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Original Article

Continuity of care combined with TCM acupoint application improves blood pressure control and quality of life in elderly hypertensive patients: a retrospective study with bootstrap mediation analysis

Yan Wang[1], Xiaoran Yang[1], Yanni Zheng[2], Yingchun Wei[3], Rong Zhao[4], Wenjing Wang[3]

[1]Department of Geriatrics & General Practice, The First People's Hospital of Lanzhou City (Second Clinical Medical College, Gansu University of Chinese Medicine), No. 1 Wujiayuan West Street, Qilihe District, Lanzhou 730050, Gansu, China; [2]Department of Ophthalmology II, The First People's Hospital of Lanzhou City (Second Clinical Medical College, Gansu University of Chinese Medicine), No. 1 Wujiayuan West Street, Qilihe District, Lanzhou 730050, Gansu, China; [3]Department of Geriatrics, The First People's Hospital of Lanzhou City (Second Clinical Medical College, Gansu University of Chinese Medicine), No. 1 Wujiayuan West Street, Qilihe District, Lanzhou 730050, Gansu, China; [4]Department of Endocrinology, The First People's Hospital of Lanzhou City (Second Clinical Medical College, Gansu University of Chinese Medicine), No. 1 Wujiayuan West Street, Qilihe District, Lanzhou 730050, Gansu, China

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Abstract: Objective: To evaluate the effects of continuity of care combined with Traditional Chinese Medicine (TCM) acupoint application on blood pressure control, metabolic parameters, psychological status, treatment adherence, and quality of life in elderly patients with essential hypertension, and to explore potential mediation pathways using Bootstrap-based multiple mediation analysis. Methods: This retrospective study included 393 elderly patients with essential hypertension (experimental group, n = 209; control group, n = 184) treated between January 2022 and January 2025. The experimental group received a 12-week integrated intervention combining TCM acupoint application and continuity of care in addition to standard antihypertensive therapy. The control group received standard antihypertensive therapy and routine nursing only. Primary outcomes were post-intervention systolic blood pressure (SBP) and SF-36 total score. Secondary outcomes included diastolic blood pressure (DBP), laboratory indices, Self-rating Anxiety Scale (SAS), Self-rating Depression Scale (SDS), Adherence to Refills and Medications Scale (ARMS), and self-management behavior scores. Results: Compared with the control group, the experimental group showed significantly lower post-intervention SBP, DBP, TC, TG, FBG, and CRP (all $P < 0.05$), as well as significantly lower SAS and SDS scores, lower ARMS scores, and higher SF-36 total scores (all $P < 0.001$). Consistent intervention effects were observed across age subgroups. Mediation analysis identified self-management behavior, anxiety status, and treatment adherence as candidate mediators; however, none reached statistical significance. Conclusion: The integrated intervention significantly improved multidimensional outcomes in elderly hypertensive patients. The identified mediation pathways are hypothesis-generating and require confirmation in future prospective studies.

Keywords: Continuity of care, traditional Chinese medicine acupoint application, elderly hypertension, self-management, treatment adherence, quality of life, mediation analysis, bootstrap method

Introduction

Hypertension is one of the most prevalent chronic conditions worldwide, estimated to affect approximately 1.28 billion adults globally. In elderly populations, it is closely linked to the risk of cardiovascular and cerebrovascular events and mortality [1, 2]. Between 1990 and 2019, the global number of people living with hypertension doubled; however, improvements in treatment and control rates have been uneven across regions, with control rates remaining below 10% in many low- and middle-income countries [1]. In Chinese individuals aged 60 years and above, the prevalence of hypertension now exceeds 50%, yet the proportion of

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patients with adequate blood pressure control remains low. With standard pharmacotherapy alone, fewer than 20% of elderly patients achieve their blood pressure targets [3].

Self-care management in elderly hypertensive patients is an area of growing concern, particularly regarding anxiety, depressive symptoms, and poor treatment adherence. These behavioral and psychological impairments cannot be adequately corrected by antihypertensive drugs and routine nursing alone [4]. This necessitates integrated care models that go beyond mere drug management to include behavioral intervention, psychotherapy, and adherence support.

Continuity of care post-discharge encompasses health services such as telephone follow-up, home visits, and digital health interventions, which have been clinically proven effective in improving outcomes across a range of chronic diseases [5-7]. Most existing studies have primarily focused on blood pressure values as a standalone outcome, without systematically considering self-management behavior, psychological status, treatment adherence, and other relevant aspects in elderly hypertensive patients.

TCM acupoint application is a non-invasive transdermal treatment method in TCM [8]. Studies have shown that formulas containing high-quality ingredients such as Tianma (Gastrodia elata), Gouteng (Uncaria rhynchophylla), Wuzhuyu (Evodia rutaecarpa) are effective in managing hypertension [9]. However, there are few well-controlled studies evaluating the combined application of continuity of care and TCM acupoint application in elderly hypertensive patients, particularly those assessing a wide range of clinical and patient-reported outcomes.

Existing research on interventions also has limitations, as most studies only address whether an intervention works rather than how it works [10]. Understanding the mechanisms of complex interventions is not only scientifically valuable but also clinically relevant. Identifying which behavioral and psychological mediators should be targeted to optimize nursing strategies is crucial. Theoretically, self-management behavior, anxiety status, and treatment adherence could act as mediators linking nursing interventions to distal outcomes such as blood pressure control and quality of life. However, the application of Bootstrap-based multiple mediation models in TCM nursing intervention research is limited.

In this context, the present retrospective study included 393 elderly patients with essential hypertension who received a 12-week intervention combining continuity of care and TCM acupoint application. We comprehensively analyzed the intervention's effects on blood pressure, laboratory indices, psychological state, treatment adherence, and quality of life. Based on the findings, we constructed a Bootstrap multiple mediation model with 5,000 resampling iterations to formally test whether self-management behavior, anxiety, and treatment adherence mediated the intervention's effects on systolic blood pressure (SBP) and SF-36 total score. The aim is to provide evidence for broader clinical application and serve as a methodological reference for understanding the underlying mechanisms.

Methods

Sample size calculation

We estimated the sample size based on the blood pressure control rate, defined as SBP < 140 mmHg and diastolic blood pressure (DBP) < 90 mmHg post-intervention. Based on a randomized controlled trial by Zhang et al. [11] investigating continuity of care combined with chronic disease management center intervention in hypertensive patients (Medicine, 2025), the blood pressure control rate in the control group was approximately 35%. A target control rate of 68% was selected based on institutional historical data and the expected effects of the intervention. Using the formula for single-proportion estimation ($N = Z^2 \times [P \times (1 - P)]/E^2$) with a two-sided significance level $\alpha = 0.05$ ($Z = 1.96$) and an allowable error $E = 0.05$, the calculated sample size was 334. Considering a 10% dropout rate, the final required sample size was approximately 371 patients. The current study recruited 393 subjects, thus meeting statistical power requirements.

Study population

This was a retrospective study of 393 elderly patients (aged > 60 years) with essential hypertension who attended the First People's Hospital of Lanzhou City between January 2022

and January 2025. Of these 393 patients, 209 were assigned to the experimental group and 184 to the control group. Ethical approval was granted by the Medical Ethics Committee of The First People's Hospital of Lanzhou City (Second Clinical Medical College, Gansu University of Chinese Medicine). Due to the retrospective nature of the study, informed consent was waived.

The inclusion criteria were: age ≥ 60 years; diagnosis of essential hypertension according to the Chinese Guidelines for the Management of Hypertension [12], with concurrent pharmacological antihypertensive treatment; intact consciousness and verbal communication ability; and complete medical and follow-up records.

Exclusion criteria were: secondary hypertension or hypertensive crisis; severe cardiac, hepatic, or renal insufficiency (glomerular filtration rate < 30 mL/min/1.73 m^2) or malignant tumor; cognitive impairment or psychiatric disorder precluding assessment using valid scales; skin lesions at application sites or allergy to TCM ingredients; incomplete medical records, loss to follow-up, or withdrawal during the intervention period; or participation in any other clinical intervention study within the previous three months.

Intervention protocol

The control group received standard antihypertensive therapy and routine nursing for 12 weeks, including adherence to prescribed medication, general health education, routine outpatient follow-up, and regular blood pressure monitoring.

The experimental group received the same standard treatment along with a 12-week integrated intervention combining continuity of care and TCM acupoint application, as described below.

TCM acupoint application: The treatment principle was to soothe the liver, suppress yang, promote blood circulation, and resolve stasis. The paste was prepared by mashing Tianma, Gouteng, Wuzhuyu, Huainiuxi (Achyranthes bidentata), Xiakucao (Prunella vulgaris), and Chuanxiong (Ligusticum chuanxiong) in specified proportions, then mixing with petroleum jelly as a base to form circular medicinal cakes (approximately 2 cm in diameter and 0.3 cm thick), which were prepared uniformly throughout the study.

Acupoint selection was based on TCM theory: Yongquan (KD1, at the anterior one-third of the plantar surface, for pacifying liver yang), Shenque (CV8, at the center of the umbilicus, for strengthening the spleen and stomach), Zusanli (ST36, 3 cun below Dubi, for tonifying qi and blood), Taichong (LR3, on the dorsum of the foot, in the depression distal to the junction of the first and second metatarsal bones, for soothing the liver), Neiguan (PC6, 2 cun above the transverse crease of the wrist, for calming the mind), and Quchi (LI11, at the lateral end of the cubital crease, for clearing heat and lowering blood pressure).

Prior to each application, the skin was cleansed, and the medicinal cake was affixed to the selected acupoints using breathable medical adhesive tape. Throughout the intervention, 2-3 acupoints were alternated per session, with each application lasting 4-6 hours and administered every other day, totaling approximately 42 sessions. The responsible nurse assessed skin reactions every four weeks. If grade II or above skin injury or allergic reaction occurred, the intervention was discontinued, and appropriate treatment was provided.

Continuity of care: At baseline (week 0), a personal health management profile was established for each patient, including basic information, blood pressure levels, medication use, lifestyle habits, and baseline scale scores, which served as the basis for individual care goals.

Subsequently, trained responsible nurses conducted telephone follow-ups every two weeks (lasting 15-20 minutes each), which included reviewing blood pressure records, assessing adherence to antihypertensive medication, confirming compliance with acupoint application, and inquiring about adverse reactions. Monthly home visits included measuring blood pressure (average of 2 consecutive readings), medication counseling, reinforcing dietary and exercise education, and checking acupoint application technique.

During the intervention, a WeChat group was established for patients and primary caregivers, where weekly health knowledge posts were published, and online consultation services were provided with responses within 24 hours. Patients with a baseline Self-rating Anxiety Scale (SAS) [13] score ≥ 50 or Self-rating Depression Scale (SDS) [14] score ≥ 53 received additional psychological counseling beyond routine follow-up; referral to a psychiatrist was arranged when necessary. At week 12, post-intervention evaluations were completed using the same measures as at baseline.

Additional nursing process and outcome indicators: In addition to the primary and secondary outcomes, data on nursing process quality, patient satisfaction, and nursing-related adverse events were routinely collected during standard clinical care and follow-up, though they were not part of the primary analysis. In this study, these existing data were re-evaluated to better assess nursing-related outcomes. Indicators of nursing process quality, including telephone follow-up completion rate, WeChat health education participation rate, and intervention discontinuation rate, were recorded in routine nursing records.

Patient satisfaction with nursing care was evaluated using a structured questionnaire administered at the end of the intervention as part of standardized procedures, with responses categorized as satisfied, moderately satisfied, or dissatisfied. Nursing complications and adverse events during the intervention period (including skin redness or scratches, discomfort at application sites, and falls or other adverse events during follow-up) were recorded in routine documentation.

Clinical data collection

General demographic and clinical data were obtained from inpatient records and follow-up documentation, including age group (< 70 years, ≥ 70 years), sex, educational level (primary school or below, junior high school, senior high school or above), smoking history, alcohol use history, hypertension grade (grade 1: SBP 140-159 mmHg; grade 2: 160-179 mmHg; grade 3: ≥ 180 mmHg), comorbidities (coronary heart disease, diabetes mellitus, hyperlipidemia), antihypertensive drug class (calcium channel blocker [CCB]; angiotensin-converting enzyme inhibitor [ACEI]; angiotensin receptor blocker [ARB]; beta-blocker; combination therapy), body mass index (BMI), and duration of hypertension.

Blood pressure data were collected from standardized measurement records pre-and post-intervention. In the morning after waking, patients rested in a sitting position for five minutes, and a nurse measured their right arm blood pressure twice consecutively using an OMRON HEM-7136 electronic sphygmomanometer; the average of the two readings was recorded as SBP and DBP. The device was calibrated monthly.

Fasting venous blood samples (5 mL) were collected before and after the intervention for laboratory testing. After centrifugation for serum separation, total cholesterol (TC) and triglycerides (TG) were measured using enzymatic colorimetry. Fasting blood glucose (FBG) was measured using the glucose oxidase method; creatinine (Cr) was measured using the picric acid rate method; and blood urea nitrogen (BUN) was measured using the urease-glutamate dehydrogenase method. All these analyses were performed on a Beckman Coulter AU5800 Automated Biochemical Analyzer. C-reactive protein (CRP) was measured by enzyme-linked immunosorbent assay (ELISA) using kits from Shanghai Enzyme-linked Biotechnology Co., Ltd., in strict accordance with the manufacturer's specifications.

Functional assessments

Scale data were collected from paper questionnaires completed by patients before and after the intervention. The Hypertension Self-Management Behavior Scale was used to measure self-management behavior, covering five dimensions: rational diet, regular exercise, timely medication adherence, blood pressure measurement, and emotion management. Each dimension score and the total score ranged from 0 to 100, with higher scores indicating better self-management.

The SAS and SDS were used to assess anxiety and depression, respectively. A standard SAS score ≥ 50 indicated the presence of anxiety,

and a standard SDS score ≥ 53 indicated the presence of depression. Treatment adherence was evaluated using the Refills and Medications Scale (ARMS) [15], which has a maximum score of 32; lower scores indicate better adherence. Patients were classified as having good (≤ 16), moderate (17-23), or poor (≥ 24) adherence.

The SF-36 [16] was used to evaluate quality of life across eight dimensions: Physical Functioning (PF), Role-Physical (RP), Bodily Pain (BP), General Health (GH), Vitality (VT), Social Functioning (SF), Role-Emotional (RE), and Mental Health (MH). Dimension scores and the total score ranged from 0 to 100, with higher scores indicating better quality of life.

Study outcomes

Primary outcomes were post-intervention SBP (core measure of blood pressure control) and SF-36 total score (core measure of quality of life improvement). Secondary outcomes included: post-intervention DBP; post-intervention laboratory indices (TC, TG, FBG, Cr, BUN, CRP); post-intervention self-management behavior dimension and total scores; post-intervention SAS score, SDS score, and anxiety/depression positivity rates; post-intervention ARMS total score and adherence classification; SF-36 dimension scores; between-group comparisons of blood pressure control rate, good adherence rate, and SF-36 total score in age subgroups (< 70 years and ≥ 70 years); and the multiple mediation effects of self-management behavior (M1), anxiety status (M2), and treatment adherence (M3) in the intervention process.

Statistical analysis

All analyses were performed using R software (version 4.5.1) and SPSS (version 27.0). Continuous data with a normal distribution were presented as mean ± standard deviation ($\bar{x} \pm sd$), while non-normally distributed continuous data were presented as median (interquartile range) [M (IQR)]. Categorical data were presented as frequency and proportion (%), and their comparisons between groups were conducted using chi-square tests. Fisher's exact test was applied when the expected cell frequency was less than 5. Within-group comparisons of pre- and post-intervention data were performed using paired t-tests. For between-group comparisons of normally distributed continuous variables, independent-samples t-tests were used, with Welch's correction applied when variance homogeneity was not satisfied. Non-normally distributed continuous variables were compared between groups using the Mann-Whitney U test. In age subgroup analyses, binary outcomes were expressed as risk ratio (RR) with 95% confidence interval (CI), and continuous outcomes as mean difference (MD) with 95% CI. For mediation analysis, the intervention group assignment was used as the independent variable, while M1 (total self-management score), M2 (SAS score), and M3 (ARMS score) served as mediators, and post-intervention SBP and SF-36 total score were the outcome variables. A multiple mediation model was constructed, and the Bootstrap method with 5,000 resampling iterations was used to estimate the 95% CI of indirect effects for each pathway. Direct and total effects were estimated using ordinary least squares regression. A 95% CI excluding zero indicated statistical significance. All tests were two-sided, with $P < 0.05$ considered statistically significant.

Results

Baseline characteristics

No statistically significant differences were found between the two groups in terms of age group (P = 0.851), sex (P = 0.958), educational level (P = 0.979), smoking history (P = 0.808), alcohol use history (P = 0.803), hypertension grade (P = 0.983), comorbidities (P = 0.994), antihypertensive drug class (P = 0.998), BMI (P = 0.681), or disease duration (P = 0.322), confirming the comparability of baseline characteristics between the two groups (**Table 1**).

Blood pressure

At baseline, SBP (P = 0.528) and DBP (P = 0.165) did not differ significantly between groups. After the intervention, both groups showed significant reductions in SBP and DBP compared with their baseline values (all P < 0.001). Between-group comparisons revealed that the experimental group had significantly lower post-intervention SBP than the control group (132.38 ± 10.30 vs. 141.30 ± 10.18 mmHg, P < 0.001), as well as significantly lower DBP (82.00 ± 7.21 vs. 90.70 ± 8.38 mmHg, P < 0.001) (**Figure 1**).

Table 1. Comparison of baseline characteristics between the two groups

Variable	Total	Experimental group (n = 209)	Control group (n = 184)	Statistic	*P* value
Age group (n, %)				0.035	0.851
< 70 years	233 (59.29%)	123 (58.85%)	110 (59.78%)		
≥ 70 years	160 (40.71%)	86 (41.15%)	74 (40.22%)		
Sex (n, %)				0.003	0.958
Male	212 (53.94%)	113 (54.07%)	99 (53.80%)		
Female	181 (46.06%)	96 (45.93%)	85 (46.20%)		
Educational level (n, %)				0.043	0.979
Primary school or below	115 (29.26%)	62 (29.67%)	53 (28.80%)		
Junior high school	152 (38.68%)	80 (38.28%)	72 (39.13%)		
Senior high school or above	126 (32.06%)	67 (32.06%)	59 (32.07%)		
Smoking history (n, %)				0.059	0.808
Yes	137 (34.86%)	74 (35.41%)	63 (34.24%)		
No	256 (65.14%)	135 (64.59%)	121 (65.76%)		
Alcohol use history (n, %)				0.062	0.803
Yes	107 (27.23%)	58 (27.75%)	49 (26.63%)		
No	286 (72.77%)	151 (72.25%)	135 (73.37%)		
Hypertension grade (n, %)				0.035	0.983
Grade 1 (SBP 140-159 mmHg)	145 (36.90%)	78 (37.32%)	67 (36.41%)		
Grade 2 (SBP 160-179 mmHg)	178 (45.29%)	94 (44.98%)	84 (45.65%)		
Grade 3 (SBP ≥ 180 mmHg)	70 (17.81%)	37 (17.70%)	33 (17.93%)		
Comorbidities (n, %)				0.077	0.994
None	98 (24.94%)	53 (25.36%)	45 (24.46%)		
Coronary heart disease	91 (23.16%)	48 (22.97%)	43 (23.37%)		
Diabetes mellitus	97 (24.68%)	52 (24.88%)	45 (24.46%)		
Hyperlipidemia	107 (27.23%)	56 (26.79%)	51 (27.72%)		
Antihypertensive drug class (n, %)				0.033	0.998
CCB	155 (39.44%)	83 (39.71%)	72 (39.13%)		
ACEI/ARB	126 (32.06%)	67 (32.06%)	59 (32.07%)		
Beta-blocker	67 (17.05%)	35 (16.75%)	32 (17.39%)		
Combination therapy	45 (11.45%)	24 (11.48%)	21 (11.41%)		
BMI	24.79 ± 3.05	24.73 ± 3.12	24.85 ± 2.98	0.411	0.681
Disease duration	8.00 (6.00)	8.00 (6.00)	8.00 (5.25)	0.991	0.322

Note: SBP, systolic blood pressure; CCB, calcium channel blocker; ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; BMI, body mass index.

Laboratory indices

At baseline, no significant between-group differences were found in any of the measured laboratory parameters (all P > 0.05). After the intervention, the experimental group showed significantly greater reductions in TC (4.92 ± 0.79 vs. 5.34 ± 0.96 mmol/L), TG (1.70 ± 0.67 vs. 2.09 ± 0.73 mmol/L), FBG (5.82 ± 1.08 vs. 6.13 ± 1.14 mmol/L), and CRP (5.97 ± 2.27 vs. 7.23 ± 2.87 mg/L) compared with the control group (all P < 0.05). In contrast, there were no significant differences in Cr and BUN between the two groups (both P > 0.05). Within-group analyses confirmed that all six laboratory indices decreased significantly from baseline to post-intervention in the experimental group (all P < 0.05), whereas TG and FBG showed no significant changes in the control group (both P > 0.05) (**Figure 2**).

Self-management behavior

At baseline, there were no significant between-group differences in scores for rational diet (P = 0.263), regular exercise (P = 0.198), timely me-

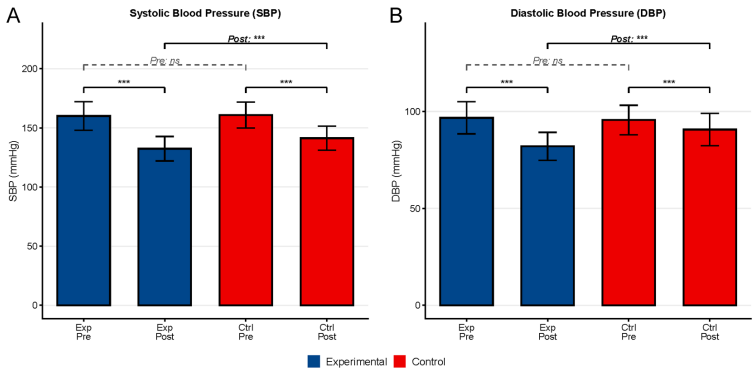

Figure 1. Comparison of blood pressure changes before and after intervention between the two groups. (A) shows changes in systolic blood pressure (SBP) before and after intervention in both groups; (B) shows changes in diastolic blood pressure (DBP) before and after intervention in both groups. Note: SBP, systolic blood pressure; DBP, diastolic blood pressure; Exp, experimental group; Ctrl, control group. ns $P \geq 0.05$, ***$P < 0.001$. Within-group comparisons were performed using paired t-tests; between-group comparisons used independent-samples t-tests. Values are expressed as mean ± standard deviation.

dication-taking (P = 0.183), blood pressure monitoring (P = 0.133), emotion management (P = 0.343), or total self-management score (P = 0.117). After the intervention, scores across all dimensions of self-management and the total score improved significantly in both groups (all P < 0.001). Notably, the experimental group achieved significantly higher scores than the control group in rational diet (P < 0.001), regular exercise (P < 0.001), timely medication-taking (P < 0.001), blood pressure monitoring (P < 0.001), emotion management (P < 0.001), and total self-management score (P < 0.001) (**Figure 3**).

Anxiety and depression

At baseline, there were no significant differences in SAS (P = 0.507) and SDS (P = 0.165) scores between the two groups. After the intervention, both scores decreased significantly in both groups (all P < 0.001 for within-group comparisons). The experimental group had significantly lower post-intervention SAS (P < 0.001) and SDS scores (P < 0.001) compared with the control group.

With regard to anxiety positivity (defined as SAS ≥ 50), the post-intervention rate was 5.7% in the experimental group versus 31.5% in the control group ($\chi^2 = 42.68$, P < 0.001). For depression positivity (defined as SDS ≥ 53), the post-intervention rate was 2.4% in the experimental group versus 31.0% in the control group ($\chi^2 = 58.05$, P < 0.001) (**Figure 4**).

Treatment adherence

The experimental group had a significantly lower post-intervention ARMS total score than the control group (P < 0.001), reflecting superior overall treatment adherence (**Figure 5A**). In terms of adherence classification, the proportions of patients with good (ARMS ≤ 16), moderate (17-23), and poor (≥ 24) adherence were 60.3%, 38.8%, and 1.0% in the experimental group, compared with 16.3%, 51.1%, and 32.6% in the control group. The between-group difference in adherence classification was statistically significant ($\chi^2 = 113.17$, P < 0.001). Specifically, the experimental group had a substantially higher proportion of patients with good adherence and a markedly lower proportion of patients with poor adherence compared with the control group (**Figure 5B**).

Quality of life

At baseline, no significant between-group differences were observed in any of the eight dimensions of the SF-36 scale, including PF (P = 0.710), RP (P = 0.656), BP (P = 0.069), GH (P = 0.065), VT (P = 0.621), SF (P = 0.454), RE (P = 0.344), MH (P = 0.276), or the SF-36 total score (P = 0.651). After the intervention, scores on all SF-36 dimensions and the total score improved significantly in both groups (all P < 0.001). The experimental group achieved significantly higher scores than the control group in all eight dimensions and the SF-36 total score (all P < 0.001) (**Figure 6**).

Nursing process quality and intervention adherence

The experimental group demonstrated significantly better nursing process quality and intervention adherence compared with the control group. Specifically, the telephone follow-up completion rate and WeChat health education participation rate were significantly higher in

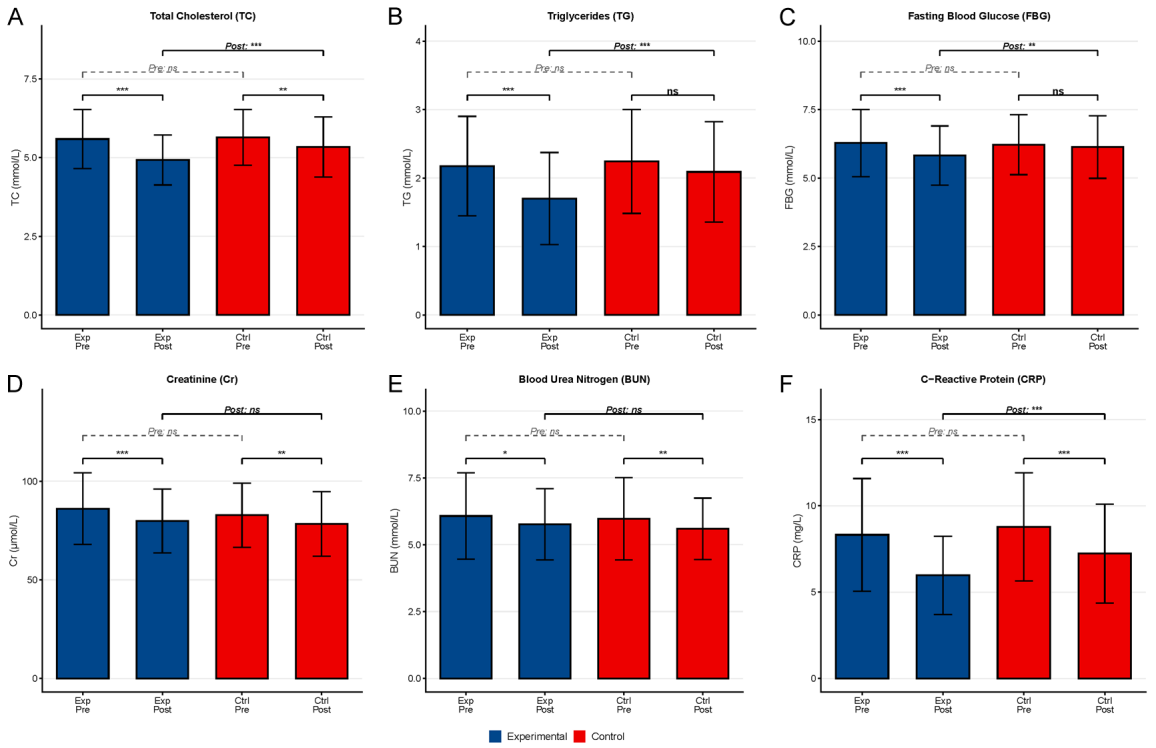

Figure 2. Comparison of laboratory index changes before and after intervention between the two groups. (A) shows changes in total cholesterol (TC); (B) triglycerides (TG); (C) fasting blood glucose (FBG); (D) creatinine (Cr); (E) blood urea nitrogen (BUN); (F) C-reactive protein (CRP). Note: TC, total cholesterol; TG, triglycerides; FBG, fasting blood glucose; Cr, creatinine; BUN, blood urea nitrogen; CRP, C-reactive protein; Exp, experimental group; Ctrl, control group. ns $P \geq 0.05$, *$P < 0.05$, **$P < 0.01$, ***$P < 0.001$. Within-group comparisons used paired t-tests; between-group comparisons used independent-samples t-tests. Values are expressed as mean ± standard deviation.

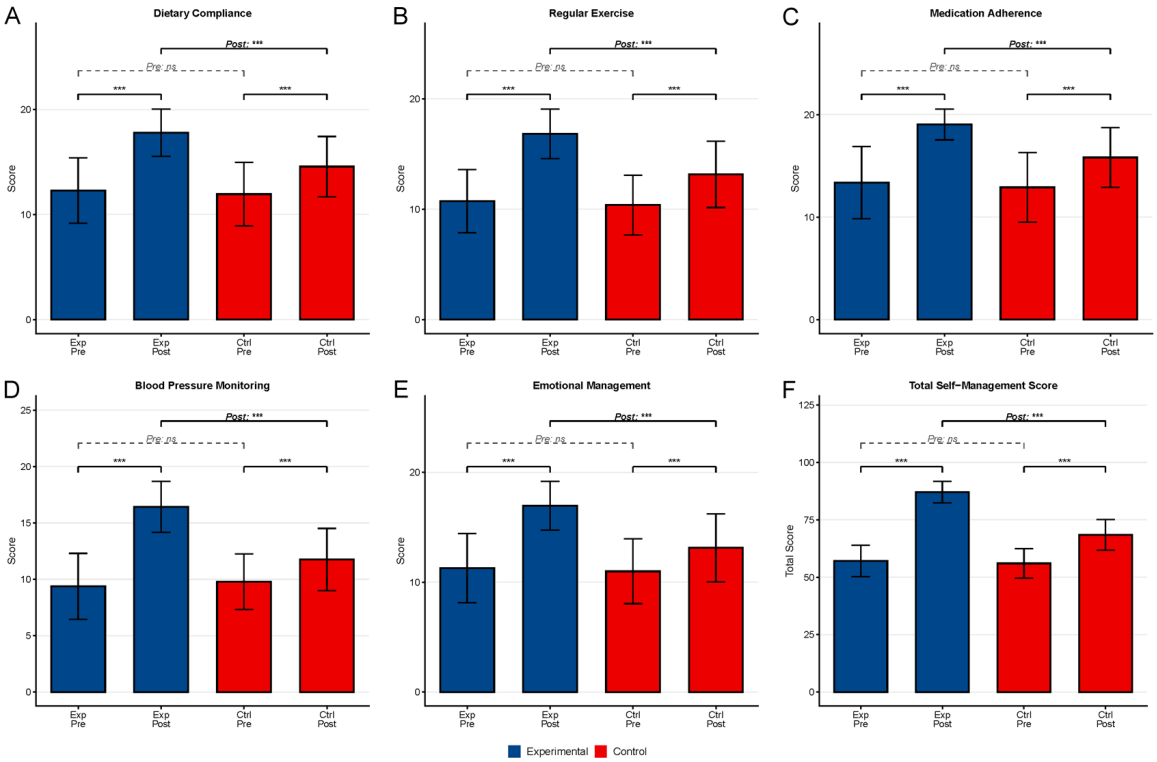

Figure 3. Comparison of self-management behavior scores before and after intervention between the two groups. (A) shows changes in rational diet scores; (B) regular exercise; (C) timely medication-taking; (D) blood pressure monitoring; (E) emotion management; (F) total self-management behavior score. Note: Exp, experimental group; Ctrl, control group. ns $P \geq 0.05$,***$P < 0.001$. Within-group comparisons used paired t-tests; between-group comparisons used independent-samples t-tests. Values are expressed as mean ± standard deviation.

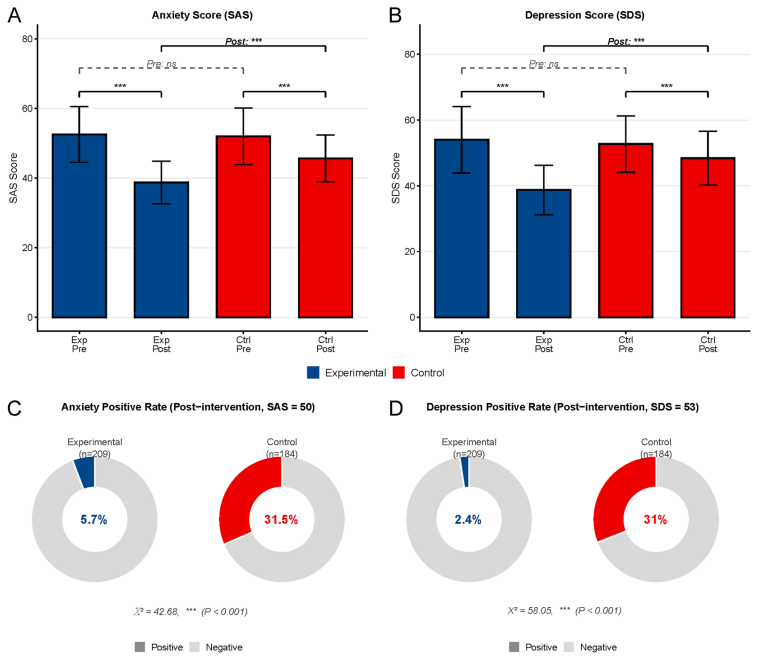

Figure 4. Comparison of anxiety and depression status before and after intervention between the two groups. (A) shows changes in Self-rating Anxiety Scale (SAS) scores; (B) Self-rating Depression Scale (SDS) scores; (C) post-intervention anxiety positivity rates; (D) post-intervention depression positivity rates. Note: SAS, Self-rating Anxiety Scale; SDS, Self-rating Depression Scale; Exp, experimental group; Ctrl, control group. ns $P \geq 0.05$, ***$P < 0.001$. Within-group comparisons used paired t-tests; between-group comparisons used independent-samples t-tests. Positivity rates were compared using chi-square tests. Values are expressed as mean ± standard deviation.

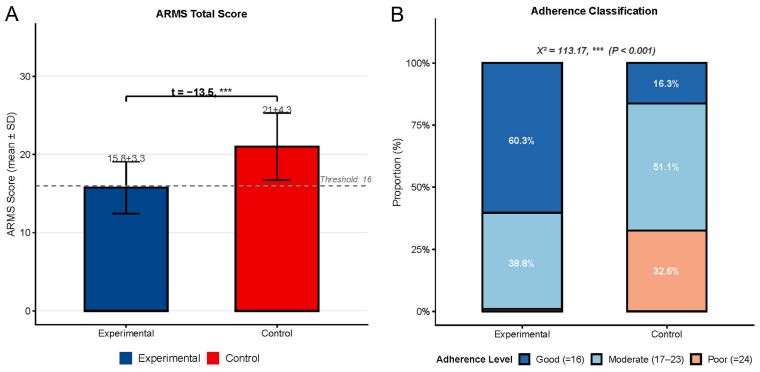

Figure 5. Comparison of treatment adherence between the two groups. (A) shows the between-group comparison of ARMS total scores; the dashed line indicates the threshold for good adherence (score of 16); (B) shows the between-group comparison of adherence classification distribution. Note: ARMS, Adherence to Refills and Medications Scale. ***$P < 0.001$. Between-group comparison of total scores used the Welch independent-samples t-test; adherence classification was compared using a chi-square test. Total score values are expressed as mean ± standard deviation.

the experimental group, while the intervention discontinuation rate was significantly lower (all $P < 0.05$) (**Table 2**).

Nursing satisfaction

Patients in the experimental group expressed significantly greater satisfaction with nursing care than those in the control group ($P < 0.001$). The experimental group had a higher proportion of patients who reported being “satisfied” and a lower proportion of patients who reported being “dissatisfied” (**Table 3**).

Nursing-related complications and adverse events

The overall incidence of nursing-related complications and adverse events was low in both groups (both $P > 0.05$). In the experimental group, some patients experienced mild redness or discomfort at the acupoint application site, but no serious adverse events were observed. The frequency of falls or other adverse events during follow-up was similar between the two groups (**Table 4**).

Age subgroup analysis

To assess the consistency of intervention effects across different age groups, patients were stratified by 70 years of age.

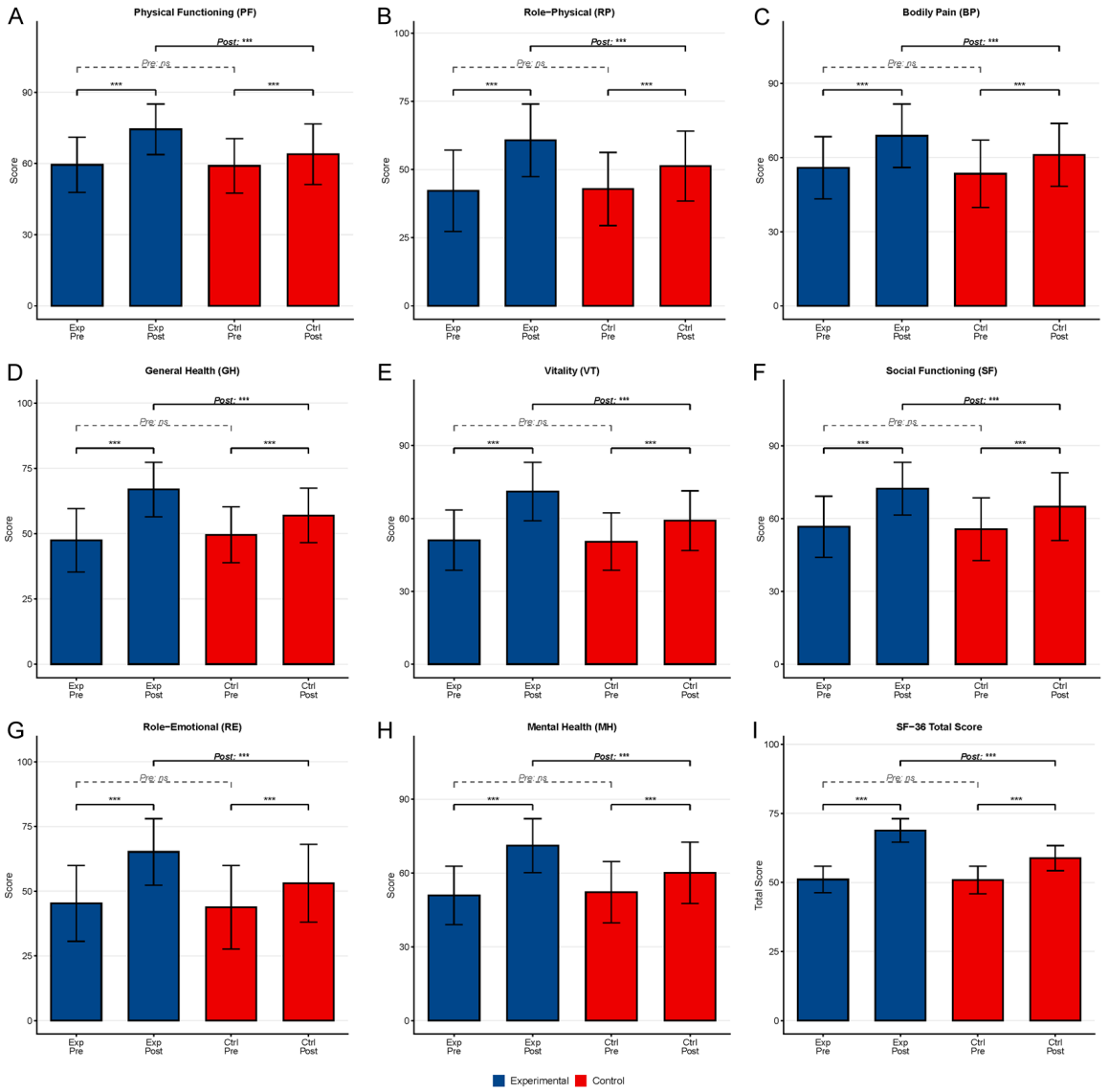

Figure 6. Comparison of quality of life before and after intervention between the two groups. (A) shows changes in physical functioning (PF); (B) role-physical (RP); (C) bodily pain (BP); (D) general health (GH); (E) vitality (VT); (F) social functioning (SF); (G) role-emotional (RE); (H) mental health (MH); (I) SF-36 total score. Note: PF, physical functioning; RP, role-physical; BP, bodily pain; GH, general health; VT, vitality; SF, social functioning; RE, role-emotional; MH, mental health; Exp, experimental group; Ctrl, control group. ns $P \geq 0.05$, ***$P < 0.001$. Within-group comparisons used paired t-tests; between-group comparisons used independent-samples t-tests. Values are expressed as mean ± standard deviation. All dimension scores and the total score range from 0 to 100, with higher scores indicating better quality of life.

Table 2. Nursing process quality and intervention adherence in the two groups

Indicator	Experimental group (n = 209)	Control group (n = 184)	χ^2 value	*P* value
Telephone follow-up completion rate, n (%)	194 (92.8%)	154 (83.7%)	10.000	0.002
WeChat health education participation rate, n (%)	176 (84.2%)	108 (58.7%)	31.783	< 0.001
Intervention discontinuation rate, n (%)	8 (3.8%)	17 (9.2%)	4.810	0.028

For the blood pressure control rate (post-intervention SBP < 140 mmHg and DBP < 90 mmHg), the experimental group achieved a control rate of 69.9% in the < 70 years sub-

Table 3. Comparison of patient satisfaction with nursing care between the two groups

Satisfaction level	Experimental group (n = 209)	Control group (n = 184)	χ^2 value	*P* value
Satisfied	142 (67.9%)	86 (46.7%)		
Moderately satisfied	60 (28.7%)	68 (37.0%)		
Dissatisfied	7 (3.4%)	30 (16.3%)	27.071	< 0.001

Table 4. Nursing-related complications and adverse events in the two groups

Indicator	Experimental group (n = 209)	Control group (n = 184)	Statistic	*P* value
Overall incidence of nursing-related complications/adverse events, n (%)	11 (5.3%)	7 (3.8%)	-	0.630
Skin redness/itching, n (%)	7 (3.3%)	1 (0.5%)	-	0.072
Discomfort at application site, n (%)	3 (1.4%)	0	-	-
Falls or other adverse events during follow-up, n (%)	1 (0.5%)	6 (3.3%)	-	0.054

group versus 18.2% in the control group (RR = 3.846, 95% CI: 2.544-5.812, P < 0.001). In the ≥ 70 years subgroup, the experimental group control rate was 66.3% versus 29.7% in the control group (RR = 2.229, 95% CI: 1.523-3.264, P < 0.001).

For the good adherence rate (ARMS ≤ 16), the experimental group had a rate of 56.1% in the < 70 years subgroup, compared with 17.3% in the control group (RR = 3.248, 95% CI: 2.096-5.032, P < 0.001). In the ≥ 70 years subgroup, the good adherence rate was 66.3% in the experimental group versus 14.9% in the control group (RR = 4.459, 95% CI: 2.532-7.851, P < 0.001).

For the post-intervention SF-36 total score, the mean difference between the experimental and control groups was 9.91 (95% CI: 8.82-11.01, P < 0.001) in the < 70 years subgroup and 10.19 (95% CI: 8.73-11.65, P < 0.001) in the ≥ 70 years subgroup. The consistent direction of intervention effects across both age subgroups confirms that the benefits of the intervention were stable across the entire elderly age spectrum (**Figure 7**).

Mediation analysis

A multiple mediation model was constructed, with intervention group assignment as the independent variable (X), total self-management score (M1), post-intervention SAS score (M2), and ARMS score (M3) as mediators, and post-intervention SBP (Y1) and SF-36 total score (Y2) as outcome variables. Bootstrap testing with 5,000 resampling iterations was used to estimate the path-specific indirect effects.

For SBP (Y1), the total effect of the intervention was significant (β = -8.922, 95% CI: -10.950 to -6.902, P < 0.001), and the direct effect was also significant (β = -6.112, 95% CI: -10.306 to -1.755, P = 0.005). The 95% CIs of all three indirect paths included zero. The indirect effect through M1 (self-management) accounted for the largest proportion (56.2%), followed by M3 (ARMS adherence, 43.2%), with M2 (anxiety score) contributing minimally (0.6%). The total indirect effect was -2.810 (95% CI: -6.332 to 0.682), with a mediation proportion of 31.5%. Bootstrap testing did not reach statistical significance, as the 95% CI of the total indirect effect included zero. Thus, the mediation of the intervention's effect on SBP through these three pathways was not statistically supported and should be interpreted as exploratory (**Figure 8A** and **8B**).

For the SF-36 total score (Y2), the total effect of the intervention was significant (β = 10.026, 95% CI: 9.152-10.899, P < 0.001), and the direct effect was also significant (β = 8.971, 95% CI: 6.989-10.960, P < 0.001). Again, the 95% CIs of all three indirect paths included zero. The indirect effect through M1 (self-management) accounted for the largest proportion (65.8%), followed by M2 (anxiety score, 34.4%), with M3 (ARMS adherence) contributing negligibly (0.1%). The total indirect effect was 1.055 (95% CI: -0.739 to 2.816), with a mediation proportion of 10.5%. Bootstrap testing again did not reach statistical significance, as the 95% CI of the total indirect effect included zero. These

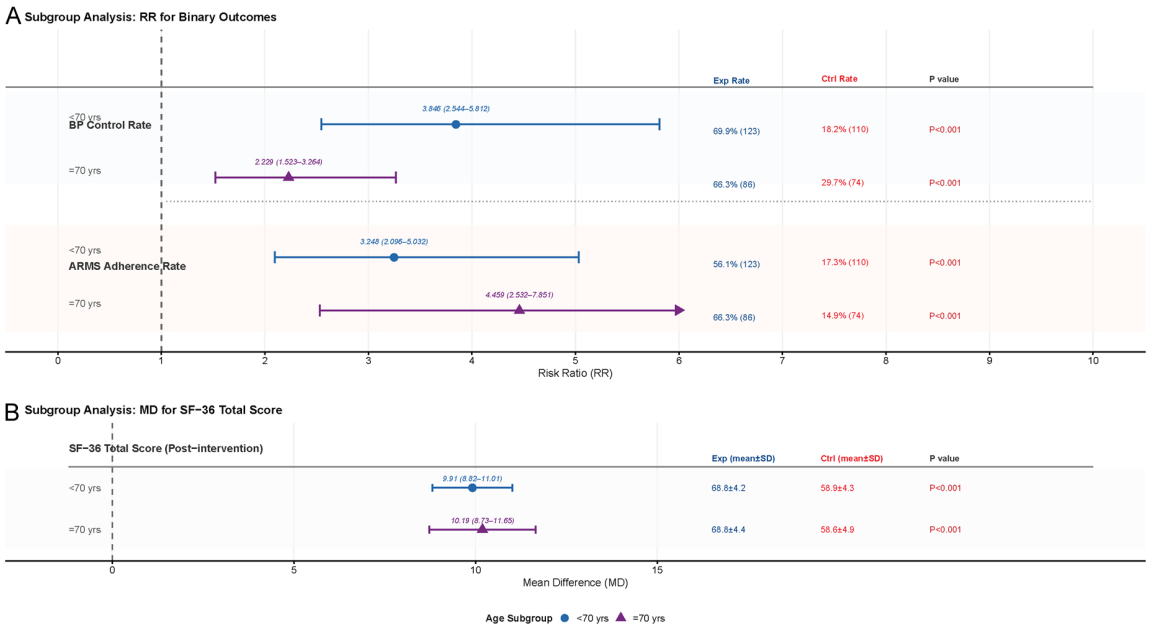

Figure 7. Age subgroup analysis (< 70 years and ≥ 70 years). (A) presents a forest plot of risk ratios (RR) for blood pressure control rate and good adherence rate (ARMS ≤ 16) across both age subgroups; (B) presents a forest plot of mean differences (MD) in post-intervention SF-36 total scores across both age subgroups. Note: RR, risk ratio; MD, mean difference; CI, confidence interval; ARMS, Adherence to Refills and Medications Scale; SF-36, 36-Item Short Form Health Survey; Exp, experimental group; Ctrl, control group. Binary outcomes were compared using chi-square tests or Fisher's exact test; continuous outcomes were compared using the Welch independent-samples t-test. The dashed line indicates the line of no effect (RR = 1.0 or MD = 0). Circles (●) represent the < 70 years subgroup; triangles (▲) represent the ≥ 70 years subgroup.

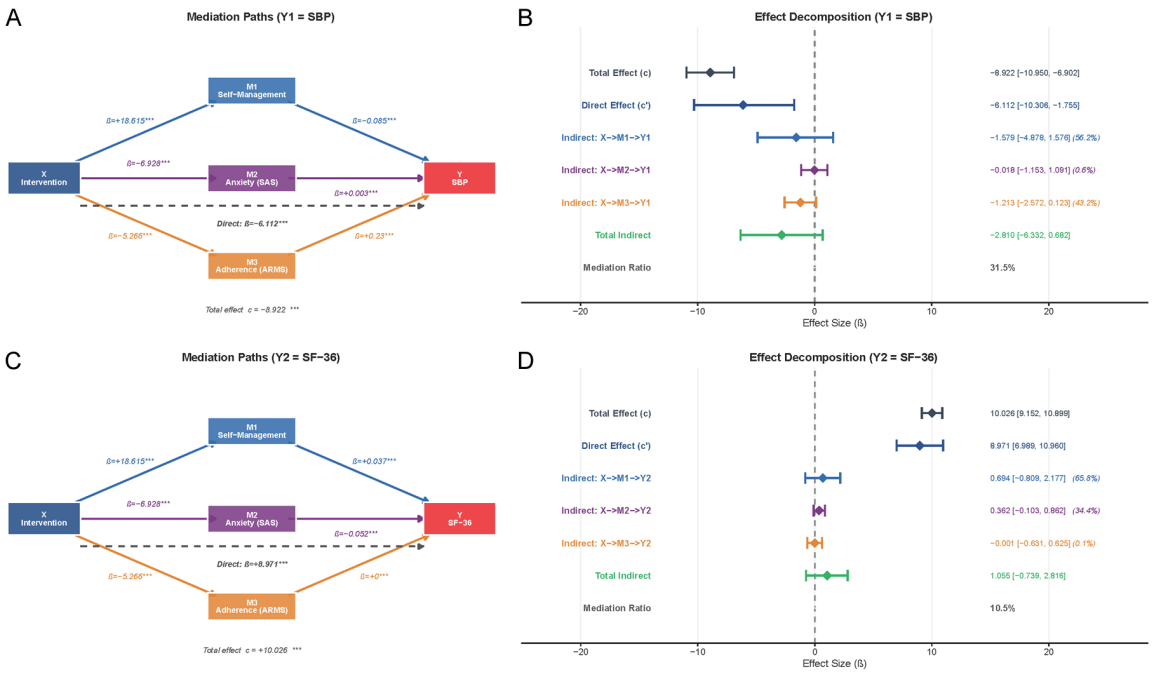

Figure 8. Mediation analysis of self-management behavior, anxiety score, and treatment adherence. (A) shows the mediation path diagram with SBP as the outcome variable; (B) the effect decomposition forest plot with SBP as the outcome; (C) the mediation path diagram with SF-36 total score as the outcome; (D) the effect decomposition forest plot with SF-36 total score as the outcome. Note: SBP, systolic blood pressure; SAS, Self-rating Anxiety Scale;

ARMS, Adherence to Refills and Medications Scale; SF-36, 36-Item Short Form Health Survey. Indirect effects were estimated using the Bootstrap method (5,000 resampling iterations) to obtain 95% confidence intervals. Direct and total effects were estimated using ordinary least squares regression. The dashed line indicates a reference of zero effect. A 95% CI excluding zero indicates statistical significance.

findings do not provide statistical evidence for mediation and should be regarded as preliminary and hypothesis-generating (**Figure 8C** and **8D**).

Intervention flow and mediation pathways

A total of 393 eligible elderly hypertensive patients were enrolled and assigned to the experimental group (n = 209) and the control group (n = 184). The experimental group received a 12-week integrated intervention combining TCM acupoint application and continuity of care on the basis of standard antihypertensive therapy. The acupoint application protocol used Tianma, Gouteng, Wuzhuyu, Huainiuxi, Xiakucao, and Chuanxiong, which were applied to the Yongquan, Shenque, Zusanli, Taichong, Neiguan, and Quchi acupoints every other day for 4 to 6 hours per session, totaling approximately 42 sessions. Continuity of care included biweekly telephone follow-ups, monthly home visits, a WeChat-based health education group, and psychological support for patients with anxiety or depression. The control group received only standard antihypertensive therapy and routine nursing. Bootstrap mediation analysis was used to explore the potential indirect effects of the intervention on blood pressure control (Y1) and quality of life (Y2) through three candidate pathways: self-management behavior (M1), anxiety level (M2), and treatment adherence (M3). Although none of the indirect effects reached statistical significance, the relative point estimates suggested that M1 accounted for the largest proportion of the total indirect effect, followed by M2 and M3. The direct effect remained significant. These results are exploratory and should not be interpreted as confirmatory evidence of mediation (Figure S1).

Discussion

This retrospective study was conducted on 393 elderly patients with essential hypertension. The results showed that the integrated intervention combining continuity of care and TCM acupoint application improved blood pressure control, lipid metabolism, inflammatory status, self-management ability, psychological well-being, treatment adherence, and quality of life. This intervention exhibited consistent effects across different age subgroups. Mediation analysis explored whether self-management behavior, anxiety status, and treatment adherence served as mediators of the intervention effects; however, none of the indirect effects reached statistical significance. These variables should be considered candidate mediators that warrant investigation in future prospective studies with larger sample sizes.

The reduction in SBP of approximately 9 mmHg in the experimental group exceeded many clinical criteria for a meaningful blood pressure change. Besides, this finding is broadly consistent with the study by Zhang et al. on continuity of care combined with chronic disease management [11]. A systematic review and meta-analysis involving 41 randomized controlled trials and 3,772 subjects showed that acupoint application plus Western medication lowered SBP by approximately 10 mmHg more than Western medication alone, which supports the findings of the current study. The blood pressure-lowering effect of TCM acupoint application may be attributed to a dual mechanism of action [9]: (1) TCM herbs (Tianma, Gouteng, Wuzhuyu, and Chuanxiong) delivered transdermally exert vasodilatory and central nervous system-modulating effects; (2) continuity of care sustains low-salt, low-fat dietary habits and regular medication adherence through timed follow-up, thereby reinforcing blood pressure homeostasis at the behavioral level.

A chronic disease management model based on telephone follow-up, WeChat health messaging, and appropriate referral can reduce SBP by approximately 6 mmHg more than control conditions in patients with essential hypertension. Such interventions also result in significant improvements in psychological status and quality of life [17], and these multimodal nursing intervention pathways are reproducible across studies.

In terms of laboratory indices, the significantly lower TC, TG, FBG, and CRP levels suggest that the intervention has a regulatory effect on metabolic syndrome-related risk factors. This finding is consistent with previous studies showing that stimulation of Zusanli and Yongquan acupoints via application can modulate autonomic nervous function and improve insulin sensitivity. There was no significant difference in Cr and BUN between the two groups, suggesting that the intervention may not affect renal function. However, it is more likely that improvements in renal function require a longer intervention period, and the 12-week observation window may have been insufficient. Studies with longer follow-up periods are needed to clarify this issue.

The experimental group scored significantly higher on all dimensions of self-management compared to the control group, indicating better continuity of care. WeChat health messaging, home visits, and structured telephone follow-up can form a continuous hospital-home-online supervision network, which helps create a positive feedback loop through knowledge delivery, skill reinforcement, and behavioral feedback to promote adherence to dietary management, exercise, and self-monitoring of blood pressure. A recent meta-analysis on self-management ability in elderly hypertensive patients indicated that such programs have a positive effect on SBP and DBP [18]. Research has also shown that digitally delivered health education can simultaneously improve self-management behavior scores, blood pressure control, and disease-related knowledge in community hypertensive patients [19], which validates the knowledge-to-behavior change pathway. In elderly hypertensive patients, nursing interventions based on the Roy Adaptation Model have similarly improved self-efficacy and self-management capacity, leading to better medication adherence and higher SF-36 scores [20], which is consistent with the multidimensional improvements observed in the current study.

The reduction in anxiety and depression was remarkable. After the intervention, the anxiety positivity rate was 5.7% in the experimental group versus 31.5% in the control group, and the depression positivity rate was 2.4% versus 31.0%. According to data reported by Fan et al. [21], the Chinese Longitudinal Healthy Longevity Survey showed that the prevalence of depression in elderly hypertensive patients was 28.3%, which is significantly associated with poorer quality of life. Thus, psychological intervention in such patients has great potential for clinical benefit. The findings support the effectiveness of the psychological support module in the continuity of care protocol, particularly the tailored counseling for patients with a baseline SAS $\geq$ 50, in reducing emotional disturbance. Research on eye movement desensitization and reprocessing has found that reducing anxiety in hypertensive patients significantly lowers SBP and improves heart rate variability [22], providing experimental evidence for the physiological anxiety-to-blood-pressure transmission pathway. Additional studies have confirmed that qualitative nursing interventions reduce anxiety and depression scale scores and improve quality of life in elderly hypertensive patients [23], which is consistent with the significant reductions in positivity rates observed in the current study.

Moreover, in addition to clinical and psychological outcomes, the present study also included nursing indicators to measure the quality, acceptability, and safety of the intervention. The results showed that the follow-up completion and participation rates were higher in the experimental group, reflecting better implementation of continuous nursing care. In addition, the intervention led to a marked improvement in patient satisfaction, suggesting that patients readily accepted the intervention and perceived it as beneficial. Most importantly, there were few nursing-related complications and no serious adverse events, indicating that the combined intervention is safe. These findings demonstrate that the intervention not only improves patients' physiological status but also enhances nursing quality and patient experience, which are essential for chronic disease management.

In terms of treatment adherence, the good adherence rate of 60.3% in the experimental group was much higher than the 16.3% in the control group, indicating that regular medication guidance and follow-up supervision are effective for long-term adherence in elderly patients. Researchers conducted a large survey of 2,615 hypertensive patients in five Eur-

opean countries and found that emotional states like anxiety, depression, and stress are core risk factors for non-adherence [24]. Interestingly, these states are also targets of the psychological support module in the current continuity of care protocol, providing external validation of the intervention design from the patient's perspective. An investigation revealed that varying blood pressure status and adherence levels influence the interaction between adherence and quality of life; research shows that mental domain scores exhibit the highest variations [25], which confirms the internal logic that improved adherence is associated with better SF-36 scores in the current study. A retrospective investigation of a smart hypertension diagnostic and treatment center found that intensive management simultaneously improved SAS and SDS scores, medication adherence, and multiple dimensions of quality of life [26], which is consistent with the multidimensional improvement pattern observed here.

The significant improvements in all eight dimensions of the SF-36 in the experimental group indicate that the intervention's benefits were not confined to a single functional area but had a wide-ranging positive impact on both physical and psychological health in elderly hypertensive patients. Mechanistically, improvements in physical functioning domains (PF, RP, BP) are most directly related to blood pressure normalization, improved lipid and glucose control, and recovery of physical capacity. Gains in psychological functioning domains (VT, SF, RE, MH) appear to depend more on reduced anxiety and depression and increased self-efficacy. The application of metacognitive strategies in health management models can effectively enhance self-management ability, lipid indices, and SF-36 total scores in hypertensive and hyperlipidemic patients [27], which confirms the simultaneous metabolic and quality of life improvements observed in the current study. According to findings from Yang et al. [28] and Bao et al. [29], comprehensive health management or geriatric assessment-based nursing interventions in elderly patients with hypertension and chronic comorbidities can improve not only blood pressure but also blood glucose and lipid indices, as well as significantly increase SF-36 scores and treatment adherence rates, providing substantial external validation of the current conclusions. The extensive benefits for quality of life arise from the combined action of both intervention components through physiological and psychological pathways.

The results of the subgroup analyses demonstrated consistent effects of the combined intervention on blood pressure control rate, good adherence rate, and SF-36 total score in both the < 70 and ≥ 70 years subgroups, confirming the applicability of the combined intervention to elderly hypertensive patients across the age spectrum. The RR was higher in the ≥ 70 years subgroup (4.459) than in the < 70 years subgroup (3.248), indicating that older patients with marginal adherence have greater room for improvement, and thus the marginal benefit of continuity of care may be greater in the older subgroup. A randomized controlled trial by Zeng et al. [30] in elderly hypertensive patients living in a rural community found that intensive nursing support led to more significant improvements in adherence and blood pressure among patients with weaker baseline self-management, which is consistent with the findings in the higher-age subgroup here and has practical implications for resource allocation in clinical practice.

In terms of mediation, the overall indirect effect on SBP was -2.810 (95% CI: -6.332 to 0.682), with a mediation proportion of 31.5%. For SF-36 total score, the overall indirect effect was 1.055 (95% CI: -0.739 to 2.816), with a mediation proportion of 10.5%. Bootstrap tests did not reach significance. The lack of statistical confirmation of a mediation effect does not mean that such a mechanism does not exist. Chen et al. [31] used path analysis in patients with essential hypertension and found that self-efficacy significantly mediated the relationship between social support, self-rated health, and self-management behavior, and that depressive symptoms also mediated the effect of self-efficacy. This model explained 28% of the variance in self-management behavior, theoretically supporting the mediating roles of M1 (self-management behavior) and M2 (anxiety status) in the current study. Research in patients with hypertensive nephropathy has also shown that psychological well-being partially mediates the relationship between self-care knowledge and disease self-management, with a mediation proportion of 23.2% [32]. A similar pattern was observed here, with anxiety status

contributing 34.4% to the SF-36 pathway, suggesting that the mediating role of psychological status in patient-reported outcomes may be consistent across diseases. The 43.2% attribution to M3 in the SBP pathway and 0.1% in the SF-36 pathway is clinically intuitive: consistent medication use has a potent and measurable effect on blood pressure values but mainly affects quality of life indirectly through blood pressure improvement. Studies on transitional care for elderly patients following percutaneous coronary intervention showed that this care model can improve quality of life by increasing self-management ability and decreasing anxiety [33], which is closely related to the indirect SF-36 pathway through self-management behavior and anxiety status identified here. Accordingly, the mediation proportions reported here (31.5% for SBP and 10.5% for SF-36) should be interpreted as descriptive estimates only, not as evidence of established mediation pathways. Furthermore, the modest theorized correlations between the three mediators likely inflate the standard errors of the individual path estimates. Future studies with larger prospective cohorts and validated mediation frameworks are required to formally test these pathway hypotheses.

Several limitations of this study should be acknowledged. First, the retrospective design precludes random allocation; although baseline characteristics were well balanced between groups, the possibility of residual confounding from unmeasured variables cannot be fully excluded. Second, the study was conducted at a single center in Lanzhou, China, which may limit the generalizability of the findings to other regions or healthcare settings. Third, the 12-week follow-up period may be insufficient to capture longer-term effects of the intervention, particularly with respect to renal function indices and sustained blood pressure control. Fourth, outcome data were collected via self-reported questionnaires, which are subject to social desirability bias, especially for self-management behavior and treatment adherence measures. Finally, the mediation analysis was exploratory in nature, as none of the indirect effects reached statistical significance, likely due to limited statistical power inherent to the retrospective design.

Future studies should adopt prospective randomized controlled trial designs with larger sample sizes and longer follow-up periods to confirm the findings reported here. Multi-center trials would enhance the generalizability of the results. In addition, formally powered mediation analyses with validated frameworks are warranted to rigorously test whether self-management behavior, anxiety status, and treatment adherence serve as mediating pathways linking the integrated intervention to blood pressure control and quality of life outcomes.

Conclusion

The integrated intervention of continuity of care combined with TCM acupoint application is a safe and effective management strategy for elderly patients with essential hypertension. This intervention achieved clinically relevant simultaneous improvements in blood pressure control, metabolic parameters, psychological status, treatment adherence, and quality of life within 12 weeks, with stable and consistent effects across age subgroups. Mediation analysis generated the hypothesis that self-management behavior, anxiety status, and treatment adherence may serve as potential pathways through which the intervention exerts its effects; however, these indirect effects were not statistically significant. Future prospective studies with larger samples are needed to formally test and confirm these mechanistic pathways. The combined approach can be regarded as a reproducible, generalizable model for the integrated community management of elderly hypertension.

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Disclosure of conflict of interest

None.

Address correspondence to: Wenjing Wang, Department of Geriatrics, The First People's Hospital of Lanzhou City (Second Clinical Medical College, Gansu University of Chinese Medicine), No. 1 Wujiayuan West Street, Qilihe District, Lanzhou 730050, Gansu, China. E-mail: w13893378535@163.com

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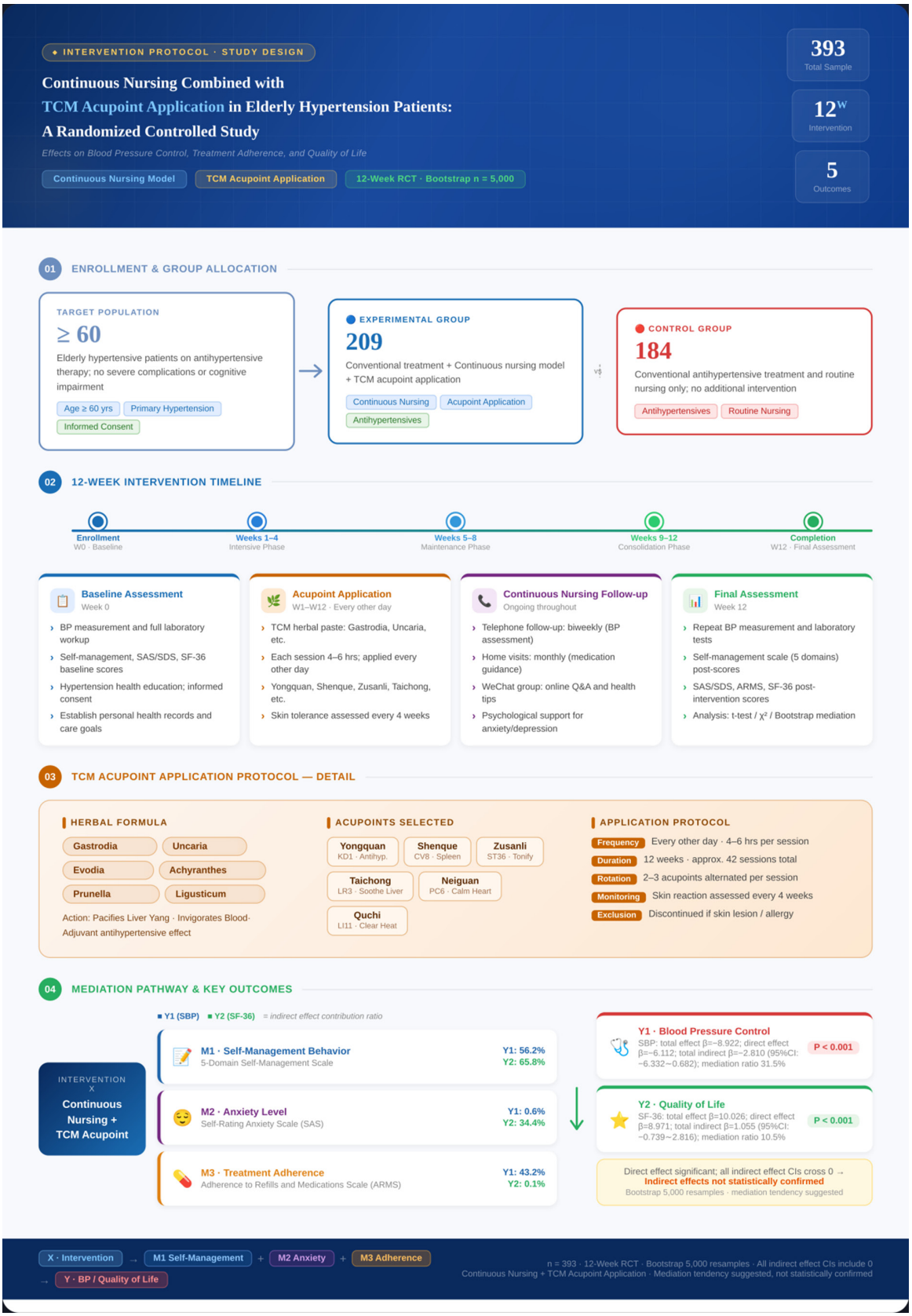

Figure S1. Schematic diagram of the intervention flow and mediation pathways. The first module presents the enrollment overview, with the total sample of 393 patients allocated to the experimental group (n = 209) and the con-

trol group (n = 184). The second module displays the 12-week intervention timeline, comprising four phases: baseline assessment (week 0), TCM acupoint application (weeks 1-12, every other day), continuity of care follow-up, and final assessment at week 12. The third module details the TCM acupoint application protocol, including the herbal formula (Tianma, Gouteng, etc.), acupoint selection (Yongquan, Shenque, Zusanli, etc.), and operational standards. Bootstrap mediation analysis explored potential indirect effects of the intervention on blood pressure control (Y1) and quality of life (Y2) through three candidate pathways: self-management behavior (M1), anxiety level (M2), and treatment adherence (M3). None of the indirect effects reached statistical significance (all 95% CIs included zero). The proportions shown reflect point estimates of relative contributions to the total indirect effect and should not be interpreted as confirmed mediation. The direct effect remained statistically significant. Note: SAS, Self-rating Anxiety Scale; ARMS, Adherence to Refills and Medications Scale; SF-36, 36-Item Short Form Health Survey; SBP, systolic blood pressure; TCM, traditional Chinese medicine. Mediation effects were tested using the Bootstrap method with 5,000 resampling iterations. M1, M2, and M3 represent self-management behavior, anxiety level, and treatment adherence, respectively. Y1 denotes blood pressure control; Y2 denotes quality of life.