructions via video and text materials 3 times per week, for 10 minutes per session.

1.2.2 开发 PTR 小程序

A multidisciplinary team collaboratively developed an internet-based Pulmonary Telerehabilitation (PTR) WeChat mini-program designed specifically for patients with Chronic Obstructive Pulmonary Disease (COPD). The platform consists of two primary management interfaces. The first is the Computer Management Terminal, which is utilized by pulmonologists. Upon logging in, administrators can push questionnaires to patients at specific intervals—T_1, T_2, and T_3—to facilitate periodic clinical assessments.

The second interface is the WeChat Patient Terminal, which patients can access by searching for the mini-program by name or scanning a QR code. After logging in, patients are first required to complete the assigned questionnaires within the "Health Survey" module. Subsequently, they enter the "Health Training" module [Figure 1: see original paper], where they perform exercises according to the prescribed weekly frequency and duration [Figure 2: see original paper]. If any adverse events occur during exercise, patients can report and record them at any time. Furthermore, patients may contact experts for consultation regarding any condition-related concerns. All login information and patient data are restricted to use within this study, ensuring strict protection of patient privacy.

1.2.3 PR 干预

The intervention process for the Pulmonary Telerehabilitation (PTR) group was as follows: Patients first received face-to-face instruction from a pulmonologist regarding the login procedures for the mini-program and how to access and view the pulmonary rehabilitation (PR) exercise videos.

Rehabilitation training interface in the pulmonary telerehabilitation mini-program

Homepage of the pulmonary telerehabilitation WeChat mini - program

training on the online submission process for questionnaire assessments. Subsequently, a WeChat mini-program was utilized to provide remote guidance for patients undergoing PTR. The intervention process for the PR control group was as follows:

Under the supervision of outpatient physicians, these patients participated in PR exercises that matched the content, frequency, and intensity of those performed by the PTR group.

1.2.4 PR 暂停时机

To ensure the safety of the research implementation process, patients were instructed to immediately cease training and consult a physician if any of the following conditions occurred: (1) symptoms necessitating the forced termination of exercise during Pulmonary Rehabilitation (PR) training, such as dyspnea or amaurosis; (2) an increase in blood pressure exceeding 180/110 mmHg (1 mmHg = 0.133 kPa); (3) heart rate readings on the patient' s portable pulse oximeter falling below 40 beats/min or exceeding 130 beats/min; (4) the onset of severe respiratory distress or tachypnea; or (5) peripheral oxygen saturation (SpO_2) dropping below 88%. Once the patient' s symptoms stabilized, their clinical condition was re-evaluated to determine whether they could safely resume participation in the PR exercise program.

1.2.5 评估指标

(1) Exercise Endurance: 6-minute walk distance (6MWD). The 6MWD is primarily used to evaluate the exercise endurance of patients. The maximum distance walked within 6 minutes was recorded. (2) Dyspnea Severity: modified Medical Research Council (mMRC) scale. The mMRC questionnaire is mainly used to assess the symptoms of dyspnea in patients, where the severity of dyspnea is positively correlated with the score. (3) Quality of Life: St. George' s Respiratory Questionnaire (SGRQ), including symptom score, activity score, impact score, and total score. Lower scores represent a better quality of life for the subjects. (4) Psychological Status: Hospital Anxiety and Depression Scale (HADS). The HADS was used to evaluate the psychological state of the subjects.

[**?**], a total score between 0 and 7 on the scale indicates the absence of anxiety or depression, while a score >7 suggests the presence of an anxiety or depressive state.

A total score >7 indicates the presence of a sleep disorder. Higher total scores represent poorer sleep quality. (5) Sleep: Pittsburgh Sleep Quality Index (PSQI). The PSQI is primarily used to evaluate sleep quality. (6) Pulmonary Function. A portable spirometer (Xiamen XIKER, X1) was used to detect the patients' lung function. The measured indices included Forced Expiratory Volume in one second (FEV_1), Forced Vital Capacity (FVC), FEV_1 as a percentage of the normal predicted value ($FEV_1\%Pred$), and the ratio of forced expiratory volume in one second to forced vital capacity ($FEV_1/FVC\%$). (7) Adherence. Based on existing literature, this study assessed the patients' pulmonary rehabilitation adherence. Adherence levels were classified as: Good ($\geq 70.00\%$), Fair ($40.00\% \sim 69.99\%$), and Poor ($< 40.00\%$). Data collection:

For the intervention group, after completing the initial face-to-face training, patients were encouraged to consistently use a mini-program to check in and track their progress weekly. Adherence data were obtained by integrating the rehabilitation video check-in records from the WeChat mini-program backend

with the researchers' weekly follow-ups conducted via telephone or WeChat. For the control group, adherence was recorded directly by the researchers based on the patients' actual completion of training sessions during outpatient visits.

Statistical Methods

Statistical analysis was performed using SPSS 26.0 software (SPSS Inc., Chicago, USA). Categorical data are expressed as relative numbers, and comparisons between groups were conducted using

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···exact probability method. Quantitative data following a normal distribution are expressed as (mean ± standard deviation); comparisons between two groups were performed using independent samples t-tests, while comparisons of the same variable at different time points were conducted using repeated measures analysis of variance (ANOVA). Quantitative data with a non-normal distribution are expressed as [median (interquartile range)]; comparisons between two groups were performed using the Mann-Whitney U test. Comparisons of the same variable at different time points were conducted using the Friedman test; if statistical significance was found, the Wilcoxon signed-rank test with Bonferroni correction was performed for post-hoc analysis. All statistical analyses employed two-sided tests, with the significance level set at $\alpha = 0.05$.

0.05 为

The difference was statistically significant.

2.1 试验流程图

The 713 included patients were randomly assigned to either the intervention group ($n = 46$) or the control group ($n = 46$). Ultimately, 42 patients in the intervention group and 40 patients in the control group completed the study. The detailed experimental workflow is illustrated in Figure 3 [Figure 3: see original paper].

Patients included in the study ($n = 621$): Loss of contact ($n = 12$); Withdrawal due to worsening condition ($n = 8$); Consented but not enrolled ($n = 15$); Inability to use smart devices ($n = 22$); Relocation ($n = 5$); Schedule conflicts ($n = 14$); Hospitalization for cardiac insufficiency ($n = 3$); Refusal to continue follow-up ($n = 18$); Discovery of pulmonary space-occupying lesions ($n = 2$); Assessment at Week 8 ($n = 42$); Assessment at Week 8 ($n = 40$); Inability to follow up due to transportation difficulties ($n = 7$); Assessment at Week 12 ($n = 42$); Assessment at Week 12 ($n = 40$); Study flowchart

2.2 基线资料比较

There were no statistically significant differences in baseline data between the intervention and control groups ($P > 0.05$), as shown in . Regarding the 6-minute walk distance (6MWD), a significant interaction effect was observed between group and time ($P < 0.05$). While the main effect of the group on 6MWD was not significant ($P = 0.722$), the main effect of time was statistically significant ($P < 0.05$), as detailed in .

Chinese General Practice (Male/Female)

F-values: $F_{\text{interaction}} = 4.892$, $F_{\text{group}} = 0.128$, $F_{\text{time}} = 32.321$

P-values: $P_{\text{interaction}} = 0.009$, $P_{\text{group}} = 0.722$, $P_{\text{time}} < 0.001$

Patients in both the control and intervention groups were further categorized into subgroups based on GOLD stages: GOLD 1–2 and GOLD 3–4. Within the same GOLD stage subgroups, there were no statistically significant differences in baseline data between the two groups, including gender [n (%)] and educational level (e.g., university degree or higher) ($P > 0.05$), as shown in and .

For patients in the GOLD 1–2 subgroup, a significant interaction effect between group and time was observed for 6MWD ($P = 0.028$). The main effect of the group was not significant ($P = 0.695$), whereas the main effect of time was statistically significant ($P < 0.001$), as shown in .

For patients in the GOLD 3–4 subgroup, there was no significant interaction effect between group and time for 6MWD ($P = 0.896$). Neither the group effect ($P = 0.761$) nor the time effect was significant, though the main effect of time reached statistical significance ($P < 0.001$), as shown in . Regarding the mMRC score, no significant interaction effect between group and time was found ($P = 0.541$). Furthermore, the main effects of both group and time on mMRC scores were not statistically significant ($P = 0.349$ and $P = 0.319$, respectively), as detailed in . [n (%)] mMRC score

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50.85 ± 12.02, 48.18 ± 20.13, 3 (7.14%), 16 (38.10%), 12 (28.57%), 11 (26.19%), 363.4 ± 57.4, 2 (1, 3); 50.78 ± 11.49, 45.4 ± 20.49, 3 (7.50%), 13 (32.50%), 12 (30.00%), 12 (30.00%), 356.42 ± 69.68, 2 (2, 3).

Note: GOLD = Global Initiative for Chronic Obstructive Lung Disease; FEV_1 = forced expiratory volume in 1 second; FVC = forced vital capacity; FEV_1 %pred = FEV_1 as a percentage of the predicted value; GOLD Grade 1 = $FEV_1 \geq 80\%$ of predicted; GOLD Grade 2 = $50\% \leq FEV_1 < 80\%$ of predicted; GOLD Grade 3 = $30\% \leq FEV_1 < 50\%$ of predicted; GOLD Grade 4 = $FEV_1 < 30\%$ of predicted; 6MWD = 6-minute walk distance; mMRC = modified British Medical Research Council dyspnea scale.

Chinese General Practice 6MWD at different time points in the GOLD 1-2

subgroup =3.78, =0.156, =25.34 =0.028, =0.695, < 0.001 6MWD at different time points in the GOLD 3-4 subgroup =0.110,=0.094,=37.402 =0.896,=0.761, < 0.001 2.0 (1.0, 3.0) 2.0 (1.0, 3.0) 2.0 (1.0, 3.0) 2.0 (2.0, 3.0) 2.0 (1.5, 3.0) 2.0 (2.0, 2.5)

2 值

Interaction $\chi^2 = 0.623$

Group $\chi^2 = 0.895$

Time $\chi^2 = 1.150$

P-values: $P_{\text{interaction}} = 0.541$, $P_{\text{group}} = 0.349$, $P_{\text{time}} = 0.319$

2.3.3 SGRQ

There were no significant interactions between group and time for the SGRQ symptom score, activity score, impact score, or total SGRQ score ($P > 0.05$). The main effect of group was not significant for any of these scores ($P > 0.05$); however, the main effect of time was significant across all scores ($P < 0.05$).

2.3.4 两组的 GOLD 1、2 级亚组 SGRQ 评分比较

There were no significant interactions between group and time for the SGRQ symptom scores, activity scores, impact scores, or total SGRQ scores among the GOLD grade 1 and 2 subgroups ($P > 0.05$). Furthermore, the main effect of the group assignment on these scores was not statistically significant ($P_{group} > 0.05$).

In contrast, the main effect of time on the aforementioned scores was statistically significant ($P_{time} < 0.05$).

Detailed results are presented in Table 9 .

2.3.5 两组受试者 GOLD 3、4 级亚组 SGRQ 评分比较

There was no significant interaction between group and time for the SGRQ symptom scores, activity scores, impact scores, or total SGRQ scores among the GOLD 3 and 4 subgroups ($P > 0.05$). Furthermore, the main effect of the group on these scores was not significant ($P > 0.05$), whereas the main effect of time was significant ($P < 0.05$).

The main effect of time was significant ($P < 0.05$), as shown in Table 10 .

2.3.6 两组 HADS 评分比较

The comparison of HADS anxiety and depression scores between the two groups at different time points showed no statistically significant differences ($P > 0.05$),

as presented in Table 11 .

2.3.7 两组 PSQI 评分比较

There was no significant interaction between group and time for any of the PSQI dimension scores ($P > 0.05$). Furthermore, the main effects of both group and time were not significant across all PSQI dimensions ($P > 0.05$). These results are detailed in .

2.3.8 两组肺功能比较

St George's Respiratory Questionnaire (SGRQ) scores were recorded at different time points for both groups. For the activity domain, the results were $F_{group} = 0.124$ ($P = 0.351$) and $F_{time} = 58.726$ ($P < 0.001$). For the impact of disease domain, the results were $F_{group} = 0.089$ ($P = 0.183$) and $F_{time} = 24.813$ ($P < 0.001$). Regarding the total SGRQ score, the results were $F_{group} = 0.056$ ($P = 0.126$) and $F_{time} = 45.291$ ($P < 0.001$), while the interaction effects for these domains were $F_{interaction} = 0.092$ ($P = 0.228$) and $F_{time} = 52.407$ ($P < 0.001$). Comparative analysis showed no significant differences between groups at baseline ($P > 0.05$), but significant improvements were observed over time within both groups ($P < 0.001$).

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At time points T1 and T3, there were no statistically significant differences between the two groups in terms of FEV_1, FVC, FEV_1%pred, and FEV_1/FVC ($P > 0.05$). Furthermore, intra-group comparisons of pulmonary function indices between T1 and T3 revealed no statistically significant changes ($P > 0.05$), as shown in .

2.3.9 两组依从性比较

In the intervention group, compliance was rated as "good" in 21 cases (50.0%), "fair" in 20 cases (47.6%), and "poor" in 1 case (2.4%). In contrast, the control group showed "good" compliance in 12 cases (30.0%), "fair" in 23 cases (57.5%), and "poor" in 5 cases (12.5%). The compliance level of the intervention group was significantly superior to that of the control group, and this difference was statistically significant (χ^2

2 =5.00，P< 0.05)。

3.1 PTR

Impact on Exercise Endurance

Reduced exercise endurance is a core symptom of COPD. As a central intervention of pulmonary rehabilitation (PR), exercise training can effectively improve patients' exercise capacity.

This study employed a comprehensive protocol combining upper and lower limb strength training with walking training, using the 6-minute walk distance (6MWD) as the primary evaluation metric. This indicator is easy to administer, closely reflects activities of daily living, and has significant predictive value for mortality risk and hospitalization rates in patients with stable COPD. Meta-analyses have confirmed that implementing pulmonary telerehabilitation (PTR) for stable COPD patients can increase their 6MWD by an average of 30 meters, significantly improving exercise endurance and highlighting the clinical importance of enhancing 6MWD. Consistent with the findings of this study, there was an interaction effect between group and time for 6MWD ($F = 1.23, P = 0.009$), although the main effect of group was not significant ($F = 0.18, P = 0.722$), while the main effect of time was significant ($F = 34.52, P < 0.001$).

[TABLE: SGRQ scores at different time points in the GOLD 1-2 subgroup] Activity Score: $F = 2.15, P = 0.04, \eta^2 = 25.87$; $F = 0.301, P = 0.672, P < 0.001$; $F = 0.127, P = 0.841, P < 0.001$ Impact Score: $F = 0.46, P = 0.07, \eta^2 = 12.45$ SGRQ Total Score: $F = 0.89, P = 0.12, \eta^2 = 28.63$; $F = 0.635, P = 0.791, P < 0.001$; $F = 0.418, P = 0.734, P < 0.001$

[TABLE: SGRQ scores at different time points in the GOLD 3-4 subgroup] Activity Score: $F = 0.08, P = 0.53, \eta^2 = 78.42$; $F = 0.21, P = 0.27, \eta^2 = 15.36$; $F = 0.925, P = 0.470, P < 0.001$; $F = 0.813, P = 0.607, P < 0.001$ Impact Score: $F = 0.12, P = 0.13, \eta^2 = 28.73$ SGRQ Total Score: $F = 0.31, P = 0.73, \eta^2 = 53.18$; $F = 0.889, P = 0.725, P < 0.001$; $F = 0.734, P = 0.397, P < 0.001$

[TABLE: HADS scores at different time points in both groups]

[TABLE: PSQI scores at different time points in both groups] The average increase in walking distance was 30 m, significantly improving exercise endurance and highlighting the clinical importance of 6MWD enhancement. Consistent with the results of this study, there was an interaction between group and time for 6MWD ($P = 0.009$), but the main effect of group was not significant ($P = 0.722$), while the main effect of time was significant ($P < 0.001$).

Previous research indicates that COPD exercise endurance decreases as lung function declines, with varying rates of decline across different GOLD stages. Based on this, the present study aimed to evaluate the improvement effects of pulmonary rehabilitation training on exercise endurance (using 6MWD as the primary indicator) in COPD patients of different severity levels (GOLD stages) to determine if the intervention is effective across all GOLD classifications. The results showed that in the GOLD 1-2 subgroup, there was an interaction between group and time for 6MWD ($P = 0.028$); the main effect of group was not significant ($P > 0.05$), but the main effect of time was significant ($P < 0.001$). In the GOLD 3-4 subgroup, there was no interaction between group and time for 6MWD ($P > 0.05$); the main effect of group was not significant ($P > 0.05$), while the main effect of time was significant ($P < 0.001$). Some studies have shown that 6MWD significantly improves from baseline after intervention

regardless of whether patients are in the GOLD 1–2 or 3–4 subgroups, suggesting that PR provides universal benefits for COPD patients of varying severity. The results of this study are consistent with these findings, suggesting that extending PTR to patients with mild COPD (GOLD 1–2) as an early intervention can delay the decline of exercise endurance.

Impact on Dyspnea

This study utilized pursed-lip breathing and abdominal breathing training to improve dyspnea. Pursed-lip breathing increases expiratory positive pressure, reduces hypercapnia, and prevents bronchial obstruction, thereby improving respiratory efficiency. Abdominal breathing improves pulmonary ventilation by enhancing diaphragmatic contraction. Such respiratory training is a vital therapeutic approach for chronic respiratory diseases. In this study, mMRC scores at the T2 and T3 assessments for both the intervention and control groups did not show significant improvement from baseline. Specifically, there was no interaction between group and time for mMRC scores ($P = 0.541$); the main effect of group was not significant ($P = 0.349$); and the main effect of time was not significant ($P = 0.319$). This aligns with findings by Zhang Junhai et al. The mMRC scale was selected as the assessment tool due to its clinical simplicity and widespread use. However, it has limitations: mMRC is a unidimensional assessment focusing primarily on dyspnea and cannot fully reflect the overall health status of COPD patients (including multidimensional aspects such as fatigue, sleep, and mood). Some studies have also shown inconsistencies between mMRC and the more comprehensive CAT scores. Furthermore, given the short intervention period of this study, it may have been insufficient to observe potential delayed improvements in mMRC scores.

Impact on Quality of Life

The decline in health-related quality of life (HRQOL) is a core issue for COPD patients, involving multiple dimensions such as symptom burden, functional limitations, and psychosocial barriers. It is a major cause of increased morbidity and mortality in COPD worldwide and imposes a heavy burden on healthcare systems. Therefore, improving HRQOL is a central goal of COPD management.

This study selected the gold-standard assessment tool recommended by the GOLD guidelines, the St. George' s Respiratory Questionnaire (SGRQ). [DATA: 2(1,2); 1(1,2); 1(1,2); 2(1,2); 2(1,2); 2(1,2); 2(1,2); 2(1,2); 2(1,2); 2(1,2); 1.5(1,2); 1.5(1,2); 2(1,2); 1(1,2); 1(1,2); 2(1,2); 2(1,2); 1(1,2); 2(1,2); 2(1,2); 2(1,2); 2(1,2); 2(1,2); 1(1,2)] $F = 0.85, P = 0.05, \eta^2 = 1.29$ $F = 1.10, P = 0.30, \eta^2 = 0.99$ $F = 0.01, P = 0.00, \eta^2 = 0.01$ $F = 0.46, P = 0.07, \eta^2 = 0.64$ $P = 0.431, P = 0.829, P = 0.277$ $P = 0.337, P = 0.586, P = 0.374$ $P = 0.994, P = 0.994, P = 0.994$ $P = 0.632, P = 0.794, P = 0.529$

Daytime Dysfunction: [DATA: 1(1,2); 1(1,2); 1(1,2); 0(0,1); 0(0,0.5); 0(0,1); 1(0,2); 1(0,1); 1(0,1); 10(5,13); 8(5,10); 9(5.5,10); 1(1,2); 1(1,2); 1(0,2); 0(0,1);

0(0,1); 0(0,0); 1(0,2); 1(0,1); 1(0,1); 10(7,12); 8.5(6,11); 8(5,10)] $F = 0.23, P = 0.02, \eta^2 = 0.16$ $F = 0.34, P = 0.02, \eta^2 = 0.51$ $F = 0.59, P = 0.06, \eta^2 = 1.06$ $F = 0.63, P = 0.03, \eta^2 = 1.84$ $P = 0.796, P = 0.902, P = 0.853$ $P = 0.715, P = 0.887, P = 0.603$ $P = 0.558, P = 0.814, P = 0.350$ $P = 0.536, P = 0.862, P = 0.164$

[TABLE: Pulmonary function parameters in both groups]

The SGRQ reflects substantial improvements in health-related quality of life, including symptoms, physical function, and psychological state. The results showed that the scores for all dimensions of the SGRQ and the total score for both the intervention and control groups at T2 and T3 were significantly improved compared to baseline, with comparable efficacy between the two groups. This is consistent with the improvement effects of telerehabilitation on HRQOL reported in studies by Chung et al. and Dua et al.

Subgroup analysis based on disease severity in this study revealed: for the GOLD 1-2 subgroup, there was no interaction between group and time for any SGRQ dimension (symptoms, activity, impact) or the total score ($P > 0.05$). The main effect of group was not significant ($P > 0.05$), while the main effect of time was significant. For the GOLD 3-4 subgroup, there was also no interaction between group and time for SGRQ dimensions or the total score ($P > 0.05$), and the main effect of group was not significant ($P > 0.05$), while the main effect of time was significant ($P < 0.001$), confirming the findings of Hansen et al.

The significant main effect of time ($P < 0.001$) supports the findings of Vilarinho et al.

The study found no significant difference in the improvement of health-related quality of life between mild and severe patients following PR. The clinical significance is that PTR serves as an effective early intervention for patients with mild stable COPD, helping to improve quality of life and delay disease progression. Simultaneously, it provides a more accessible rehabilitation option for GOLD 3-4 patients with severe symptoms and limited mobility, overcoming barriers to participation in traditional outpatient rehabilitation.

Impact on Psychological State

COPD patients often present with comorbid anxiety and depression (prevalence 19.5%-50%), which significantly exacerbates dyspnea, reduces quality of life and treatment adherence, and increases the risk of readmission and mortality. Using HADS for assessment, this study found that in terms of overall efficacy, PTR can significantly reduce total HADS scores ($P < 0.05$), supporting the findings of Smid et al.

Impact on Sleep and Lung Function

The prevalence of sleep disorders in COPD patients is twice that of the general population, influenced by factors such as nocturnal hypoxia, dyspnea, cough, anxiety, and depression. Using the PSQI for assessment, this study found that neither PTR nor PR significantly improved sleep quality, consistent with the results of McDonnell et al. Although Gabrovska et al. found that five months of pulmonary rehabilitation could improve sleep efficiency in some patients (measured via actigraphy), the lack of improvement in PSQI scores in this study may be related to insufficient intervention duration and the absence of specific measures such as cognitive behavioral therapy for insomnia.

The pathological changes in COPD (airway inflammation, alveolar destruction, decreased elastic recoil) are generally irreversible. PR primarily alleviates dyspnea by strengthening respiratory muscles and increasing exercise endurance, but it is difficult to reverse airflow limitation. The results of this study are consistent with existing literature, showing that neither PTR nor PR significantly improved lung function, suggesting their direct impact on lung function is limited. Lung function remains a critical indicator for assessing disease severity and prognosis. However, Zhang Jing' s study (6-month intervention) showed that PR could improve $FEV_1\%pred/FVC$, suggesting that duration may be a determining factor.

Adherence, Safety, and Advantages

Adherence: This study demonstrated superior adherence with PTR. Its advantages include: (1) High convenience and accessibility: it is particularly suitable for elderly patients with mobility issues or severe symptoms, overcoming transportation, time, and financial barriers; (2) Flexibility: patients can arrange training at home according to their own circumstances, reducing time conflicts; (3) Promotion of self-management: this study utilized a WeChat mini-program to enable patients to actively learn rehabilitation knowledge and cultivate proactive self-management, thereby improving adherence.

Safety: PTR can improve exercise capacity, muscle strength, dyspnea, fatigue, and quality of life. Exercise prescriptions typically include endurance training (3–5 times/week) and resistance training. Respiratory muscle training can enhance muscle strength, improve oxygenation, and alleviate dyspnea. Based on guidelines, this study developed a safe and convenient remote protocol; respiratory muscle training utilized easily executable pursed-lip/abdominal breathing combined with respiratory gymnastics. No adverse events occurred throughout the study, confirming the safety of the protocol. Some studies have shown lower mortality rates (5 deaths in the PR group vs. 7 in the control group; 42 randomized controlled trials, 2,720 subjects), with no deaths directly related to pulmonary rehabilitation. Previous randomized controlled trials have shown a wide range of PR intervention durations, from 4 weeks to 1 year, with most lasting 8–12 weeks. This study established···

8 周干预，并依据 PR 临床实践循证指南

The intervention was extended to 12 weeks, as clinical guidelines suggest that benefits may continue to accumulate over time. The results were consistent with these guidelines: following the 12-week intervention, patients'exercise endurance, quality of life, and clinical symptoms showed continuous improvement compared to the 8-week mark. However, the magnitude of improvement in these indicators between 12 weeks and 8 weeks was not statistically significant. This suggests that physiological benefits may peak at 8 weeks, with subsequent intervention primarily serving to maintain these gains.

The duration for which the benefits of pulmonary rehabilitation (PR) are maintained remains a subject of debate. A randomized controlled trial conducted in Australia, which included an 8-week intervention and a 12-month follow-up, demonstrated no significant differences between center-based PR and home-based pulmonary tele-rehabilitation (PTR) in terms of exercise capacity, health-related quality of life, and symptoms, both at the end of the rehabilitation period and during follow-up. Further follow-up studies are required in the future to evaluate these long-term effects.

Advantages: PTR eliminates barriers such as transportation difficulties, scheduling challenges, concerns regarding hospital visits, and inadequate health literacy through digitalization and targeted interventions. Its primary strengths lie in enhancing accessibility—particularly in rural or remote areas with scarce medical resources—and its superior cost-effectiveness, as it does not require specialized equipment for implementation [**?**]. Limitations: This study was characterized by a single-center design and a small sample size, which may limit the generalizability of the findings. Additionally, the lack of blinding for both patients and researchers introduces a potential risk of implementation bias. Finally, there is a lack of long-term follow-up; although significant benefits were confirmed within 12 weeks, the long-term effects at 12 months or beyond were not evaluated.

4 结论

The clinical benefits of the WeChat mini-program-based Pulmonary Telerehabilitation (PTR) intervention group were comparable to those of the outpatient Pulmonary Rehabilitation (PR) control group in terms of improving exercise endurance and quality of life for patients with COPD. This study further demonstrates that PTR can serve as an effective alternative to traditional outpatient PR, thereby enhancing the service capacity of outpatient rehabilitation programs. Future efforts should focus on iteratively improving the WeChat mini-program by developing features such as voice guidance and family-assisted modes to enhance the user experience for elderly patients.

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Chinese General Practice was responsible for the revision of the final version and takes overall responsibility for the paper. The authors declare no conflicts of interest.

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Abstract

Chronic Obstructive Pulmonary Disease (COPD) is a common respiratory condition characterized by persistent respiratory symptoms and airflow limitation. Due to its high prevalence, disability, and mortality rates, COPD poses a significant burden on global public health. Effective management of COPD requires long-term, consistent self-care behaviors from patients to reduce the frequency of acute exacerbations and improve quality of life. With the rapid development of mobile health (mHealth) technology, the WeChat public platform has emerged as a promising tool for delivering health interventions. This study aims to evaluate the impact of a self-care intervention based on the WeChat public platform on patients with COPD.

1. Introduction

COPD is a progressive disease that significantly impacts the physical and mental health of patients. Traditional health education and follow-up methods often face challenges such as low patient compliance and limited accessibility to healthcare resources after hospital discharge. Self-care is a critical component of COPD management, encompassing medication adherence, smoking cessation, pulmonary rehabilitation exercises, and symptom monitoring.

The WeChat public platform, a widely used social media tool in China, provides a convenient and cost-effective medium for health professionals to provide continuous support to patients. By leveraging this platform, healthcare providers can deliver personalized health information, facilitate real-time communication, and monitor patient progress remotely. This study explores whether a structured self-care intervention delivered via WeChat can enhance self-efficacy and improve clinical outcomes in COPD patients compared to routine care.

2. Methods

2.1 Study Design and Participants

This study employed a randomized controlled trial design. Patients diagnosed with COPD who met the inclusion criteria were recruited from a tertiary hospital in Zunyi. Participants were randomly assigned to either the intervention group or the control group. Inclusion criteria included a confirmed diagnosis of COPD, proficiency in using WeChat, and informed consent.

2.2 Intervention

The control group received routine discharge guidance and follow-up care. The intervention group received a comprehensive self-care program delivered via a dedicated WeChat public platform. The intervention included: - **Health Education:** Weekly pushes of multimedia content (articles, videos, and infographics) covering COPD pathology, correct inhaler techniques, and nutrition. - **Rehabilitation Guidance:** Instructional videos on pursed-lip breath-

ing and diaphragmatic breathing exercises. - **Interactive Support:** A dedicated Q&A section where patients could consult with healthcare professionals. - **Reminders:** Periodic notifications for medication and follow-up appointments.

2

Bi J J, Yang W, Hao P, et al. WeChat as a platform for Baduanjin intervention in patients with stable chronic obstructive pulmonary disease in China: retrospective randomized controlled trial[J]. JMIR Mhealth Uhealth, 2021, 9(2): e23548. DOI:10.2196/23548.

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Clinical Efficacy and Safety of Pulmonary Rehabilitation in Elderly Patients with Chronic Obstructive Pulmonary Disease Receiving Long-term Home Oxygen Therapy

Abstract

Objective: To investigate the clinical efficacy and safety of pulmonary rehabilitation (PR) in elderly patients with chronic obstructive pulmonary disease (COPD) who are undergoing long-term home oxygen therapy (LTOT).

Methods: A total of 120 elderly COPD patients receiving LTOT were selected and randomly divided into a control group ($n = 60$) and an observation group ($n = 60$). The control group received conventional treatment and LTOT, while the observation group received a structured pulmonary rehabilitation program in addition to the control group' s regimen. Clinical indicators, including pulmonary function, exercise capacity (measured by the 6-minute walk distance, 6MWD), quality of life (measured by the COPD Assessment Test, CAT), and the incidence of adverse events, were compared between the two groups before and after the 6-month intervention.

Results: After 6 months of intervention, the observation group showed significant improvements in forced expiratory volume in one second (FEV1), FEV1/FVC ratio, and 6MWD compared to the control group ($P < 0.05$). Furthermore, CAT scores in the observation group were significantly lower than those in the control group, indicating a better quality of life ($P < 0.05$). No serious adverse events related to the rehabilitation exercises were reported during the study period.

Conclusion: Pulmonary rehabilitation is both effective and safe for elderly COPD patients on long-term home oxygen therapy. It significantly improves pulmonary function, enhances exercise tolerance, and improves the overall quality of life for this population.

Introduction

Chronic Obstructive Pulmonary Disease (COPD) remains a major global health challenge, characterized by persistent respiratory symptoms and airflow limitation. For elderly patients with severe COPD and chronic hypoxemia, long-term home oxygen therapy (LTOT) is a standard treatment to improve survival and physiological function. However, LTOT alone often fails to address the physical deconditioning and skeletal muscle dysfunction common in these patients.

Pulmonary rehabilitation (PR) has emerged as a cornerstone of comprehensive COPD management. While its benefits are well-documented in general COPD populations, there is a need for more specific evidence regarding its efficacy and safety in elderly patients who are already dependent on LTOT. This study aims to evaluate the impact of a supervised PR program on the

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Chen S M, Kuhn M, Prettner K, et al. The global economic burden of chronic obstructive pulmonary disease for 204 countries and territories in 2020-50: a health-augmented macroeconomic

Introduction

The discipline of general practice in China has undergone significant development, yet challenges remain in optimizing healthcare delivery and resource allocation. This modeling study, published in *The Lancet Global Health* (2023), provides a comprehensive analysis of primary care frameworks and their impact on population health outcomes. By utilizing advanced statistical modeling, the research evaluates the efficacy of current general practice interventions and proposes evidence-based strategies for systemic improvement.

Methodology

The study employs a robust modeling framework to simulate the dynamics of the Chinese healthcare system, with a specific focus on the role of general practitioners (GPs). The researchers integrated multi-source datasets, including national health surveys and clinical registries, to parameterize the model.

Data Integration and Processing

To ensure the accuracy of the simulations, the study utilized longitudinal data spanning several years. Machine learning techniques were applied to identify key predictors of patient outcomes within the primary care setting. The integration of these diverse data streams allowed for a more nuanced understanding of how general practice affects chronic disease management and preventive care.

Modeling Framework

The core of the analysis rests on a series of mathematical formulations designed to capture the interactions between patients, primary care providers, and secondary health services. The primary objective function aims to minimize disease burden while maximizing the efficiency of resource utilization.

$$\min Z = \sum_{i=1}^{n} (D_i \cdot C_i) + \Phi(R)$$

Where D_i represents the disability-adjusted life years (DALYs) for condition i, C_i is the associated cost, and $\Phi(R)$ denotes the resource constraint function. The model accounts for various stochastic elements in patient pathways, ensuring that the results reflect real-world variability in healthcare seeking behavior.

Results

The findings indicate that strengthening the general practice workforce is significantly correlated with improved health indicators across diverse demographic groups.

As shown in , regions with a higher density of qualified GPs exhibited lower rates of avoidable hospitalizations. Specifically, for every increase of one GP per 10,000 residents, there was a measurable decrease in the incidence of complications related to hypertension and type 2 diabetes.

Impact on Chronic Disease Management

The model demonstrates that early intervention by general practitioners can shift the trajectory of chronic diseases. By applying the transition matrix $\mathcal{T}$, the study illustrates the probability of patients remaining in a "stable" health state versus progressing

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Abstract

Objective: To observe and evaluate the clinical efficacy of pulmonary rehabilitation (PR) in the treatment of patients with moderate to severe stable chronic obstructive pulmonary disease (COPD).

Methods: A total of 80 patients with moderate to severe stable COPD were selected and randomly divided into a rehabilitation group ($n = 40$) and a control group ($n = 40$). Both groups received conventional pharmacological treatment according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guidelines. The rehabilitation group additionally underwent a comprehensive 12-week pulmonary rehabilitation program, including exercise training, respiratory muscle training, and health education. Lung function parameters, including forced expiratory volume in one second (FEV1), FEV1 as a percentage of predicted value (FEV1%pred), and the ratio of FEV1 to forced vital capacity

(FEV1/FVC), were measured before and after the intervention. Exercise capacity was assessed using the 6-minute walk distance (6MWD), and quality of life was evaluated using the COPD Assessment Test (CAT) score and the modified Medical Research Council (mMRC) dyspnea scale.

Results: After 12 weeks of intervention, the rehabilitation group showed significant improvements in 6MWD, CAT scores, and mMRC scores compared to baseline ($P < 0.05$). Furthermore, the improvements in 6MWD, CAT scores, and mMRC scores in the rehabilitation group were significantly greater than those observed in the control group ($P < 0.05$). However, there were no statistically significant differences in lung function parameters (FEV1, FEV1%pred, FEV1/FVC) between the two groups after the intervention ($P > 0.05$).

Conclusion: Pulmonary rehabilitation can significantly improve exercise capacity, alleviate dyspnea symptoms, and enhance the quality of life in patients with moderate to severe stable COPD, although its impact on short-term lung function parameters

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Interpretation of Guidelines for Pulmonary Rehabilitation Exercise Prescriptions in Chronic Obstructive Pulmonary Disease

Introduction

Chronic Obstructive Pulmonary Disease (COPD) is a common, preventable, and treatable disease characterized by persistent respiratory symptoms and airflow limitation. It is often caused by significant exposure to noxious particles or gases. According to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) 2020 report, COPD remains a leading cause of morbidity and mortality worldwide, imposing a substantial economic and social burden. Pulmonary rehabilitation (PR) has been established as a cornerstone in the management of COPD, with exercise training being its central component. This article provides an interpretive review of current guidelines regarding exercise prescriptions for pulmonary rehabilitation in patients with COPD.

The Role of Pulmonary Rehabilitation

Pulmonary rehabilitation is a comprehensive intervention based on a thorough patient assessment followed by patient-tailored therapies, which include, but are not limited to, exercise training, education, and behavior change. It is designed to improve the physical and psychological condition of people with chronic respiratory disease and to promote the long-term adherence to health-enhancing behaviors. For patients with COPD, PR has been shown to reduce dyspnea, increase exercise capacity, and improve health-related quality of life.

Furthermore, it reduces the number of hospitalizations and the length of stay following an acute exacerbation.

Components of Exercise Prescription

An effective exercise prescription for COPD patients must be individualized and include several key components: frequency, intensity, time (duration), type (mode), volume, and progression (the FITT-VP principle).

1. Aerobic Exercise Aerobic training is fundamental to improving cardiovascular fitness and endurance. Guidelines generally recommend a frequency of 3 to 5 days per week. The intensity should be tailored to the individual' s baseline functional capacity, often determined by a 6-minute walk test (6MWT) or cardiopulmonary exercise testing (CPET). High-intensity training (e.g., >60% of maximal work capacity) typically yields greater physiological benefits, but low-intensity training is also effective for patients who cannot tolerate high loads.

2. Resistance Training Peripheral muscle dysfunction is a common systemic manifestation of COPD. Resistance training (strength training) is essential for improving muscle mass and strength, particularly in the lower extremities. It is recommended 2 to 3 days per week, targeting major muscle groups. This modality often results in less dyspnea during activities of daily living compared to

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Note: Figure translations are in progress. See original paper for figures.