Postprint of a Study on the Effects of Web-Based Intervention on Exercise Behavior in Post-PCI Patients

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 prevention and control period, traditional face-to-face interventions in rehabilitation centers were subject to numerous limitations. Internet-based interventions overcome constraints such as geographical location, working hours, and transportation, and can further reduce medical expenses.

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

Methods A total of 76 patients who underwent PCI for the first time in the Department of Cardiology at Tangshan Workers' Hospital from November 2021 to June 2022 were selected as study subjects. Patients were randomly divided into a control group and an experimental group, with 38 cases in each group. The experimental group received internet-based intervention in addition to routine care, while the control group received routine care only. Before the intervention and 3 months after the intervention, the Knowledge-Attitude-Practice Questionnaire for Rehabilitation Exercise in Coronary Heart Disease Patients, the International Physical Activity Questionnaire-Short Form, and patient exercise logs were used to assess exercise rehabilitation KAP level, physical activity level, and exercise adherence.

Results Three months after the intervention, the knowledge dimension, attitude dimension, behavior dimension, and total score in the experimental group were all higher than those in the control group ($P<0.05$); the knowledge dimension, attitude dimension, behavior dimension, and total score in the experimental group 3 months after the intervention were all higher than those before the intervention ($P<0.05$). Three months after the intervention, both low physical

activity level and total physical activity level in the experimental group were higher than those in the control group (P<0.05); both low physical activity level and total physical activity level in the experimental group 3 months after the intervention were higher than those before the intervention (P<0.05). Three months after the intervention, the difference in exercise adherence between the two groups was statistically significant (P=0.003); Logistic regression analysis showed that the intervention method was an independent influencing factor of exercise adherence (P=0.007), and compared with the control group, the risk of exercise non-adherence in the experimental group was relatively lower [OR=0.143, 95%CI (0.034, 0.594)].

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

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]Catheter Room, 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 significant limitations. Internet-based interventions overcome constraints related to geographic location, working hours, and transportation while reducing medical costs.

Objective: To examine the effects of internet-based interventions on knowledge, attitude, and practice (KAP) toward rehabilitation exercise, physical activity (PA) level, 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 enrolled. Patients were randomly divided into a control group

and an experimental group (38 patients each). The experimental group received internet-based intervention in addition to routine nursing care, while the control group received routine nursing care only. Before and three months after the intervention, the Rehabilitation Exercise Knowledge-Belief-Practice Scale for Patients with Coronary Heart Disease (REKBPCHD), the International Physical Activity Questionnaire-Short Form (IPAQ-SF), and patients' exercise logs were used to assess KAP level, PA level, and exercise adherence, respectively.

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

Conclusion: Internet-based intervention can effectively improve KAP levels toward rehabilitation, physical activity levels, and exercise adherence 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 (CHD). Due to its advantages of minimal invasiveness, avoidance of thoracotomy, rapid recovery, and definitive efficacy, PCI significantly reduces mortality and improves quality of life in CHD patients, making it the preferred treatment approach. However, post-PCI restenosis is closely related to patients' lifestyle factors, particularly physical activity. Regular physical activity can reduce the incidence of coronary events and mortality while improving patients' quality of life. Nevertheless, only 22% of hospitals nationwide have implemented cardiac rehabilitation programs. Studies have found that while 92.1% of patients are willing to participate in cardiac rehabilitation, only 39.5% of cardiovascular patients are aware of it. Patients' mastery of exercise rehabilitation knowledge influences their exercise behavior, yet cardiac rehabilitation has not been widely popularized in China. Patients demonstrate

low awareness, participation, and compliance with exercise rehabilitation, with most failing to benefit from these programs. Internet-based interventions using big data platforms can provide exercise rehabilitation guidance while overcoming limitations of geography, working hours, and transportation. Therefore, this study implemented continuous nursing care based on network platforms for post-PCI patients to improve their exercise behavior.

Methods

Sample Size Calculation Using exercise KAP level as the primary outcome measure and based on the sample size formula for comparing two sample means, with reference to relevant literature, we set α=0.05 ($_{0\cdot05}/_{2}$=1.96) and β=0.1 ($_{0\cdot01}$=1.282), with δ/σ=0.85. The calculation yielded n_1=n_2 31 cases. Considering a 20% attrition rate, the final sample size was determined to be 38 cases per group.

Study Subjects 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 numbers "1" and "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 CHD, age$ $18 years; (2) CHD patients with low-to-moderate exercise risk stratification; (3) First-time PCI; (4) No limb mobility impairment; (5) Ejection fraction >40%; (6) Clear consciousness, basic reading and writing ability, and normal communication skills.

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.

Intervention Methods Experimental Group: The experimental group received internet-based intervention in addition to routine nursing care and was provided with exercise logs.

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. The intervention protocol was developed jointly by researchers and the cardiac rehabilitation therapist. Before implementation, team members developed the internet intervention protocol and exercise logs through literature review and expert consultation.

Intervention phase: Patients in the experimental group received internet-based intervention via WeChat platform along with exercise logs. While hospitalized and clinically stable, patients received 2-3 interventions daily (approximately 40 minutes each) under medical supervision; exercise was stopped immediately if chest tightness or pain occurred, with blood pressure and heart rate measured before and after exercise. One to two days before discharge, patients received one intervention daily (15-20 minutes each), were added to WeChat, and joined a WeChat group. From 1-3 months post-discharge: video intervention once weekly in the first month, then 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; those who failed to share for more than 2 days received phone calls to ensure completion of exercise targets; patients were encouraged to ask questions, which researchers answered thoroughly. The specific intervention protocol is detailed in .

Control Group: The control group received routine nursing care and 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 at discharge, provided with follow-up appointment information, and followed up at 3 months post-discharge.

Measurement Tools 1. Rehabilitation Exercise Knowledge-Belief-Practice Scale for Patients with Coronary Heart Disease (REKBPCHD): Developed by Zhao Mengli et al., this questionnaire comprises 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.

2. International Physical Activity Questionnaire-Short Form (IPAQ-SF): The Chinese version translated by Qu Ningning et al. was used to assess patients' physical activity, with test-retest reliability of 0.63-0.89. The IPAQ-SF contains 7 items surveying activity levels over the past week. Weekly physical activity level was calculated as: MET-min/week = MET value of each activity $\times$ daily time (min/day) $\times$ weekly days (days/week). MET values were 3.3 MET for walking, 4.0 MET for moderate-intensity activity, and 8.0 MET for vigorous-intensity activity. According to IPAQ Working Group recommendations, total physical activity was categorized into low, moderate, and high levels.

3. Exercise Compliance: Compliance was measured by consistency between patients' exercise behavior and guidance provided. Based on patients' exercise logs, those meeting the exercise standards were considered compliant, while others were non-compliant.

Data Collection and Quality Control Both groups completed self-assessments before and after intervention. Pre-intervention data were collected in-person by two research assistants who distributed questionnaires in the ward and collected them immediately upon 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 during the intervention phase, with the principal investigator providing guidance and supervision. Before data collection, both research assistants received standardized training on scale administration and completion methods. To prevent bias, research assistants remained blinded to group assignments. All data were double-checked and entered by two personnel.

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-test for between-group comparisons and paired t-test 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

Comparison of Baseline Data No significant differences were observed between the two groups in age, gender, BMI distribution, education level, length of hospital stay, exercise habits, left ventricular ejection fraction, rehabilitation exercise risk stratification, coronary angiography reports, number of coronary stents, or number of coronary balloons ($P>0.05$) .

Comparison of Rehabilitation Exercise KAP Scores Before and After Intervention Before intervention, no significant differences were found between groups in knowledge dimension, attitude dimension, practice dimension, or total score ($P>0.05$). After three months of intervention, the experimental group showed significantly higher scores in all dimensions and total score compared with the control group ($P<0.05$). Within the control group, no significant differences were observed between pre-intervention and post-intervention scores

(P>0.05). Within the experimental group, post-intervention scores in all dimensions and total score were significantly higher than pre-intervention scores (P<0.05) .

Comparison of Physical Activity Levels Before and After Intervention Before intervention, no significant differences were observed between groups in low, moderate, or high physical activity levels (P>0.05). After three months of intervention, no significant difference was found in moderate-to-high physical activity level between groups (P>0.05). However, the experimental group demonstrated significantly higher low physical activity level and total physical activity level compared with the control group (P<0.05). Within the control group, no significant differences were observed between pre-intervention and post-intervention physical activity levels (P>0.05). Within the experimental group, post-intervention low physical activity level and total physical activity level were significantly higher than baseline levels (P<0.05) .

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

Discussion

Exercise rehabilitation is the core component of cardiac rehabilitation, yet patients have limited knowledge about it. Effective health education can enhance patients' awareness, establish exercise beliefs, and generate positive attitudes toward participation. However, due to lack of medical background, traditional face-to-face verbal health education often fails to ensure comprehension and retention. Patients worry about their ability to resume normal life and activities after discharge and desire continuous care. Therefore, this study implemented internet-based intervention for post-PCI patients and found that the experimental group had significantly higher KAP levels regarding exercise rehabilitation after three months compared with the control group (P<0.05), consistent with findings from Wang et al. This improvement likely occurred because internet-based intervention conveniently and efficiently connects healthcare providers with patients, enabling timely health education, feedback, and communication, which enhances knowledge acquisition and intervention effectiveness. Understanding exercise rehabilitation knowledge influences patients' exercise achievement rates; informed patients demonstrate greater health concern, stronger willingness to participate, and better implementation capacity. This study's results show that internet-based intervention not only improved exercise rehabilitation KAP but also enhanced physical activity levels and exercise

compliance (P<0.05), similar to findings by Bravo-Escobar et al. Furthermore, logistic regression analysis confirmed that the experimental group had a lower risk of non-adherence [OR=0.143, 95%CI (0.034, 0.594)], substantiating the effectiveness of internet-based intervention.

This study demonstrates that the REKBPCHD and IPAQ-SF can simply, rapidly, and economically assess exercise behavior in post-PCI patients, providing timely understanding of rehabilitation KAP and physical activity levels to guide exercise prescription. In clinical practice, when cardiopulmonary exercise testing is unavailable, target heart rate method can be used to determine exercise intensity, with gradual intensity progression while monitoring perceived exertion and teaching patients self-pulse monitoring to achieve appropriate exercise intensity. This study established exercise rehabilitation goals and implemented internet-based cardiac rehabilitation education, exercise guidance, and supervision, which strengthened patients' health awareness, addressed knowledge gaps, fostered exercise beliefs, and translated them into exercise behaviors, thereby improving exercise capacity.

Internet-based intervention can effectively improve exercise rehabilitation KAP, promote exercise behavior, and provide reference for clinical practice. However, due to resource constraints, this single-center study has limitations. Future research should expand to multi-center studies and incorporate objective exercise rehabilitation measures such as 6-minute walk tests, along with safety indicators, to further explore the impact of remote nursing on exercise behavior.

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 and takes responsibility for the article as a whole. 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

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

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