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Research Article

The Impact of Frailty Intervention for Community-Dwelling Older Adults on Physical and Mental Health from the Perspective of the HAPA Theory

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Abstract

Objective: To investigate the effects of a dynamic intervention model for frailty in community-dwelling older adults-developed based on the Health Action Process Approach theory-on their physical and mental health. Methods: A total of 160 frail older adults screened from six communities in Xi'an were selected as study subjects and randomly divided into a control group and an intervention group, each comprising 80 participants. The control group received traditional health management methods, while the intervention group received the dynamic intervention model for frailty in community-dwelling older adults developed in this study. The two groups were compared in terms of demographic characteristics, the Mini-Nutrition Status Scale, biochemical indicators, the Brief Geriatric Depression Scale, the Chinese version of the Barthel Index, and the European Five-Dimensional Health Scale scores. Results: In the comparison of baseline data between the two groups, there were no statistically significant differences in demographic characteristics, health status, nutrition, self-care ability, depression status, or the incidence of adverse events ($P > 0.05$); Following the intervention, the intervention group demonstrated significantly better scores than the control group at 6 and 12 months in terms of nutrition, self-care ability, depression, and quality of life ($P < 0.05$); The research results of biochemical indicators such as HCG, IGF-1, HB and 25-(OH)2D3 in the elderly showed that there was no statistically significant difference in the biochemical indicators between the intervention group and the control group in the two follow-ups ($P > 0.05$). Conclusion: The dynamic frailty intervention model for community-dwelling older adults, developed based on the HAPA theory, can significantly improve their nutritional status, self-care ability, depressive symptoms, and quality of life, thereby promoting their physical and mental health.

Keywords

HAPA Theory, Community-Dwelling Older Adults, Frailty, Physical and Mental Health

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1. Introduction

According to data released by the National Bureau of Statistics in January 2026, China's population aged 60 and older has reached 323 million, accounting for 23% of the total population. It is projected that by 2050, the proportion of Chinese adults aged 60 and older will exceed 30% [1]. As the aging population continues to grow, health issues among the elderly can no longer be ignored. In addition to health issues stemming from the decline of their physical functions, older adults must also cope with psychological challenges arising from reduced social interaction, bereavement, and living alone. Since the vast majority of older adults in China live in communities, how to integrate social resources to provide community-based psychological services for older adults and promote their physical and mental health has become a significant research topic in the field of proactive health [2]. The Health Action Process Approach [3] (HAPA) is a theoretical model. It was proposed by Schwarzer in Germany based on Bandura's "Self-Efficacy Model". It holds that the change of healthy behaviors is a continuous process involving the initiation, maintenance, and possible recovery after interruption, and emphasizes the need for repeated assessment of behaviors and their psychological states at different stages. Currently, this theory has been widely applied in various fields of health behavior management, such as healthy diet, diabetes management, improvement of hypertension in the elderly, and perioperative exercise. [4-7]. It implements corresponding intervention measures for people at different behavioral stages and systematically evaluates the applicability and effectiveness of the comprehensive frailty intervention model, providing theoretical support for the timely intervention of frail elderly people in our communities. This study builds a dynamic intervention model for frailty in community elderly people based on this theory, aiming to explore its impact on the physical and mental health of community elderly people.

2. Subjects and Methods

2.1. Study Participants

A total of 160 frail elderly individuals identified through screening in six communities in Xi'an were selected as study participants. Inclusion criteria: (1) Age ≥ 60 years; (2) Met frailty screening criteria: Tilburg Frailty Index (TFI) ≥ 5; (3) Proficient in using a smartphone; (4) Alert and oriented; (5) Provided informed consent and voluntarily agreed to participate in this study. Exclusion criteria: 1) History of mental illness or language communication barriers; 2) Occurrence of serious adverse events or complications after enrollment; 3) Patients with terminal illnesses such as malignant tumors; 4) Currently participating in other research studies.

2.2. Intervention Method

2.2.1. Formation of the Research Team

The expert panel for this research project consists of 2 public health experts, 2 senior community health care specialists, and 2 geriatric care experts. A working group formed by these experts collectively discussed and developed a frailty intervention model for the elderly, which includes specific components such as frailty awareness training, physical exercise, nutritional intervention, oral health management, cognitive training, and medication management.

2.2.2. Frailty Intervention Model for the Elderly

The control group will adopt traditional health management methods, including the establishment of health records by the community, the conduct of health lectures, and the provision of health guidance to frail older adults in the community. The intervention group will adopt the dynamic community-based frailty intervention model developed in this study, as detailed below.

(i). Pre-intervention Phase

The target audience for this phase includes prospective participants, their caregivers, and community managers. Prior to the intervention, the project leader provided training to the advisory team on research objectives, framework, and protocols, and to the implementation team on the research protocol, implementation process, and knowledge of frailty. Intervention Team: Composed of an advisory team and an implementation team. The advisory team consisted of experts from geriatrics, rehabilitation, nutrition, psychology, nursing management, and public health management, who guided the implementation of the intervention protocol and addressed inquiries; The implementation team consists of community administrators, project staff, and research team members, who are responsible for carrying out the intervention measures. Intervention Content: Distribute the *Community Management Manual for Frail Older Adults*. Physicians from the Rehabilitation Department assist in filming exercise instruction videos and creating step-by-step exercise diagrams. Provide pens, notebooks, resistance bands, dinner plates, food scales, and fitness trackers to frail older adults in the intervention group to support exercise, dietary and nutritional tracking, and sleep monitoring.

(ii). Intention Phase

The intervention targets the study's intended population, caregivers, and community managers. Intervention content primarily includes the following aspects: 1) Addressing frailty risk factors: Focusing on reversible factors such as sarcopenia, malnutrition or weight loss, depression, and vitamin B12 deficiency. 2) Physical exercise: Implement aerobic warm-ups, resistance training, balance exercises, and flexibility training; appropriate intensity is defined as

self-perceived effort level being less than 7 and the maximum repetition load being less than 60%, as assessed by professionals; each session lasts 40–60 minutes, 2–3 times per week with at least one day of rest between sessions; exercise prescriptions are regularly assessed and updated, and participants are required to follow and record them; adjustments are made gradually for those who cannot tolerate the regimen. 3) Nutritional Intervention: Develop a plan based on the Dietary Guidelines Pyramid; record food intake at least 3 days per week; ensure adequate daily water intake and protein consumption, with high-quality protein accounting for ≥50% and distributed evenly across three meals; ensure consumption of ≥12 food varieties daily and ≥25 weekly, and standardize meal structure; individuals at nutritional risk should supplement with enteral nutrition formulas under professional guidance. 4) Medication Management: Assess comorbidities and medication use; educate on the risks of polypharmacy; collaborate with primary care providers to dynamically optimize medication regimens; strictly avoid inappropriate medication use. 5) Oral Health Management: Strengthen education on oral and denture hygiene; provide guidance on proper care methods; ensure timely referral for specialized treatment. 6) Psychological Intervention: Identify and address negative psychological triggers; guide participants in positively coping with aging and illness; inform them of professional resources for severe psychological issues. 7) Cognitive Training: Implement non-pharmacological training to enhance memory, logical reasoning, attention, and reaction time, such as recalling daily routines, performing arithmetic, spot-the-difference exercises, and finger exercises. 8) Social Support Therapy: Establish community-based psychological service centers for the elderly, form mutual-aid groups for seniors, organize parent-child interaction activities, and provide home visit services for those in need.

(iii). Action Phase

The intervention targets are the active participants in the study, their caregivers, and community managers. a. Intervention Duration: The intervention period for this study is one year; the first three months involve phased implementation according to the plan; the following nine months focus on reinforcing intervention effects and conducting follow-up. During follow-up, telephone follow-ups are conducted weekly from months 3 to 6, and monthly from months 6 to 12, with home visits conducted as necessary. b. Intervention Locations: Community health service centers and participants' homes. c. Intervention Methods: During the pre-intention phase, methods such as thematic lectures, viewing educational videos, and case sharing will be used; during the intention and action phases, a combined "online + offline" approach will be primarily adopted."Online"interventions include WeChat official accounts, WeChat groups, and telephone communication, while "offline" interventions include group sessions, face-to-face personalized coaching, and in-home personalized guidance. Regular follow-ups, dynamic evaluations, and timely adjustments will be conducted, with data collected at 0, 6, and 12 months.

2.3. Evaluation Indicators

Based on the research objectives and content, and in conjunction with clinical practice, the evaluation indicators were determined after reviewing a large body of literature and consulting with experts. These indicators include nutritional status, biochemical markers, fun ctional independence, quality of life, and depression. 1) Short-form Mini-Nutritional Assessment (MNA- SF): This scale was developed by Rubenstein et al [8] in 2001 as a simplified version of the Mini-Nutrition Assessment. It is suitable for clinically assessing the nutritional status of elderly patients. The assessment covers six aspects: weight loss, BMI, stress or acute illness, functional capacity, mental illness, and loss of appetite/dyspepsia/difficulty chewing or swallowing. The total score is 14 points; a score of ≤11 indicates a risk of malnutrit ion, while 12–14 is considered normal. 2) Biochemical Indicators: Hemoglobin, serum human chorionic gonadotropin (HCG), Insulin-like growth factor-1 (IGF-1), and Total 25-hydroxyvitamin D (25-(OH)2D3). Hemoglobin is measured by the Clinical Laboratory using impedance flow cytometry; 25-hydroxyvitamin D is measured using high-performance liquidchro matography-tandem mass spectrometry; serum HCG and IGF-1 are measured by the Radioimmunoassay Center using magnetic particle chemiluminescence. 3) Activities of Daily Living (ADL): Assessed using the Chinese version of the Barthel Index (BI). The BI comprises 10 items of activities of daily living, with a total score ranging from 0 to 100. A higher score indicates lower dependence and better self-care ability. 4) Quality of Life: Assessed using the European Quality of Life-5 Dimensions (EQ-5D) questionnaire, developed by the EuroQol Group. This questionnaire consists of two parts: the EQ-5D health description system and the Visual Analogue Scale (VAS). The EQ-5D comprises five dimensions: mobility, self-care, usual activities, pain or discomfort, and anxiety or depression. Each dimension is scored on a 5-point scale: very difficult, severely difficult, moderately difficult, slightly difficult, and no difficulty, corresponding to scores of 1 to 5. A higher score indicates a better health status. The EQ-VAS self-rated health system uses a 0–100 point scale representing the two extremes of the respondent's perception, where 100 indicates "the individual feels in the best possible health" and 0 indicates "the individual feels in the worst possible health."5) 15-item Geriatric Depression Scale (GDS-15): This scale was developed in 1986. Its internal consistency coefficient (α) is 0.793, and its test-retest reliability is 0.728. It is currently widely used in clinical and psychological fields. The scale consists of 15 items, with a total score ranging from 0 to 15. A score of 8 or higher indicates the presence of depressive

symptoms; the higher the score, the more severe the depression.

2.4. Statistical Analysis

A database was established using Epidata 3.0, with data entered by two independent operators. Statistical analysis was performed using SPSS 24.0. Descriptive statistics—including mean (x) and standard deviation (s), frequency, and proportion—were used to characterize the general demographic and scoring data of the study participants. Independent samples t-tests and chi-square tests were employed to compare baseline data between the two groups. Generalized linear models were used to assess balance between and within groups before and after the intervention, thereby evaluating the intervention's effectiveness.

3. Results

3.1. Comparison of Baseline Characteristics Between the Two Groups

A total of 160 subjects were enrolled according to the inclusion and exclusion criteria, with 80 in the intervention group and 80 in the control group. Two-sample t-tests and chi-square tests were used to compare baseline data between the two groups. No statistically significant differences were found in demographic characteristics, health status, nutrition, self-care ability, depression status, or the incidence of adverse events ($P > 0.05$), as shown in Table 1. Comparisons of baseline scores for nutrition, self-care ability, depression, and quality of life among study participants also showed no statistically significant differences ($P > 0.05$), as shown in Table 2.

Table 1. Comparison of Baseline Demographic Characteristics of the Research Subjects (N = 160).

Item	Overall (N = 160)	Intervention group (N = 80)	Control group (N = 80)	*P*
Gender				0.490
Man	48 (30.0%)	26 (32.5%)	22 (27.5%)	
Woman	112 (70.0%)	54 (67.5%)	58 (72.5%)	
Age (years) Marital status	70.6±5.6	70.1±5.4	71.0±5.9	0.308
Marital status				0.715
Married	120 (75.0%)	61 (76.2%)	59 (73.8%)	
Unmarried / Divorced / Widowed	40 (25.0%)	19 (23.8%)	21 (26.2%)	
Educational level				0.413
Primary school or below	37 (23.1%)	14 (17.5%^)	23 (28.8%)	
Middle School	49 (30.6%)	26 (32.5%)	23 (28.8%)	
High School / Vocational School	52 (32.5%)	28 (35.0%)	24 (30.0%)	
College degree or above	22 (13.8%)	12 (15.0%)	10 (12.5%)	
The nature of previous work				0.400
Based mainly on mental effort	56 (35.0%)	32 (40.0%)	24 (30.0%)	
Primarily relying on physical strength	75 (46.9%)	34 (42.5%)	41 (51.2%)	
Both mental and physical capabilities are present.	29 (18.1%)	14 (17.5%)	15 (18.8%)	
Family per capita income	3000 (2982.7-3520.7)	3000 (3032.5-3797.5)	3000 (2705.2-3471.6)	0.144
Types of medical insurance methods				0.550
Self-funded	1 (0.6%)	1 (1.3%)	0 (0.0%)	
Urban resident medical insurance	59 (36.9%)	26 (32.5%)	33 (41.2%)	
Urban employee medical insurance	91 (56.9%)	48 (60.0%)	43 (53.8%)	
Commercial insurance	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Others	9 (5.6%)	5 (6.2%)	4 (5.0%)	

Item	Overall (N = 160)	Intervention group (N = 80)	Control group (N = 80)	*P*
Medical expense burden				0.062
No burden	78 (48.8%)	34 (42.5%)	44 (55.0%)	
Have certain financial burdens	63 (39.3%)	32 (40.0%)	31 (38.7%)	
The economic burden is too heavy	19 (11.9%)	14 (17.5%)	5 (6.3%)	

Table 2. *Comparison of baseline nutritional status, self-care ability, depression and quality of life scores of the research subjects (N = 160).*

Item	Overall (N = 160)	Intervention group (N = 80)	Control group (N = 80)	*P*
Nutritional status score	10.54±2.23	10.75±1.78	10.34±2.60	0.669
Self-care ability status score	94.65±6.78	90.85±11.12	91.28±10.10	0.627
Depression score	4.28±3.32	4.05±3.16	4.51±3.47	0.364
Quality of life score	75.22±13.32	74.39±14.22	76.06±12.39	0.592

3.2. Comparison of Follow-up Data at 6 and 12 Months Post-Intervention Between the Two Groups

Data collection for this study was conducted at 6 and 12 months post-intervention. A total of 18 participants (22.5%) in the intervention group and 14 participants (17.5%) in the control group were lost to follow-up. Analysis of the data revealed that the intervention group's scores for nutrition, self-care ability, depression, and quality of life at 6 and 12 months were all superior to those of the control group, with statistically significant differences ($P < 0.05$), as shown in Table 3.

Table 3. *Comparison of nutritional, self-care ability, depression and quality of life scores between the two groups at 6 months and 12 months of follow-up.*

	Follow-up for 6 months			Follow-up for 12 months		
Item	Intervention group (N=65)	Control group (N=69)	*P*	Intervention group (N=62)	Control group (N=66)	*P*
Nutritional status score	11.65±2.15	10.70±2.09	0.005*	11.40±1.80	10.42±2.35	0.028*
Self-care ability status score	97.85±4.84	96.06±5.82	0.007*	97.26±4.41	95.30±6.13	0.048*
Depression status score	3.43±2.83	4.58±3.28	0.045*	3.63±2.10	4.52±2.51	0.048*
Quality of life score	87.15±11.01	82.32±12.87	0.030*	82.06±13.17	76.71±11.91	0.007*

*: $p<0.05$

3.3. Effects of the Intervention on Biochemical Indicators

In this study, changes in biochemical indicators such as HCG, IGF-1, HB, and 25-(OH)2D3 in the elderly were collected with the informed consent of the participants. There were no statistically significant differences in biochemical indicators between the intervention group and the control group during the two follow-up visits, as shown in Table 4.

Table 4. Effects of Intervention on Biochemical Indicators.

Item		β	95% confidence interval	*P* value
HCG	Baseline values of the control group	1.29	1.01, 1.57	<0.001
	Difference between baseline groups (intervention group - control group)	0.28	-0.33, 0.89	0.369
	Follow-up 1	0.93*	0.39, 1.48	0.001*
	Follow-up 2	0.20	-018, 0.58	0.301
	Intervention group * Follow-up 1	-0.84	-1.80, 0.12	0.084
	Intervention group * Follow-up 2	-0.39	-1.19, 0.41	0.334
IGF-1	Baseline values of the control group	131.28	121.61, 140.96	<0.001
	Difference between baseline groups (intervention group - control group)	8.37	-5.17, 21.92	0.226
	Follow-up 1	6.17	-2.93, 15.27	0.184
	Follow-up 2	-0.18	-5.55, 5.19	0.947
	Intervention group * Follow-up 1	40.04*	27.66, 52.41	<0.001*
	Intervention group * Follow-up 2	7.27	-2.18, 16.71	0.132
Hemoglobin	Baseline values of the control group	137.79	134.98, 140.60	<0.001
	Difference between baseline groups (intervention group - control group)	-0.22	-4.37, 3.93	0.917
	Follow-up 1	3.98*	1.03, 6.94	0.008*
	Follow-up 2	-0.73	-2.29, 0.84	0.362
	Intervention group * Follow-up 1	-1.84	-5.28, 1.61	0.297
	Intervention group * Follow-up 2	-1.18	-3.44, 1.09	0.307
25-$(OH)_2$D3	Baseline values of the control group	20.33	18.70, 21.96	<0.001
	Difference between baseline groups (intervention group - control group)	2.80*	0.33, 5.27	0.026
	Follow-up 1	-5.76*	-8.24, -3.28	<0.001*
	Follow-up 2	3.45*	1.70, 5.20	<0.001*
	Intervention group * Follow-up 1	1.05	-2.25, 4.35	0.534
	Intervention group * Follow-up 2	-1.08	-3.52, 1.36	0.384

*: $p<0.05$

4. Discussion

4.1. Long-term Dynamic Intervention Can Significantly Improve Their Depressive Symptoms and Nutritional Status

In terms of nutritional status, there was no significant difference in the scores between the two groups of elderly people at the baseline comparison. However, at 6 months and 12 months of follow-up, there was a significant difference in the scores between the intervention group and the control group, indicating that effective intervention can to some extent improve the nutritional status of the elderly and alleviate frailty. This is consistent with the research results of Sun Xuemei et al [9]. It may be because through the increase in nutritional intake, physiological functions such as muscle strength and walking speed were improved, nutritional deficiencies were corrected, inflammatory levels were reduced, and social psychological support was enhanced. These factors worked together to ultimately alleviate the nutritional frailty state of the

elderly. In addition, the depression scores of the elderly in the intervention group showed an optimized trend. The study by Nascimento et al [10]. found that a comprehensive intervention combining nutrition, physical and cognitive aspects had a greater therapeutic effect on the depression symptoms of elderly people in the community who were in a state of weakness and pre-weakness during the 6-month and 12-month follow-up, which is consistent with the results of this study. Psychological intervention mainly relies on various intervention methods including problem-solving to help the frail individuals actively prevent and cope with negative emotions such as depression [11]. The follow-up tracking of the elderly in the intervention later stage mainly relies on telephone contact, and the compliance of the elderly with the intervention plan will largely affect the final result.

4.2. The Dynamic Intervention for Community Elderly Frailty Has No Significant Effect on Biochemical Indicators

The research results in the biochemical indicators show that at the 6th and 12th months of follow-up, the levels of HCG, IGF-1, hemoglobin, and 25-(OH)2D3 in the intervention group of the elderly did not show significant changes. Studies have shown that an increase in HCG levels is helpful in improving the weight and muscle mass of elderly men [12], while the IGF-1 level is generally low in people with reduced grip strength and decreased physical ability [13]. The intervention implemented in this study had no significant effect on the serum HCG and IGF-1 levels of community elderly, and it is still unable to provide effective evidence to prove the association with frailty. In addition, in the follow-up process of the intervention group in this study, there was no significant difference in the hemoglobin level of community elderly, and hemoglobin is closely related to dietary habits. Further exploration is needed with larger sample size of research data. Studies have shown that vitamin D is an important regulatory factor for muscle function, and 25-hydroxyvitamin D is the main storage form and transport form of vitamin D in the human body, with a longer half-life and more stable in the serum, being the gold standard for reflecting the level of vitamin D in the body [14]. However, the serum 25-hydroxyvitamin D level is affected by factors such as diet, outdoor activities, and exogenous supplement intake. It can be clearly observed in the study that in the control group without intervention, the 25-(OH)2D3 level of the elderly significantly decreased at the 6th month of follow-up and significantly increased at the 12th month, which may be related to the seasonal changes during the follow-up. The second follow-up was in winter, with cold weather and less sunlight, and the elderly's outdoor activity time was significantly reduced, which may lead to a decrease in the serum 25-(OH)2D3 level; conversely, the third follow-up was in summer, with abundant sunlight. Although this pattern has a limited effect on the biochemical indicators of the elderly, it cannot be denied that through intervention management, the elderly's awareness of outdoor training, healthy diet, social participation, and social support have increased.

4.3. This Intervention Model Effectively Improved the Quality of Life and Self-care Ability of Frail Elderly People

The follow-up survey results showed that at 6 months and 12 months of the intervention, the quality of life of community-dwelling elderly in the intervention group was better than that of the control group; by the 12th month, the self-care ability of the elderly in the intervention group was also superior to that of the control group. In this study, the intervention group received multi-component exercise training 2-3 times per week. The exercise prescription for this training was developed by professional exercise physicians based on the physical conditions of the frail elderly. Before the intervention, researchers who received unified training were divided into groups and conducted on-site teaching and progressive group training. Given that the elderly have poor memory, to ensure the intervention effect and improve their compliance, recorded exercise guidance videos were paired throughout the intervention process, exercise maps were distributed to each elderly person, and fully equipped exercise wristbands were provided. Previous randomized controlled trial studies [15-17] that targeted community-dwelling elderly showed that moderate exercise training for the elderly could improve muscle strength, walking ability, balance ability, and grip strength, which were consistent with the results of this study. These improvements in strength could delay or even enhance the decline in basic daily activities of the elderly with age, such as daily shopping, cooking, cleaning at home, etc., thereby effectively improving their self-care ability and quality of life.

5. Conclusions

This study focuses on the impact of the dynamic intervention model for elderly frailty constructed under the guidance of the HAPA theory on their physical and mental health. After one year of intervention follow-up, it was found that the community-based frailty intervention for the elderly from the HAPA theoretical perspective has a positive effect on their physical and mental health, improving their nutritional status, depressive symptoms, self-care ability and quality of life. However, the research results also have certain limitations, such as a short follow-up period and insignificant improvement in biochemical indicators. In the future, a more cautious attitude will be adopted to further improve the research plan and implementation process.

Abbreviations

HAPA	Health Action Process Approach

TFI	Tilburg Frailty Index
MNA- SF	Short-form Mini-Nutritional Assessment
HCG	Human Chorionic Gonadotropin
IGF-1	Insulin-like Growth Factor-1
25-(OH)2D3	Total 25-hydroxyvitamin D
ADL	Activities of Daily Living
BI	Barthel Index
EQ-5D	European Quality of Life-5 Dimensions
VAS	Visual Analogue Scale
GDS-15	15-item Geriatric Depression Scale

Author Contributions

Wang Dan: Funding acquisition, Methodology, Supervision

Yu Xingfeng: Data curation, Methodology

Zhang Yulian: Formal Analysis, Project administration

Meng Yifei: Data curation, Investigation

Su Yuting: Investigation, Writing – original draft

Niu Yaqi: Conceptualization, Writing – review & editing

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Conflicts of Interest

The author declares that there are no any conflicts of interest.

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