Postprint: Effects of Web-Based Intervention on Exercise Behavior in Patients After Percutaneous Coronary Intervention

Authors: Wang Dan 1, Wang Jianhui 2*, Dong Jianxiu 2, Chang Wenhong 3, Qin Lu 1, Liu Qi 1, Chen Chen 1

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Abstract

Background During the COVID-19 pandemic, traditional face-to-face interventions in rehabilitation centers faced numerous limitations. Online interventions overcome constraints related to geographical location, working hours, and transportation, while also reducing medical costs.

Objective To investigate the effects of online intervention on exercise rehabilitation knowledge-attitude-practice (KAP), physical activity level, and exercise adherence in patients following percutaneous coronary intervention (PCI).

Methods Seventy-six patients who underwent PCI for the first time in the Department of Cardiology at Tangshan Workers' Hospital between November 2021 and June 2022 were enrolled as study participants. Participants were randomly assigned to a control group and an experimental group, each consisting of 38 patients. The experimental group received online intervention in addition to routine care, whereas the control group received routine care only. Exercise rehabilitation KAP level, physical activity level, and exercise adherence were assessed before the intervention and at 3 months post-intervention using the Knowledge-Attitude-Practice Questionnaire for Rehabilitation Exercise in Coronary Heart Disease Patients, the International Physical Activity Questionnaire-Short Form, and patient exercise logs.

Results At 3 months post-intervention, the experimental group exhibited significantly higher scores in the knowledge dimension, attitude dimension, behavior dimension, and total score compared with the control group ($P<0.05$). The experimental group also demonstrated significant improvements in these dimensions from baseline to 3 months post-intervention ($P<0.05$). At 3 months post-intervention, both low-intensity physical activity level and total physical activity level were higher in the experimental group than in the control group ($P<0.05$),

and these levels had increased significantly from baseline in the experimental group (P<0.05). There was a statistically significant difference in exercise adherence between the two groups at 3 months post-intervention (P=0.003). Logistic regression analysis revealed that the intervention method was an independent factor influencing exercise adherence (P=0.007), with the experimental group showing a relatively lower risk of exercise non-adherence compared with the control group [OR=0.143, 95%CI (0.034, 0.594)].

Conclusion Web-based intervention can effectively improve exercise rehabilitation KAP level, physical activity level, and exercise adherence in post-PCI patients.

Full Text

Effect of an Internet-Based Intervention on Exercise Behavior in Patients After Percutaneous Coronary Intervention

WANG Dan[1], WANG Jianhui[2]*, DONG Jianxiu[2], CHANG Wenhong[3], QIN Lu[1], LIU Qi[1], CHEN Chen[1]

[1]College of Nursing and Rehabilitation, North China University of Science and Technology, Tangshan 063200, China
[2]Nursing Department, Tangshan Gongren Hospital, Tangshan 063000, China
[3]Catheterization Laboratory, Tangshan Gongren Hospital, Tangshan 063000, China

Corresponding author: WANG Jianhui, Chief Superintendent Nurse; E-mail: anita30@163.com

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Abstract

Background: During the COVID-19 pandemic containment period, traditional face-to-face interventions at rehabilitation centers faced numerous limitations. Internet-based interventions overcome constraints related to geographic location, working hours, and transportation while reducing medical costs.

Objective: To investigate the effects of internet-based interventions on knowledge, attitude, and practice (KAP) regarding exercise rehabilitation, physical activity levels, and exercise compliance in patients after percutaneous coronary intervention (PCI).

Methods: Seventy-six patients who underwent their first PCI in the Department of Cardiology at Tangshan Gongren Hospital between November 2021 and June 2022 were selected as study participants. Patients were randomly divided into a control group and an experimental group, with 38 patients in each group.

The experimental group received internet-based intervention in addition to routine nursing care, while the control group received routine nursing care only. Before the intervention and three months after the intervention, the Rehabilitation Exercise Knowledge-Attitude-Practice Scale for Coronary Heart Disease Patients, the International Physical Activity Questionnaire-Short Form (IPAQ-SF), and patient exercise logs were used to assess exercise rehabilitation KAP levels, physical activity levels, and exercise compliance.

Results: Three months after the intervention, the experimental group showed significantly higher scores than the control group in the knowledge dimension, attitude dimension, practice dimension, and total KAP score ($P < 0.05$). The experimental group's scores in all three dimensions and total score were also significantly higher at three months compared to baseline ($P < 0.05$). After three months, the experimental group demonstrated higher low-level physical activity and total physical activity compared to the control group ($P < 0.05$), and these levels were also significantly elevated compared to the experimental group's baseline ($P < 0.05$). Exercise compliance differed significantly between the two groups three months post-intervention ($P = 0.003$). Logistic regression analysis revealed that the intervention method was an independent factor affecting exercise compliance ($P = 0.007$). Compared with the control group, the experimental group had a relatively lower risk of exercise non-compliance [OR = 0.143, 95% CI (0.034, 0.594)].

Conclusion: Internet-based intervention can effectively improve exercise rehabilitation KAP levels, physical activity levels, and exercise compliance in patients after PCI.

Keywords: Percutaneous coronary intervention; Web-based intervention; Locomotor activity; Health knowledge, attitudes, practice; Rehabilitation; Exercise adherence

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Introduction

Percutaneous coronary intervention (PCI) is a crucial revascularization treatment for coronary heart disease. Due to its advantages of minimal invasiveness, avoidance of thoracotomy, rapid recovery, and definitive efficacy, PCI significantly reduces mortality and improves quality of life for coronary heart disease patients, making it the preferred treatment approach [1]. However, post-PCI restenosis is closely related to patients' lifestyle factors [2], particularly physical activity. Regular physical activity can reduce the incidence of coronary events and mortality [3] while improving patients' quality of life [4]. Currently, only 22% of hospitals nationwide have implemented cardiac rehabilitation programs [5]. Research indicates that while 92.1% of patients are willing to participate in cardiac rehabilitation, only 39.5% of cardiovascular patients are aware of its existence [6]. Patients' mastery of exercise rehabilitation knowledge influences their exercise behavior [7], yet cardiac rehabilitation has not been widely popularized

in China. Patients generally demonstrate low awareness, participation, and compliance with exercise rehabilitation, with most failing to benefit from these programs [8]. Internet-based interventions using big data platforms can provide exercise rehabilitation guidance while overcoming limitations of geographic location, working hours, and transportation. Therefore, this study implemented continuous nursing care via a network platform for post-PCI patients to improve their exercise behavior.

Methods

1.1 Sample Size Calculation Using exercise KAP level as the primary outcome measure and based on the sample size formula for comparing means between two groups [9], with reference to relevant literature [10], we set $\alpha = 0.05$ ($_{0\cdot05}/_{2} = 1.96$) and $\beta = 0.1$ ($_{0\cdot1} = 1.282$). With δ/σ at 0.85, the calculated sample size was $n_1 = n_2$ 31 cases. Considering a 20% attrition rate, the final sample size was determined to be 38 cases per group.

1.2 Study Participants Seventy-six patients who underwent their first PCI in the Department of Cardiology at Tangshan Gongren Hospital from November 2021 to June 2022 were selected. Patients were randomly assigned to groups using 76 identical, opaque, sealed envelopes containing either "1" or "2" (38 each). Patients who drew "1" were assigned to the control group, and those who drew "2" to the experimental group.

Inclusion criteria: (1) Met WHO diagnostic criteria for coronary heart disease [11], aged $ $18 years; (2) Classified as low or moderate risk in the exercise risk stratification for coronary heart disease patients [12]; (3) First-time PCI recipient; (4) No limb mobility impairment; (5) Ejection fraction >40%; (6) Clear consciousness with basic reading and writing abilities, able to communicate normally.

Exclusion criteria: (1) Severe chronic obstructive pulmonary disease, pneumonia, or bronchitis; (2) Severe complications such as heart failure, cardiogenic shock, or severe arrhythmia; (3) >75% stenosis in other vessels post-PCI; (4) Ventricular aneurysm formation.

This study was approved by the Ethics Committee of Tangshan Gongren Hospital (GRYY-LL-KJ2022-K68), and informed consent was obtained from all patients.

1.3 Intervention Methods

1.3.1 Experimental Group **1.3.1.1 Preparation Phase:** An internet intervention team was established, comprising one master's supervisor, one cardiac rehabilitation therapist, one cardiovascular nursing graduate student, and

two research assistants. The principal investigator was the cardiovascular nursing graduate student who had systematically studied cardiac rehabilitation content and received overall guidance and supervision from the master's supervisor and cardiac rehabilitation therapist throughout the study. The internet intervention protocol was jointly developed by researchers and the cardiac rehabilitation therapist. Before the intervention, team members developed the protocol through literature review and expert consultation.

1.3.1.2 Intervention Phase: The experimental group received internet-based intervention (via WeChat platform) in addition to routine nursing care and was provided with exercise logs.

- **During hospitalization (2-3 times/day, ~40 min/session):** Exercise was performed under medical supervision while the patient's condition was stable post-PCI. Blood pressure and heart rate were measured before and after exercise, and activity was immediately stopped if chest tightness or pain occurred.
- **1-2 days before discharge (once daily, 15-20 min/session):** Patients were added to a WeChat group.
- **1-3 months after discharge:** Video intervention via WeChat was conducted once weekly in the first month and once monthly in months 2-3. Videos of Tai Chi, Baduanjin, and other exercises were sent. Patients were encouraged to post exercise diaries in the WeChat group. Patients who failed to share for more than 2 days received phone calls to ensure timely completion of exercise targets. Patients were encouraged to ask questions, which researchers answered thoroughly. The specific intervention protocol is detailed in Table 1 .

1.3.2 Control Group The control group received health education covering rest environment, exercise (general rehabilitation exercise guidance without specific requirements for form or frequency), diet, lifestyle habits, and infection prevention. Patients were added to WeChat before discharge, provided with follow-up appointment information, and followed up at 3 months post-discharge.

1.4 Measurement Tools 1.4.1 Rehabilitation Exercise Knowledge-Attitude-Practice Scale for Coronary Heart Disease Patients (REKBPCHD): Developed by Zhao Mengli et al. [13], this scale includes three dimensions: knowledge (maximum score 24), attitude (maximum score 25), and practice (maximum score 30), with a total possible score of 79. The Cronbach's α coefficient was 0.833 in the original study and 0.891 in this study.

1.4.2 International Physical Activity Questionnaire-Short Form (IPAQ-SF): The Chinese version translated by Qu Ningning et al. [14] was used to assess patients' physical activity levels, with test-retest reliability of 0.63-0.89. The IPAQ-SF contains 7 items investigating activity levels over the past week. Weekly physical activity level was calculated as: MET-min/week = MET value of each activity $\times$ daily duration (min/day) $\times$ weekly frequency

(days/week). MET values were 3.3 for walking, 4.0 for moderate-intensity activity, and 8.0 for vigorous-intensity activity. Based on recommendations from the IPAQ working group [15], total physical activity was categorized into low, moderate, and high levels.

1.4.3 Exercise Compliance: Compliance was measured by whether patients' exercise behavior aligned with recommendations [16], based on exercise logs. Meeting the recommended exercise standards was considered compliant, while failure to meet standards was considered non-compliant.

1.5 Data Collection and Quality Control Both groups completed self-assessments before and after the intervention. Baseline data were collected in the ward by two research assistants who distributed questionnaires for immediate completion. Post-intervention data were collected via electronic questionnaires. For patients unable to complete questionnaires independently, two research assistants read each item and recorded responses. Strict inclusion and exclusion criteria were followed, with the principal investigator providing guidance and supervision throughout the intervention. Before data collection, both research assistants received standardized training on scale administration. To prevent bias during data collection, research assistants remained blinded to group allocation. All data were double-checked and entered by two individuals.

1.6 Statistical Analysis SPSS 25.0 software was used for statistical analysis. Normally distributed or approximately normally distributed continuous data were expressed as mean ± standard deviation ($\bar{x} \pm s$), with independent samples t-tests for between-group comparisons and paired t-tests for within-group pre-post comparisons. Non-normally distributed continuous data were expressed as median (P25, P75), with Wilcoxon rank-sum test for between-group comparisons. Categorical data were analyzed using ^{2} test or Fisher's exact test. Logistic regression analysis was used to explore the effect of internet-based intervention on exercise compliance. $P < 0.05$ was considered statistically significant.

Results

2.1 Comparison of Baseline Data Between Groups No statistically significant differences were found between the two groups in age, gender, BMI distribution, education level, length of hospital stay, exercise habits, left ventricular ejection fraction, cardiac rehabilitation risk stratification, coronary angiography reports, number of coronary stents placed, or number of coronary balloons used ($P > 0.05$). See Table 2 .

2.2 Comparison of Rehabilitation Exercise KAP Scores Before and After Intervention Before the intervention, no significant differences existed

between groups in knowledge, attitude, practice dimensions, or total KAP score ($P > 0.05$). Three months after the intervention, the experimental group showed significantly higher scores than the control group in all three dimensions and total score ($P < 0.05$). The control group showed no significant differences in any dimension or total score between baseline and 3 months ($P > 0.05$). The experimental group demonstrated significantly higher scores at 3 months compared to baseline in all dimensions and total score ($P < 0.05$). See Table 3 .

2.3 Comparison of Physical Activity Levels Before and After Intervention Before the intervention, no significant differences existed between groups in low, moderate, or high physical activity levels ($P > 0.05$). After 3 months, no significant difference was found between groups in moderate-to-high physical activity level ($P > 0.05$). However, the experimental group showed significantly higher low-level physical activity and total physical activity compared to the control group ($P < 0.05$). The control group showed no significant differences in low, moderate-to-high, or total physical activity levels between baseline and 3 months ($P > 0.05$). The experimental group demonstrated significantly higher low-level physical activity and total physical activity at 3 months compared to baseline ($P < 0.05$). See Table 4 .

2.4 Exercise Compliance Exercise compliance differed significantly between the two groups after the intervention ($^2 = 9.091$, $P = 0.003$). See Table 5 . Logistic regression analysis showed that the intervention method was an independent factor affecting exercise compliance ($P = 0.007$). Compared with the control group, the experimental group had a relatively lower risk of exercise non-compliance [OR = 0.143, 95% CI (0.034, 0.594)].

Discussion

Exercise rehabilitation is the core component of cardiac rehabilitation [12], yet patients have limited knowledge about it [16]. Effective health education can enhance patients' awareness, establish exercise beliefs, and generate positive attitudes toward participating in exercise rehabilitation. However, due to patients' lack of medical background, traditional face-to-face verbal health education often fails to ensure comprehension and retention [17]. Patients worry about their ability to live and function normally after discharge and express a desire for continuous nursing care [18].

Therefore, this study implemented internet-based intervention for post-PCI patients and found that the experimental group's exercise rehabilitation KAP level was significantly higher than the control group's after 3 months ($P < 0.05$), consistent with findings from Wang et al. [19]. This is likely because internet-based intervention conveniently and efficiently connects healthcare providers with patients, enabling health education while allowing for immediate feedback

and communication. This approach facilitates timely knowledge acquisition and enhances intervention effectiveness. Understanding exercise rehabilitation knowledge addresses patients' blind spots, helps them develop exercise beliefs, translates these into exercise behaviors, and ultimately improves exercise capacity.

This study's results demonstrate that internet-based intervention not only improved exercise rehabilitation KAP levels but also enhanced physical activity levels and exercise compliance ($P < 0.05$), similar to findings by Bravo-Escobar et al. [21]. Logistic regression analysis further confirmed the effectiveness of internet-based intervention, showing that the experimental group had a lower risk of exercise non-compliance compared to the control group [OR = 0.143, 95% CI (0.034, 0.594)].

The findings indicate that the Rehabilitation Exercise KAP Scale for Coronary Heart Disease Patients and IPAQ-SF provide simple, rapid, and economical assessment of exercise behavior in post-PCI patients, offering timely information about their rehabilitation KAP and physical activity levels to guide exercise prescriptions. In clinical practice, when cardiopulmonary exercise testing is not recently available, target heart rate method can be used to determine exercise intensity [22], with gradual intensity progression [23]. Clinicians should monitor patients' self-perceived fatigue levels and teach them how to self-monitor heart rate to achieve appropriate exercise intensity.

This study established exercise rehabilitation goals and provided cardiac rehabilitation health education, exercise guidance, and supervision via a network platform, which strengthened patients' health awareness, resolved their concerns about exercise rehabilitation, and improved their exercise capacity. However, due to resource constraints, this single-center study has limitations. Future work should include multi-center studies and incorporate objective measures of exercise rehabilitation, such as the 6-minute walk test, along with safety indicators to further explore the impact of remote nursing on exercise behavior.

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Author Contributions

WANG Dan implemented the intervention and drafted the manuscript. WANG Dan and WANG Jianhui conceptualized the research direction. WANG Jianhui

provided overall coordination and supervision of the study and took responsibility for the entire article. WANG Dan and DONG Jianxiu developed the intervention protocol. DONG Jianxiu supervised the research process. WANG Dan, WANG Jianhui, DONG Jianxiu, and CHANG Wenhong revised the manuscript. WANG Dan and QIN Lu organized and analyzed the data. LIU Qi and CHEN Chen collected the data.

Conflict of Interest Statement

The authors declare no conflict of interest.

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Correspondence to: WANG Jianhui, Nursing Department, Tangshan Gongren Hospital, Tangshan 063000, China. Email: anita30@163.com