

A Multidisciplinary Health Belief Model Intervention Reduces Musculoskeletal Pain in Nursing Homes: A Randomized Controlled Trial

A multidisciplinary intervention informed by the Health Belief Model to ease pain in older adults

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Abstract

Introduction: Musculoskeletal pain is common among older adults, especially those in nursing homes. Effective management requires clinical interventions and behavioral changes supported by theoretical frameworks. This study evaluated the effectiveness of a multidisciplinary intervention based on the Health Belief Model in reducing pain and improving preventive health behaviors among nursing home living.

Methods: In this randomized controlled trial (parallel – group), 120 older adults in Tehran were randomly assigned to intervention or control groups. The eight-week intervention included vitamin D supplementation, physiotherapy, stress management, and HBM-based educational sessions. Outcomes were measured at baseline, immediately after the intervention, and at three- and six-month follow-ups using the Visual Analog Scale, DASS-21, and HBM-based questionnaires. Data were analyzed with ANCOVA and repeated-measures ANOVA.

Results: The intervention significantly improved all HBM constructs ($p < 0.05$), reduced six-month pain intensity (6.50 ± 1.467 vs. 7.02 ± 1.334 ; $p = 0.001$), and enhanced preventive behaviors ($p < 0.001$). Depression, anxiety, and stress also decreased, with the greatest effect on anxiety ($p < 0.001$).

Conclusion: HBM-based multidisciplinary interventions may be an effective strategy for managing musculoskeletal pain and promoting health behaviors in nursing home living.

Trial registration: IRCT20220904055881N1. Registered on 11 February 2023(11/02/2023).

<https://www.irct.ir/search/result?query=IRCT20220904055881N1>

Introduction

At the biological level, aging results from the gradual accumulation of molecular and cellular damage over time, leading to a decline in physical and cognitive capacities, physiological function, and an increased susceptibility to disease [1]. According to the United Nations, individuals aged 60 years and older are considered elderly [2]. Population aging is a global trend, and it is projected that by 2025, one in six people will be over 60 years old; furthermore, the population aged 80 years and older is expected to increase from 143 million in 2019 to 426 million by 2050 [1]. Iran is also experiencing rapid aging; according to the 2016 census, the elderly population was approximately 7,414,091 individuals [3]. This demographic shift, along with social, economic, and cultural changes, has altered family structures and increased reliance on long-term care facilities [4]. Many families, due to various constraints, are unable to provide continuous care, making the transition to nursing homes associated with psychological consequences such as reduced self-esteem, loneliness, social isolation [6], and increased stress and anxiety [7].

Aging is associated with a higher prevalence of chronic diseases, particularly musculoskeletal disorders (MSDs), which are a leading cause of disability and reduced quality of life [8]. MSDs range from acute injuries to chronic conditions and are often accompanied by pain, functional limitations, and reduced mobility [9]. Globally, approximately 1.71 billion people are affected, and MSDs are a major contributor to years lived with disability [9]. In Iran, the burden of these disorders is increasing [10].

Behavioral factors such as physical inactivity [11] and repetitive mechanical stress [12], as well as non-behavioral factors such as aging [13] and sex [14], contribute to MSDs. Pain is a key symptom [15], and older adults are particularly vulnerable [16, 17]. Contributing factors include inactivity [16], psychological stress [18], depression, and vitamin D deficiency [19]. Effective management of MSD pain in older adults is critical, as it affects function, independence, and quality of life [20–22]. Interventions include nutrition (e.g., vitamin D supplementation) [23, 24], physical activity [25], and stress management [26], but adherence is often limited due to disease characteristics and individual perceptions. Aging is associated with cognitive and perceptual changes [27], which influence understanding of pain and health behaviors; therefore, theory-based interventions are essential.

The Health Belief Model (HBM) provides a suitable framework to facilitate behavior change and adherence to pain management [28]. This model emphasizes beliefs, attitudes, and perceptions and is appropriate for preventing chronic conditions [29]. Higher self-efficacy and fewer perceived barriers are associated with greater engagement in preventive behaviors [30]; individuals with high self-efficacy manage MSD pain more effectively [31]. Studies show that perceiving the benefits of exercise promotes osteoporosis prevention [32], and HBM-based education enhances self-efficacy and preventive behaviors [33].

Globally, strategies include multidisciplinary rehabilitation programs in Germany [34, 35], NGO support in the United States [37], and public campaigns in the United Kingdom [38], although research funding is limited [36]. In Iran, routine care is available, but specialized services for MSDs are limited, and nursing homes may not meet all standards [39].

Addressing MSDs in older adults requires a multidisciplinary approach, including raising knowledge, promoting evidence-based interventions, and engaging older adults [36]. The multifactorial nature of MSDs makes multifaceted interventions essential [40]. Considering the high prevalence of MSD pain, increased vulnerability in nursing homes, and the lack of comprehensive HBM-based interventions, targeted research is needed. Most previous studies have focused on single-component interventions or community-dwelling older adults. The aim of this study was to evaluate the

effectiveness of a multidisciplinary intervention (including vitamin D supplementation, stress management, physical activity, and modification of the older adults' beliefs) in reducing musculoskeletal pain and improving preventive health behaviors in older adults living in nursing homes in Tehran.

Results

The mean age of the control group was 65.22 years, and that of the intervention group was 65.27 years. Baseline comparability between the groups was assessed using independent t-tests for continuous variables and Chi-square and Fisher's exact tests for categorical variables, revealing no significant differences and confirming initial equivalence (Table 2).

Following the intervention, the mean scores of all HBM constructs in the intervention group increased significantly ($P < 0.001$, Table 3), and these improvements were maintained and further strengthened at the 3- and 6-month follow-ups. High η^2 values indicated a strong effect of the intervention on participants' knowledge, health-related beliefs, and self-efficacy.

Regarding preventive health behaviors, no significant differences were observed at baseline ($p > 0.05$, Table 4). However, immediately post-intervention and at the 3- and 6-month follow-ups, the distribution of responses for vitamin D intake, stress management, and proper body posture differed significantly in favor of the intervention group ($p < 0.001$).

Repeated-measures ANOVA indicated that both groups experienced changes over time, but the intervention had the greatest impact on reducing anxiety. Pain intensity in the intervention group decreased progressively, with the largest between-group difference observed at the six-month follow-up (Table 5).

Overall, these findings suggest that a multicomponent intervention based on the Health Belief Model had a significant effect on improving health beliefs and behaviors, while concurrently reducing pain and anxiety among older adults.

Discussion

The present study aimed to evaluate the effectiveness of multidisciplinary interventions based on the HBM in reducing the severity of musculoskeletal pain and promoting preventive behaviors among older adults living in nursing homes. The findings indicated that these interventions effectively improved the core constructs of the HBM and reinforced three targeted health behaviors, including vitamin D supplementation, stress management, and proper postural practices.

The results showed that structured educational interventions led to a significant increase in knowledge in the intervention group, whereas no significant change was observed in the control group. The persistence of this effect at three- and six-month follow-ups demonstrates the effectiveness of the educational content and delivery methods [30, 57–62]. Knowledge, as a key construct of the HBM, plays a fundamental role in shaping attitudes and preventive behaviors [62]. Interactive educational sessions- including explanations of pain mechanisms, the importance of supplements, and correct postural practices - were particularly effective for older adults with cognitive or physical limitations [59].

Sensitivity and perceived severity of the condition in the intervention group improved significantly, consistent with previous research [30, 57, 58, 63]. Individuals are more likely to engage in detection, prevention, or treatment when they perceive themselves at risk, recognize the potential severity of consequences, and trust the effectiveness of the intervention [64–66].

Perceived benefits increased, and perceived barriers decreased significantly in the intervention group, facilitated by theoretical education combined with practical strategies, including home exercise, stress management, motivation enhancement, and positive thinking [30, 63, 69, 70]. Self-efficacy also increased significantly, in line with Karimian's findings [71], with the presence of a trained physiotherapist playing a key role in guiding exercises, providing encouragement, answering questions, and offering individualized adjustments.

Cues to action improved significantly in the intervention group, consistent with previous studies [57, 59]. Reminder tools, support from healthcare providers, and posters served as environmental cues that reinforced preventive behaviors. Vitamin D supplementation increased significantly [60, 72, 73], and stress management interventions reduced depression, anxiety, and stress [63, 75].

Proper body posture practices also improved, consistent with Eskandarinasab's findings [76], and maintaining a healthy lifestyle during older adulthood enhanced physical and psychological functioning as well as overall health [77]. The severity of musculoskeletal pain decreased significantly in the intervention group, consistent with Moradi's study [58].

These findings indicate that multicomponent interventions based on the HBM effectively improve health-related attitudes, perceptions, and behaviors among older adults while simultaneously reducing the severity of musculoskeletal pain [58, 79]. Additionally, the synergistic interaction among intervention components -including physiotherapy, physical activity, and supplementation - enhanced both physical and psychological outcomes, as the effect of each component was reinforced by the others.

Conclusion

The findings indicate that multidisciplinary interventions based on the HBM may represent an effective approach for reducing musculoskeletal pain, promoting preventive health behaviors, and enhancing the psychological and psychosomatic well-being of those living in nursing homes.

Methods

Study design and setting

This randomized controlled parallel-group trial with a 1:1 allocation ratio was designed as a superiority trial and was conducted from January to July 2024 in nursing homes in Tehran, Iran, and included older adults aged 60 years and above. Participants were randomly assigned to the intervention and control groups. The control group received no intervention and was only assessed at the same time points as the intervention group. Tehran was selected due to its ethnic and demographic diversity, which previous epidemiological studies have shown to be representative of the overall Iranian population [41, 42], thereby enhancing the generalizability of the findings at the national level. Due to budgetary and staffing constraints, neither patients nor members of the public were involved in the design, conduct, or dissemination of the study. Blinding was not implemented, as the behavioral nature of the intervention precluded the concealment of group allocation from participants, care providers, and outcome assessors. The study was conducted in accordance with the Consolidated Standards of Reporting Trials (CONSORT) guidelines to ensure methodological rigor and transparency. The trial was registered with the Iranian Registry of Clinical Trials (IRCT) under the identifier IRCT20220904055881N1, and no significant modifications were made to the protocol after the commencement of the study. The study employed a repeated-measures design across four time points: baseline, immediately post-intervention, three months post-intervention, and six months post-intervention.

Sample size

The sample size was calculated to detect a minimum clinically important difference in pain severity, based on the parameters reported by Rostami et al. [43]. Considering a 95% confidence level ($\alpha = 0.05$) and 80% power, a minimum of 55 participants per group (control and intervention) was required. Assuming a 10% dropout rate, 60 participants were recruited per group, resulting in a total sample size of 120 individuals.

Participants and Recruitment

Before the start of the study, the health education specialist met with the relevant authorities to obtain the necessary permissions from registered nursing homes in Tehran, Iran. The objectives and nature of the study were explained to the managers of the nursing homes, and after providing full explanations regarding the study's aims, implementation methods, and potential risks, written informed consent was obtained from the participants. Participants were instructed to report any adverse events or unwanted incidents to a physician immediately for evaluation. Participation in the study was entirely voluntary, and participants were informed of their right to withdraw from the study at any time without any consequences. To ensure adequate representation of the target population, Tehran was divided into four geographical clusters (north, south, east, and west). In each cluster, two nursing homes were randomly selected using a lottery method. In total, 120 participants meeting the pre-established inclusion and exclusion criteria were enrolled from the selected nursing homes. Participants were assigned to the intervention and control groups through simple randomization using a manual lottery method. Allocation concealment was carried out using sequentially numbered, opaque, sealed envelopes prepared by an independent person. Due to the nature of the intervention, blinding of participants and outcome assessors was not feasible. The participant recruitment process was conducted in accordance with CONSORT guidelines, and the flow of participants is presented in Fig. 1.

Eligibility criteria

Participants consisted of older adults residing in nursing homes in Tehran. Inclusion and exclusion criteria were determined through a detailed review of the individuals' medical records. Relevant information was extracted and verified in collaboration with the head nurse of each ward to ensure accurate assessment of participants' cognitive status, physical capacity, and medication use. Inclusion criteria were as follows: age between 60 and 70 years (this age range was selected considering the nature of the intervention, which involved multiple physical activities, to ensure that participants possessed sufficient physical capacity to engage in the intervention), residency in nursing homes in Tehran, presence of musculoskeletal pain based on self-report or clinical diagnosis, ability to perform physical activity exercises (such as stretching and walking) as assessed by a physiotherapist, adequate cognitive function to comprehend and respond to study questionnaires (Mini-Cog score ≥ 3) [44], and provision of written informed consent. Individuals meeting the inclusion criteria were randomly assigned to the intervention and control groups.

Exclusion criteria included diagnosis of Alzheimer's disease or other forms of dementia, severe mobility limitations preventing participation in physical activity, use of prescribed analgesic medications, or any medical condition contraindicating participation in the study interventions (such as severe cardiovascular or respiratory disease), as determined by a physician.

Development of Educational Content

Prior to the implementation of the educational content, an expert panel comprising health education specialists, general practitioners, physiotherapists, and psychologists reviewed the materials to ensure that they were clear, understandable, and appropriate for the nursing home context. Subsequently, the educational content was revised and tailored using the ASSURE model to address the specific needs of the target population.

The educational materials were developed based on the Instructional System Design (ISD) model, specifically utilizing the ASSURE framework [45–47], to promote preventive behaviors against musculoskeletal pain in accordance with the HBM. The ASSURE framework consists of six steps:

1. **Analyze Learners:** The research team (physician, physiotherapist, psychologist, and health education specialist) examined participants' characteristics, including gender, age, literacy level, cultural background, and living conditions in the nursing homes, in order to tailor the educational content to their specific needs.
2. **State Standards and Objectives:** Behavioral objectives were established across the seven constructs of the HBM (knowledge, perceived sensitivity, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy), as summarized in Table 1. It was hypothesized that participants in the intervention group would demonstrate significant improvements in these constructs compared to the control group following the intervention.
3. **Select Strategies, Technology, Media, and Materials:** Considering the resources available in the nursing homes and the participants' limited access to technology, educational strategies included group discussions, question-and-answer sessions, and the use of printed materials such as posters and illustrative images.
4. **Use Technology, Media, and Materials:** The educational materials were pilot-tested with participants to ensure clarity, comprehensibility, and motivational appeal, thereby enhancing their engagement.
5. **Require Learner Participation:** Participants performed multiple physical activities under supervision to ensure correct exercise techniques and to reinforce active learning.
6. **Evaluation and revision:** The educational content, its implementation process, and participant outcomes were evaluated, and necessary revisions were made to address any identified issues.

Instrument

These data were collected using three validated instruments: a self-developed HBM-based questionnaire, the Visual Analog Scale (VAS) for pain assessment, and the Depression, Anxiety, and Stress Scale (DASS-21).

HBM-Based Questionnaire

This instrument was used to develop a self-designed questionnaire aimed at assessing HBM constructs related to musculoskeletal pain in older adults. The original questionnaire consisted of 61 items, which were reduced to 50 items following pilot testing and expert feedback. The final version of the questionnaire comprised three sections: Demographics (8 items), Health-related behaviors (3 items scored on a 5-point Likert scale ranging from 1 = never to 5 = always), and HBM constructs (39 items across seven domains: knowledge [4 items], perceived sensitivity [3 items], perceived severity [6 items], perceived benefits [5 items], perceived barriers [10 items], cues to action [5 items], and self-efficacy [6 items], all scored on a 5-point Likert scale from 1 = strongly disagree to 5 = strongly agree). To develop the questionnaire, a keyword search was conducted using the terms "pain," "musculoskeletal disorders," and "elderly." Since no standardized HBM-based tool for musculoskeletal disorders in older adults was available, the questionnaire was derived from studies that examined HBM constructs in related areas. Content validity was confirmed through review by a panel of 10 experts (health education specialists, general practitioners, and physiotherapists), leading to the revision or removal of 22 items. Construct validity was established via exploratory factor analysis (EFA) on 260 eligible older adults between May and July 2023. The Kaiser-Meyer-Olkin (KMO) measure was 0.823, indicating an adequate sample size, and seven factors aligned with HBM constructs were identified, explaining 59% of the variance. Reliability was confirmed with a Cronbach's alpha of 0.87, exceeding the acceptable threshold.

Visual Analog Scale (VAS)

A visual analog scale (VAS) for measuring pain [48]. A pain scale is a tool that doctors use to help assess a patient's pain level. A person usually self-reports pain using a specially designed scale, sometimes with the help of a doctor, parent, or guardian. The Visual Analogue Scale (VAS) is a pain ruler that includes a horizontal line graded from 0 to 10, where 0 indicates complete painlessness and 10 indicates unbearable pain. At one end is 'no pain' and at the other end is 'the worst pain' or 'indescribable pain'. The person puts a cross X on the line to indicate the intensity of their pain. A doctor then measured the line with a ruler to obtain a pain score. The validity and reliability of this instrument have been confirmed in Iran [49].

The Depression, Anxiety, and Stress Scale (DASS-21)

The Depression, Anxiety, and Stress Scale (DASS-21) was used to assess depression and stress. This questionnaire consists of 21 items, with 7 items for each subscale. The depression subscale includes items that measure low mood, lack of self-confidence, hopelessness, feelings of

worthlessness, disinterest in activities, loss of enjoyment in life, low energy, and a sense of incapacity. The anxiety subscale contains items aimed at assessing physiological arousal, fears, and situational anxiety, while the stress subscale includes items such as difficulty relaxing, nervous tension, irritability, and restlessness [50]. In a study conducted in Iran in the field of psychology, the Cronbach's alpha for this questionnaire was reported as 0.86, indicating acceptable reliability of the instrument among Iranians [51].

Intervention

This randomized controlled trial (RCT), conducted from January to February 2024 (8 weeks), evaluated an 8-week multicomponent intervention based on the HBM aimed at improving musculoskeletal pain-reducing behaviors among elderly individuals living in nursing homes in Tehran, Iran. The intervention group received a structured program delivered by an interdisciplinary team consisting of a general practitioner, physiotherapist, psychologist, and health education specialist, all of whom had appropriate professional qualifications and clinical experience in elderly care. The control group received standard nursing home care without the intervention. The intervention integrated physical, nutritional, psychological, and educational components to manage musculoskeletal pain and targeted HBM constructs, including knowledge, perceived sensitivity, perceived severity, perceived benefits, perceived barriers, cues to action, and self-efficacy. The program was designed to remove perceptual barriers and promote long-term health behaviors in a resource-limited setting. Data were collected using three validated instruments: an HBM-based questionnaire, the Visual Analog Scale (VAS), and the Depression Anxiety Stress Scales (DASS-21).

Outcomes were measured at four time points: T0 (pre-intervention), T1 (post-intervention), T2 (3 months after the intervention), and T3 (6 months after the intervention).

Vitamin D intake: The physician delivered a one-hour lecture on the benefits of vitamin D supplementation and proper administration. During the session, the physician addressed questions from the elderly. Each participant received a daily dose of 600–800 international units of vitamin D tablets [52] for six months. One of the nursing home staff members was responsible for administering the tablets daily to the elderly individuals living in the nursing home. The physician was also required to respond to any questions from the elderly throughout the intervention period. Vitamin D supplementation does not have significant interactions with common medications; therefore, participants were allowed to continue their usual treatments during the study period, except for medications used to relieve musculoskeletal pain.

Physiotherapy: This component included daily walking and stretching exercises aimed at improving the elderly's walking ability and reducing musculoskeletal pain. Physical activity involved at least 30 minutes of daily walking and maintaining proper body posture during routine activities. Walking was performed on a smooth, flat surface within the nursing home for 30 minutes. Proper body posture refers to the alignment of different joints in relation to each other, as the position of each joint affects the others. An optimal joint position minimizes pressure on the joints and keeps muscle activity at a minimum [53]. Proper body posture encompasses correct joint positioning while standing, walking, sitting, and sleeping, with minimal stress applied to support muscles, joints, and ligaments. The sessions were conducted over 8 weeks, with three one-hour sessions per week to maintain the physical condition of the elderly [54]. Educational methods used in these sessions included lectures, practical demonstrations, role modeling, posters, and images to provide both visual and hands-on learning opportunities for the participants. The interventions included training on maintaining proper body posture during daily activities, stretching exercises to prevent injuries and falls, stretching to strengthen the leg muscles, exercises to improve balance while walking, and appropriate stretches to enhance muscle strength and reduce musculoskeletal disorders [55].

Psychological sessions were conducted by a psychologist. Based on the available conditions and resources, stress and depression reduction sessions were organized so that all elderly participants could benefit. These sessions included increasing awareness about anxiety, stress, depression, and their symptoms, identifying dietary triggers that may contribute to these conditions, practicing deep breathing, improving sleep quality, fostering effective communication with friends, listening to music, emphasizing the importance of daily routines, and encouraging participation in daily activities. The sessions also focused on managing negative thoughts through positive self-talk, engaging in group activities and social interaction with peers at the nursing home, and maintaining communication with family members. The psychologist conducted these sessions over 8 weeks, with 2 sessions per week, each lasting 90 minutes [56]. Training in the nursing home was carried out as group discussions with proper instruction in relevant techniques.

In all sessions, the role of the health education specialist was highly central and can be considered the cornerstone of the intervention, as the primary aim was to modify perceptions and correct misconceptions among the elderly as an essential prerequisite for the adoption of preventive behaviors and the promotion of health. The training sessions were conducted by this specialist, who attended all intervention sessions to ensure that the beliefs and perceptions of the elderly were effectively influenced. The main objectives of the training were to clarify misunderstandings, reinforce accurate health beliefs, and enhance the HBM constructs, including perceived benefits, self-efficacy, perceived sensitivity, and perceived severity, thereby reducing perceived barriers and facilitating the implementation of preventive behaviors. By guiding the learning process, correcting attitudes, and providing clear and comprehensible explanations, the health education specialist created a foundation for cognitive change and belief restructuring, playing a key role in motivating participants, increasing self-efficacy, and strengthening adherence to health-promoting behaviors.

Participants' attendance in the intervention sessions was regularly recorded and monitored by the research team. During the intervention period, the research team directly supervised the participants' exercises. Following the completion of the exercise sessions and during the three- and six-month

follow-ups, two nursing home staff members were responsible for reminding the elderly to perform the exercises and correcting any misconceptions, given the potential for participants to forget the instructions. Posters and educational images were also provided to the elderly to reinforce adherence to the exercises. In this program, the health education specialist played a central and coordinating role alongside the physician, physiotherapist, and psychologist. Their presence at the nursing home every ten days not only provided educational guidance but also directed the process of correcting beliefs, enhancing self-efficacy, and translating clinical recommendations into sustainable health behaviors. Adverse events included any potential side effects resulting from the interventions, such as gastrointestinal reactions to vitamin D supplementation or exercise-related injuries. Non-systematic monitoring of these events was conducted through participant self-reports to the study physician throughout the intervention period.

Collected data were recorded and stored in a secure database. Access to the data was limited to members of the research team, and regular backups were performed to ensure data security and integrity.

Data analysis

All data were analyzed using IBM SPSS Statistics, version 25. First, baseline comparability of demographic and clinical variables between the intervention and control groups was assessed using independent t-tests for continuous variables and Chi-square tests for categorical variables, after confirming normality of data with the Shapiro- Wilk test. To examine the effect of the intervention on pain severity and the constructs of the HBM, analysis of covariance (ANCOVA) was performed. The intervention/control group was included as a fixed factor, and baseline values (T0) were entered as covariates. Effect sizes (η^2) were calculated to quantify the magnitude of the intervention effects. Bonferroni correction was applied to control for type I error due to multiple comparisons among HBM constructs. Considering the repeated-measures design, changes in pain scores as well as depression, anxiety, and stress over time were analyzed using repeated measures ANOVA, with η^2 reported as effect sizes. Between-group comparisons at each time point were conducted using independent t-tests, and Bonferroni correction was applied to control for multiple testing. Where possible, exact p-values were reported, and a significance level of $p < 0.05$ was considered for all analyses. This approach allowed for the assessment of the true effect of the intervention while controlling for baseline differences, increasing the statistical power of the analysis and ensuring robust interpretation of results.

Ethical considerations

Ethical approval for this study was obtained from the Research Council of Tarbiat Modares University under reference number IR.MODARES.REC.1401.111, and it was also approved by the Iranian Registry of Clinical Trials for conducting this clinical trial. Prior to participation, all participants provided written informed consent after receiving detailed verbal and written explanations regarding the study's objectives, procedures, and potential benefits. Study materials, including the questionnaire and consent form, were also approved by the university's ethics committee. The study will be conducted in accordance with the Declaration of Helsinki.

Recommendation for practice

Considering the cognitive changes that occur during aging, interventions based on the HBM can serve as particularly effective tools for the prevention of chronic diseases and the management of multimodal pain associated with musculoskeletal issues in older adults living in nursing homes. By addressing perceptual and cognitive barriers and tailoring programs to the cognitive capacities of older adults, these interventions are effective in promoting preventive behaviors related to musculoskeletal pain and can contribute to improving quality of life and enhancing independence among older adults in care settings.

Strengths

One of the main strengths of this study is the adoption of a multidisciplinary approach rather than focusing on a single component (such as education alone). This integrated approach significantly enhanced the impact of the intervention and produced more durable and long-lasting outcomes. In addition, the use of the HBM, one of the well-recognized and widely applied models in health behavior change, provided the study with theoretical coherence, logical reasoning, and high explanatory power in assessing preventive and pain-management behaviors. Another important strength is the direct focus on older adults living in nursing homes, a vulnerable group that is often overlooked in health policy. This focus can help draw policymakers' and healthcare providers' attention to this underserved population and support the improvement of care services and planning tailored to their needs.

Limitations

Several limitations should be considered. First, the study population was limited to nursing home residents, which may restrict the generalizability of the findings to community-dwelling older adults. Second, reliance on self-reported measures may introduce reporting bias. Third, certain environmental and lifestyle variables could not be fully controlled. Future research could benefit from longer follow-up periods, objective behavioral assessments, and investigation of the mediating mechanisms underlying the intervention effects.

Suggestion

Future research is recommended to employ a qualitative study design in order to identify the factors and barriers influencing behaviors, allowing for broader conclusions to be drawn from the existing beliefs and obstacles faced by older adults living in nursing homes. Additionally, future studies can examine environmental determinants and health policies that directly affect behavior. Furthermore, focusing on all factors that contribute to pain can be a vital step in improving the quality of life of this population.

Abbreviations

MSD: Musculoskeletal diseases

HBM: Health belief model

RCT: Randomized controlled trial

CONSORT: Consolidated Standards of Reporting Trials

VAS: Visual analog scale

DASS: Depression, Anxiety, and Stress Scale

EFA: Exploratory factor analysis

KMO: Kaiser-Meyer-Olkin

Declarations

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Authors' contribution

SH was the main investigator. SST was the study supervisor. SST and SH designed the study and contributed to all aspects of the study. RM helped in data collection. AM was the study advisor, analyzed the data, responded to reviewers' comments, and provided the final draft. All authors contributed to the writing process and approved the final version.

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Competing interests

The authors declare no competing interests.

Availability of data and materials.

All the data collected and/or processed during the current study are released within the paper. The HBM-based questionnaire, Visual Analog Scale (VAS), Depression, Anxiety, and Stress Scale (DASS-21), and consent forms are available from the corresponding author upon request (tavafian@modares.ac.ir). De-identified participant data, the data dictionary, and statistical code (SPSS scripts) are not publicly available due to ethical limitations but can be obtained from the corresponding author, subject to Tarbiat Modares University Ethics Committee approval. The statistical analysis plan and the complete trial protocol are registered at the Iranian Registry of Clinical Trials (IRCT) with registration number IRCT20220904055881N1 at <https://www.irct.ir/search/result?query=IRCT20220904055881N1>.

Ethics approval and consent to participate

We confirm that all methods described in this study were performed in accordance with the relevant guidelines and regulations, including the Declaration of Helsinki. This study has received ethical approval from the Ethics Committee of Tarbiat Modares University (IR. MODARES. REC.1401.111) it was registered with the Iranian Clinical Trial Registration (IRCT20220904055881N1). An informed consent from completed all study participants.

Consent for publication

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References

1. World Health Organization. *Ageing and health* (World Health Organization, 2024). <https://www.who.int/news-room/fact-sheets/detail/ageing-and-health>
2. United Nations High Commissioner for Refugees. Older persons <https://emergency.unhcr.org/protection/persons-risk/older-persons> (2025).
3. Statistical Center of Iran. *National Population and Housing Census 2016: Selected Findings* (SCI, 2017).
4. Qadmpur, E., Karami, A. & Khodarahimi, S. Comparison of spiritual well-being, ambiguity tolerance, and happiness in elderly people living in homes and nursing homes. *J Med. Ethics*. **13**, 1–13 (2019).
5. Zhao, D. et al. Experiences of family caregivers and nursing home staff interactions during the adaptation process of elderly individuals moving to nursing homes: a qualitative study. *J BMJ Open*. **14**, e084138 (2024).
6. Sabzichy, S., Bahari, F. & Hamidipour, R. The effect of group forgiveness training on intimacy and feeling loneliness among the elderly in nursing homes. *J Posit. Psychol. Res*. **3**, 77–91 (2017).
7. Naderi, L. & Parandan, S. H. Prediction of vulnerability to stress based on personality traits, locus of control, social support and resilience of elderly residents in Kermanshah nursing home. *J Chapters Psychol. Res*. **14**, 75–91 (2023).
8. Centers for Disease Control and Prevention. Musculoskeletal disorders among aircrew. Atlanta (GA): CDC (2017). <https://www.cdc.gov/niosh/topics/aircrew/musculoskeletaldisorders.html>
9. World Health Organization. Musculoskeletal conditions Geneva: World Health Organization <https://> (2021).
10. Shahrezaee, M. et al. Burden of musculoskeletal disorders in Iran during 1990–2017: estimates from the Global Burden of Disease Study 2017. *J Arch. Osteoporos*. **15**, 103 (2020).
11. Avidos, L., Reis, A., Fernandes, F. & Quialheiro, A. Immobility syndrome – consequences of lower limb unloading: a systematic literature review. *J Geriatr. Gerontol*. **9**, 202 (2020).
12. Gonçalves, H. et al. Assessment of work-related musculoskeletal disorders by observational methods in repetitive tasks - a systematic review. *J Occup. Environ. Saf. Health III*. **13**, 455–453 (2021).
13. Chen, X., Chen, K. & Zou, J. Exercise for age-related musculoskeletal disorders. *J Front. Public. Health*. **11**, 1337093 (2023).
14. Hashemi Habybabady, R. et al. Investigating occupational and personal factors effective in causing musculoskeletal disorders in the personnel of one of the hospitals in Zahedan city. *J TB*. **23**, 50–65 (2024).
15. Global Alliance for Musculoskeletal Health. Key facts and figures (2023). <https://gmusc.com/key-facts-and-figures/>
16. de Oliveira, B. D. N. et al. Musculoskeletal pain in elderly in a city in southern Brazil: prevalence and associated factors. *J Res. Soc. Dev*. **10**, e25210716532 (2021).
17. Shamsi, M., Safari, A., Samadzadeh, S. & Yoosefpour, N. The prevalence of musculoskeletal pain among the above 50-year-old population referred to the Kermanshah-Iran health bus in 2016. *J BMC Res. Notes*. **13**, 72 (2020).
18. Moerkerke, M. et al. A comprehensive mapping of stress system interactions with pain and their contribution to chronification of musculoskeletal pain: protocol of the STRAIN study. *J PLoS One*. **20**, e0324089 (2025).
19. Alonso-Pérez, J. L. et al. Relationship between serum vitamin D levels and chronic musculoskeletal pain in adults: a systematic review. *J Nutrients*. **16**, 4061 (2024).
20. Imagama, S. et al. Shoulder pain has the most impact on poor quality of life among various types of musculoskeletal pain in middle-aged and elderly people: Yakumo study. *J Mod. Rheumatol*. **30**, 568–572 (2020).
21. Jeong, H. & Lee, Y. Sex-based differences in the quality of life of elderly Koreans with chronic musculoskeletal pain. *J Environ. Res. Public. Health*. **17**, 743 (2020).
22. Şahin, N., Devrimsel, G., Karahan, A. Y. & Sargin, S. The effects and characteristics of musculoskeletal pain on quality of life in geriatric patients. *J Eur. J. Geriatr. Gerontol*. **2**, 13–17 (2020).
23. Ali, M., Uddin, Z. & Hossain, A. Combined effect of vitamin D supplementation and physiotherapy on reducing pain among adult patients with musculoskeletal disorders: a quasi-experimental clinical trial. *J Front. Nutr*. **8**, 717473 (2021).
24. Tartibian, B., Fasihi, L. & Eslami, R. Association between serum vitamin D and femoral bone mineral density in active and inactive elderly women. *J Q. J. Casp. Health Aging* (2021). 6,11 – 9.
25. Ayegboyin, M. & Salami, K. K. Social dimensions of musculoskeletal pain experiences among the elderly in southwestern Nigeria. *J Health* (2019). 11,953 – 70.
26. Bernier Carney, K. M., Young, E. E., Guite, J. W. & Starkweather, A. R. A systematic review of biological mechanisms and chronic pain outcomes during stress reduction interventions. *J Biol. Res. Nurs*. **22**, 205–216 (2020).

27. Getzmann, S. et al. Cognitive aging at work and in daily life: a narrative review on challenges due to age-related changes in central cognitive functions. *J Front. Psychol.* **14**, 1232344 (2023).
28. Glanz, K., Rimer, B. K. & Viswanath, K. *Theory, Research, and Practice in Health Behavior and Health Education* (Jossey-Bass, 2015).
29. Jorvand, R., Ghofranipour, F., Haeri Mehrizi, A. & Tavousi, M. Evaluating the impact of HBM-based education on exercise among health care workers: the usage of mobile applications in Iran. *J BMC Public. Health.* **20**, 546 (2020).
30. Norozi, E., Nazari, F. & Moodi, M. The effect of educational intervention based on the health belief model on osteoarthritis-preventive behaviors in middle-aged women. *J Educ. Health Promot.* **9**, 327 (2020).
31. Martinez-Calderon, J., Flores-Cortes, M., Morales-Asencio, J. M. & Luque-Suarez, A. Which psychological factors are involved in the onset and/or persistence of musculoskeletal pain? An umbrella review of systematic reviews and meta-analyses of prospective cohort studies. *J Clin. J. Pain.* **36**, 626–637 (2020).
32. Elesawy, M. F., Gawad, S. F. E. & Ahmed, S. H. Effect of educational program regarding prevention of osteoporosis among employees women at South Valley University. *J Egypt. J. Health Care.* **12**, 1104–1114 (2021).
33. Rezaei, M. et al. The effect of osteoporosis prevention empowerment program on the self-efficacy of Iranian older adults. *J Client Cent. Nurs. Care.* **5**, 53–62 (2019).
34. Salathé, C. R. et al. Treatment efficacy, clinical utility, and cost-effectiveness of multidisciplinary biopsychosocial rehabilitation treatments for persistent low back pain: a systematic review. *J Global Spine.* **8**, 872–886 (2018).
35. Foster, N. E. et al. Prevention and treatment of low back pain: evidence, challenges, and promising directions. *J Lancet.* **391**, 2368–2383 (2018).
36. Lewis, R. et al. Strategies for optimizing musculoskeletal health in the 21st century. *J BMC Musculoskelet. Disord.* **20**, 164 (2019).
37. Arthritis Foundation. About Arthritis <https://> (2026).
38. Arthritis Foundation, Arthritis Research UK/Versus Arthritis. Musculoskeletal health – a public health approach (2026). <https://www.versusarthritis.org/policy/policyreports/musculoskeletal-health>
39. Nasiri, M. et al. Compliance to universal design criteria in nursing homes of Tehran. *J Iran. J. Ageing.* **11**, 340–347 (2016).
40. Habibi, S., Tavafian, S. S., Maghbouli, R. & Montazeri, A. The effectiveness of multidisciplinary interventions based on health belief model on musculoskeletal pain in the elderly living in nursing homes: a study protocol for a randomized controlled trial. *J Trials.* **25**, 406 (2024).
41. Montazeri, A., Goshtasebi, A., Vahdaninia, M. & Gandek, B. The Short Form Health Survey (SF-36): translation and validation study of the Iranian version. *J Qual. Life Res.* **14**, 875–882 (2005).
42. Montazeri, A., Goshtasebi, A. & Vahdaninia, M. Educational inequalities in self-reported health in a general Iranian population. *J BMC Res. Notes.* **1**, 50 (2008).
43. Goli Rostami, Z., Tavafan, S. & Dolatshahi, E. Comparison of effects of different educational programs on vitamin D levels of middle-aged women. *J IJMPP.* **3**, 57–61 (2018).
44. Borson, S. et al. The mini-cog: a cognitive 'vital signs' measure for dementia screening in multi-lingual elderly. *J Int. J. Geriatr. Psychiatry.* **15**, 1021–1027 (2000).
45. Heinich, R., Molenda, M., Russell, J. D. & Smaldino, S. *Instructional Media and Technologies for Learning* 6th edn (Upper Saddle River (NJ) (Prentice Hall, 1999).
46. Shelly, G. B., Gunter, G. A. & Gunter, R. E. *Teachers discovering computers: integrating technology in a connected world.* (7th ed. Boston) (Cengage Learn. (2012).
47. Smaldino, S. E., Lowther, D. L., Russell, J. D. & Mims, C. *Instructional Technology and Media for Learning* 10th edn (Pearson, 2015).
48. Begum, M. R. & Hossain, M. A. Validity and reliability of visual analog scale (VAS) for pain measurement. *J Med. Case Rep. Rev.* **2**, 394–402 (2019).
49. Rezvani, A. M., Sirati Neir, M., Ebadi, A. & Moradian, S. T. Correlation of the visual analog scale for pain assessment with the short-form McGill pain questionnaire in patients with chronic low back pain. *J Qom Univ. Med. Sci.* **1**, 31–34 (2012).
50. Lovibond, S. H. *Manual for the Depression Anxiety Stress Scales* 2nd edn (Psychology Foundation of Australia, 1995).
51. Sharifirad, G., Ghaffari, M., Zanjani, S. & Hassanzadeh, A. The effectiveness of educational intervention based on the PRECEDE model on the level of stress among the elderly at elderly clubs. *J Educ. Health Promot.* **2**, 3 (2013).
52. Chang, S. W. & Lee, H. C. Vitamin D and health-the missing vitamin in humans. *J Pediatr. Neonatol.* **60**, 237–244 (2019).
53. Sedaghati, P., Zolghade, H. & Daneshmandi, H. Postural control status about anthropometric and postural indices of active people. *J Sport Biomechan.* **15**, 50–60 (2019).
54. Mahmoudi, F., Shahrjerdi, S. & Golpayegani, M. Changes in pain and kyphosis angle following a corrective exercise program in elderly women: a randomized controlled trial. *J JRUMS.* **15**, 849–860 (2017).
55. Ahadi, M. et al. *Rehabilitation in Older Adults: Lifestyle Modification: A Guide for the Elderly, Healthy and Active Aging.* (Iran Publisher if known 2023).

56. Toroghi, H. & Masoudi, S. The effectiveness of acceptance and commitment therapy on the reduction of perceived stress in the elderly affected by chronic pain. *J Aging Psychol.* **5**, 1–11 (2019).
57. Elryes, A. et al. Effect of applying Health Belief Model on osteoarthritis preventive behaviors in middle-aged women. *J Port Said Sci. J. Nurs.* **10**, 254–280 (2023).
58. Moradi, Z., Tavafian, S. S. & Kazemi, S. S. Educational intervention program based on health belief model and neck pain prevention behaviors in school teachers in Tehran. *J BMC Public. Health.* **22**, 1501 (2022).
59. Abdel-Sattar, S. A., Sarhan, A. E., Eiz-Elregal, F. A. & El Sayed, H. A. Knowledge and behavior of Saudi women regarding osteoporosis prevention based on the health belief model. *J Med. Sci.* **24**, 2739–2751 (2020).
60. Ghoreishi, M. S., Peyman, N. & Abusalehi, A. The effect of educational intervention based on the Health Belief Model on using vitamin D supplements among female high school students in Mashhad. *J Health Dev.* **8**, 59–71 (2019).
61. Fongsri, U., Rawiworrakul, T., Kaewboonchoo, O. & Kolladarungkri, T. Effects of a self-efficacy promoting program for low back pain prevention in patient transfer workers at a university hospital in Bangkok. *J Asia Pac.* **2**, 47–53 (2011).
62. Hosking, S. M., Dobbins, A. G., Pasco, J. A. & Brennan, S. L. Knowledge change regarding osteoporosis prevention: translating recommended guidelines into user-friendly messages within a community forum. *J BMC Res. Notes.* **8**, 1–5 (2015).
63. Khazar, N., Jalili, Z. & Nazary manesh, L. The effect of educational intervention based on health belief model on nurses' stress management in intensive care units. *J Iran. J. Health Educ. Health Promot.* **7**, 300–311 (2020).
64. Vaezi, M. The effect of educational interventions based on Health Belief Model in adopting preventive behaviors of musculoskeletal problems in female Afghan health workers. *J Int. J. Musculoskelet. Pain Prev.* **1**, 137–142 (2016).
65. Soleymanian, A. et al. Development and validation of a health belief model-based instrument for measuring factors influencing exercise behaviors to prevent osteoporosis in pre-menopausal women (HOPE). *J BMC Musculoskelet. Disord.* **15**, 61 (2014).
66. Weinberg, R. S. & Gould, D. *Foundations of Sport and Exercise Psychology.* (Champaign (IL)) (Human Kinetics 2023).
67. Sanaei Nasab, H. et al. The effect of educational intervention with the health belief model on knowledge, perceptions and self-efficacy among adolescent high school girls about osteoporosis, Tehran, Iran 2010–2011. *J Urmia Univ. Med. Sci.* **24**, 163–169 (2013).
68. Torshizi, L. et al. The effect of education based on health belief model on preventive factors of osteoporosis among postmenopausal women. *J Iran. J. Nurs.* **22**, 71–82 (2009).
69. Mann, E. G., Johnson, A., VanDenKerkhof, E. G. & Tranmer, J. E. What are the barriers and facilitators for the self-management of chronic pain with and without neuropathic characteristics? *J Pain Manag Nurs.* **18**, 295–308 (2017).
70. Tomé-Pires, C. et al. Perceived barriers, facilitators and usefulness of a psychoeducational intervention for individuals with chronic musculoskeletal pain and depression in primary care. *J Front. Psychol.* **14**, 1099419 (2023).
71. Karimiankakolaki, Z. et al. Effect of education using virtual social networks on promoting women's self-efficacy in preventing osteoporosis. *J Educ. Community Health.* **5**, 57–62 (2018).
72. Giustina, A. et al. Vitamin D in the older population: a consensus statement. *J Endocr.* **79**, 31–44 (2023).
73. Albasheer, O. et al. Effects of vitamin D supplementation on symptoms and clinical outcomes in adults with different baseline vitamin D levels: an interventional study. *J Health Popul. Nutr.* **44**, 176 (2025).
74. Park, K. S. et al. Education and exercise program improves osteoporosis knowledge and changes calcium and vitamin D dietary intake in community-dwelling elderly. *J BMC Public. Health.* **17**, 966 (2017).
75. Leung, D. K. et al. Nonpharmacological interventions for chronic pain in older adults: a systematic review and meta-analysis. *J Gerontologist.* **64**, gnae010 (2024).
76. Eskandari Nasab, N. et al. Investigating the effect of posture correction on the amount of musculoskeletal pain of patient carriers in Bahoner Hospital. *Kerman J Tkj.* **16**, 90–96 (2024).
77. Niama, A. M. & Naji, A. B. Using the health belief model to predict the self-efficacy of physical activity among older adults at geriatric care home. *J Teikyo Med.* **45**, 4983–4990 (2022).
78. El-Tallawy, S. N. et al. Management of musculoskeletal pain: an update with emphasis on chronic musculoskeletal pain. *J Pain Ther.* **10**, 181–209 (2021).
79. Luo, E. Self-management behavior analysis of chronic pain patients based on the theory of health belief model: an empirical study in Chengdu [dissertation]. Macau: University of Macau) (. (2020).

Tables

Table 1. The Performance Objectives based on the constructs of the health belief model, based on the results of the exploratory factor analysis, are as follows:

Construct	Performance Objectives	Teaching methods and materials	Intervention
Cues to action	Increasing older adults' responsiveness to factors and cues that trigger activities aimed at reducing musculoskeletal pain.	question and answer, Using reminders such as posters and photos	Creating beliefs and using reminders to engage the elderly in performing behaviors.
Perceived Barriers	Reducing factors that the elderly perceive as barriers to performing behaviors that alleviate musculoskeletal pain.	question and answer, poster, and photo	Removing barriers and correcting misconceptions in the elderly.
Perceived Severity	Increasing the elderly's understanding of the severity of musculoskeletal pain, its consequences, and resulting disability.	question and answer, poster, and photo	Creating awareness of the negative consequences of pain for the elderly (reduced quality of life, decreased mobility, and lowered individual productivity), presenting the adverse outcomes for the elderly, and providing statistics on musculoskeletal pain in older adults.
Self-Efficacy	Creating the elderly's belief and confidence that they are capable of performing the behavior, as well as encouraging and motivating them while performing the desired behavior.	Role-playing, performing movements from simple to complex, posters, and photos.	Using role models for the elderly and reducing stress to perform new behaviors, as well as encouraging and motivating this group to engage in the behavior.
Knowledge	Increasing the elderly's awareness of the causes of musculoskeletal pain and ways to alleviate it.	Group discussion, question and answer, poster, and photo	Discussion and question-and-answer sessions to inform the elderly about the causes of pain and methods for reducing musculoskeletal pain.
Perceived Benefits	Creating beliefs about the benefits of performing pain-reducing behaviors.	question and answer, poster, and photo	Discussion on the positive outcomes of performing the behavior and building the elderly's belief in the benefits of performing it.
Perceived Sensitivity	Creating awareness in elderly individuals with musculoskeletal pain regarding the impact of pain on their quality of life.	question and answer, poster, and photo	Creating awareness in elderly individuals that they are consistently at risk of musculoskeletal problems and the associated pain, and that due to their age, they are more susceptible to these conditions.

Table 2. Comparison of the socio-demographic characteristics of the elderly between the two groups

variables		Control group(n=60)	Intervention group(n=60)	Total (n=120)	P
		Mean±SD	Mean ±SD	Mean ±SD	
Age		65.22±2.78	65.27±2.68	65.24±2.71	0.920*
BMI		25.93±4.53	25.34±4.09	25.64±4.31	0.455*
		N (%)			
Education	Primary	35(58.33)	45(75)	80(66.67)	0.146**
	Secondary	21(35)	12(20)	33(27.5)	
	Higher	4(6.67)	3(5)	7(5.83)	
Job	Employee	8(13.33)	5(8.33)	13(10.83)	0.564**
	Worker	1(1.67)	3(5)	4(3.33)	
	Housewife	25(41.67)	24(40)	49(40.84)	
	Nurse	0(0)	1(1.67)	1(0.83)	
	Teacher	3(5)	1(1.67)	4(3.33)	
	Other job	23(38.33)	26(43.33)	49(40.84)	
Gender	Famale	29(48.33)	27(45)	56(46.7)	0.714**
	Male	31(51.67)	33(55)	64(53.3)	
Illness	Diabetes	9(15)	10(16.67)	19(15.84)	0.073**
	High blood pressure	8(13.33)	2(3.34)	10(8.33)	
	Blood fat	3(5)	0(0)	3(2.5)	
	Cancer	0(0)	1(1.67)	1(0.83)	
	Heart disease	2(3.34)	4(6.66)	6(5)	
	Other disease	8(13.33)	4(6.66)	12(10)	
	No disease	30(50)	39(65)	69(57.5)	

* Independent t-test

** Chi-square test

Table3. Health Belief Model Scores before and after the intervention in the intervention and control groups

Variable	Time	Group		Difference of mean	P
		Control Mean $\pm$ SD	Intervention Mean $\pm$ SD		
Knowledge	Pre-test	13.23 $\pm$ 2.801	14.07 $\pm$ 1.528	0.84	0.045*
	Immediately after the intervention	13.48 $\pm$ 2.740	16.03 $\pm$ 1.057	2.55	<0.001 $\eta^2=0.686^{**}$
	3 months after the intervention	13.18 $\pm$ 2.626	17.67 $\pm$ 0.816	4.49	<0.001 $\eta^2=0.830^{**}$
	6 months after the intervention	12.87 $\pm$ 2.620	18.97 $\pm$ 0.736	6.10	<0.001 $\eta^2=0.955^{**}$
Perceived Sensitivity	Pre-test	10.63 $\pm$ 1.353	11.27 $\pm$ 1.233	0.64	0.008*
	Immediately after the intervention	10.85 $\pm$ 1.388	13.70 $\pm$ 1.381	2.85	<0.001 $\eta^2=0.794^{**}$
	3 months after the intervention	10.73 $\pm$ 1.260	13.93 $\pm$ 1.205	3.20	<0.001 $\eta^2=0.541^{**}$
	6 months after the intervention	10.47 $\pm$ 1.214	14.07 $\pm$ 1.103	3.60	<0.001 $\eta^2=0.655^{**}$
Perceived Severity	Pre-test	22.02 $\pm$ 2.954	22.27 $\pm$ 3.102	0.25	0.652*
	Immediately after the intervention	21.02 $\pm$ 2.795	25.03 $\pm$ 2.712	4.01	<0.001 $\eta^2=0.719^{**}$
	3 months after the intervention	21.63 $\pm$ 3.565	28.27 $\pm$ 2.881	6.64	<0.001 $\eta^2=0.750^{**}$
	6 months after the intervention	21.62 $\pm$ 3.589	28.70 $\pm$ 2.061	7.08	<0.001 $\eta^2=0.792^{**}$
Perceived Benefits	Pre-test	17.32 $\pm$ 2.783	17.05 $\pm$ 2.971	-0.27	0.613*
	Immediately after the intervention	17.48 $\pm$ 3.165	18.97 $\pm$ 2.755	1.49	<0.001 $\eta^2=0.746^{**}$
	3 months after the intervention	17.20 $\pm$ 2.833	20.35 $\pm$ 2.146	3.15	<0.001 $\eta^2=0.810^{**}$
	6 months after the intervention	16.75 $\pm$ 3.213	22.18 $\pm$ 1.308	5.43	<0.001 $\eta^2=0.842^{**}$
Perceived Barriers	Pre-test	37.15 $\pm$ 6.054	37.98 $\pm$ 7.058	0.83	0.489*
	Immediately after the intervention	37.58 $\pm$ 5.694	37.17 $\pm$ 6.847	-0.41	<0.001 $\eta^2=0.933^{**}$
	3 months after the intervention	36.93 $\pm$ 6.025	36.18 $\pm$ 6.310	-.075	<0.001 $\eta^2=0.915^{**}$
	6 months after the intervention	33.73 $\pm$ 4.758	33.78 $\pm$ 8.939	0.05	<0.001 $\eta^2=0.578^{**}$
Cues to action	Pre-test	11.80 $\pm$ 3.492	11.90 $\pm$ 4.257	0.10	0.888*
	Immediately after the intervention	11.93 $\pm$ 3.162	15.42 $\pm$ 3.954	3.49	<0.001 $\eta^2=0.926^{**}$
	3 months after the intervention	12 $\pm$ 3.252	18.37 $\pm$ 3.626	6.37	<0.001 $\eta^2=0.896^{**}$
	6 months after the intervention	11.72 $\pm$ 3.258	21.50 $\pm$ 3.017	9.78	<0.001 $\eta^2=0.876^{**}$
Self-Efficacy	Pre-test	16.37 $\pm$ 4.096	16.18 $\pm$ 3.520	-0.19	0.793*
	Immediately after the intervention	16.55 $\pm$ 3.881	20.05 $\pm$ 3.239	3.50	<0.001 $\eta^2=0.921^{**}$
	3 months after the intervention	16.62 $\pm$ 3.954	23.60 $\pm$ 2.912	6.98	<0.001 $\eta^2=0.935^{**}$
	6 months after the intervention	14.92 $\pm$ 3.614	26.82 $\pm$ 2.071	11.90	<0.001 $\eta^2=0.950^{**}$

* Independent t-test

**Analysis of covariance (ANCOVA)

Table 4. Comparison of Pain Prevention Behaviors of Intervention and Control Groups

Variables	Intervention					Control					df	p
	N (%)					N (%)						
	never	rarely	Some times	often	always	never	rarely	Some times	often	always		
Vitamin D intake	10(12)	23(38.3)	23(38.3)	4(2.5)	0(0)	14(23.3)	18(30)	26(43.3)	1(1.7)	1(1.7)	4	0.372
Pre-test												
Immediately after the intervention	0(0)	0(0)	1(1.7)	29(48.3)	30(50)	11(18.3)	16(26.7)	29(48.3)	4(6.7)	0(0)	4	0.001
3 months after the intervention	0(0)	0(0)	0(0)	7(11.7)	53(83.3)	13(21.7)	23(38.3)	23(38.3)	1(1.7)	0(0)	4	0.001
6 months after the intervention	0(0)	0(0)	0(0)	2(3.3)	58(96.7)	10(16.7)	25(41.7)	23(38.3)	2(3.3)	0(0)	4	0.001
Stress management	14(23.3)	19(31.7)	23(38.3)	4(6.7)	0(0)	12(20)	23(38.3)	25(41.7)	0(0)	0(0)	4	0.202
Pre-test												
Immediately after the intervention	0(0)	0(0)	7(11.7)	23(55)	20(33.3)	10(16.7)	26(43.3)	21(35)	3(5)	0(0)	4	0.001
3 months after the intervention	0(0)	0(0)	0(0)	26(43.3)	34(56.7)	11(18.3)	29(48.3)	20(33.3)	0(0)	0(0)	4	0.001
6 months after the intervention	0(0)	0(0)	0(0)	16(26.7)	44(73.3)	11(18.3)	30(50)	19(31.7)	0(0)	0(0)	4	0.001
Proper body posture	15(25)	25(41.7)	18(30)	2(2.5)	0(0)	16(26.7)	22(36.7)	19(31.7)	3(2.5)	0(0)	4	0.903
Pre-test												
Immediately after the intervention	0(0)	0(0)	6(10)	37(61.7)	17(28.3)	11(18.3)	25(41.7)	19(31.7)	5(8.3)	0(0)	4	0/001
3 months after the intervention	0(0)	0(0)	0(0)	29(48.3)	31(51.7)	14(23.3)	27(45)	17(28.3)	2(3.3)	0(0)	4	0.001
6 months after the intervention	0(0)	0(0)	0(0)	19(31.7)	41(68.3)	14(23.3)	26(43.3)	20(33.3)	0(0)	0(0)	4	0.001

Table 5. Comparison of DASS (Depression, Anxiety, and Stress) and Pain in Intervention and Control Groups

Variables	Time	Control	Intervention	P
		Mean $\pm$ SD	Mean $\pm$ SD	
Depression	Pre-test	15.80 $\pm$ 2.916	16.10 $\pm$ 4.124	0.646*
	Immediately after the intervention	15.97 $\pm$ 2.768	15.63 $\pm$ 3.636	0.573**
	3 months after the intervention	15.80 $\pm$ 2.462	15.43 $\pm$ 3.357	0.496**
	6 months after the intervention	16.07 $\pm$ 2.755	15.13 $\pm$ 3.197	0.089**
p	0.001***			
Anxiety	Pre-test	12.63 $\pm$ 2.743	12.90 $\pm$ 3.502	0.643*
	Immediately after the intervention	12.97 $\pm$ 2.538	12.30 $\pm$ 3.055	0.196**
	3 months after the intervention	13.93 $\pm$ 2.358	11.90 $\pm$ 2.790	0.001**
	6 months after the intervention	13.37 $\pm$ 2.718	11.80 $\pm$ 2.673	0.002**
P	0.001***			
Stress	Pre-test	17.97 $\pm$ 3.923	18.73 $\pm$ 4.539	0.324*
	Immediately after the intervention	17.90 $\pm$ 3.932	17.90 $\pm$ 4.221	1**
	3 months after the intervention	18 $\pm$ 3.454	17.67 $\pm$ 4.087	0.630**
	6 months after the intervention	18.10 $\pm$ 3.690	17.27 $\pm$ 3.737	0.221**
p	0.001***			
Pain	Pre-test	6.95 $\pm$ 1.371	6.95 $\pm$ 1.721	1*
	Immediately after the intervention	6.95 $\pm$ 1.371	6.92 $\pm$ 1.690	0.906**
	3 months after the intervention	6.98 $\pm$ 1.384	6.58 $\pm$ 1.522	0.135**
	6 months after the intervention	7.02 $\pm$ 1.334	6.50 $\pm$ 1.467	0.046**
p	0.001***			

* Independent t-test

**Bonferroni

***Repeated measures ANOVA

Figures

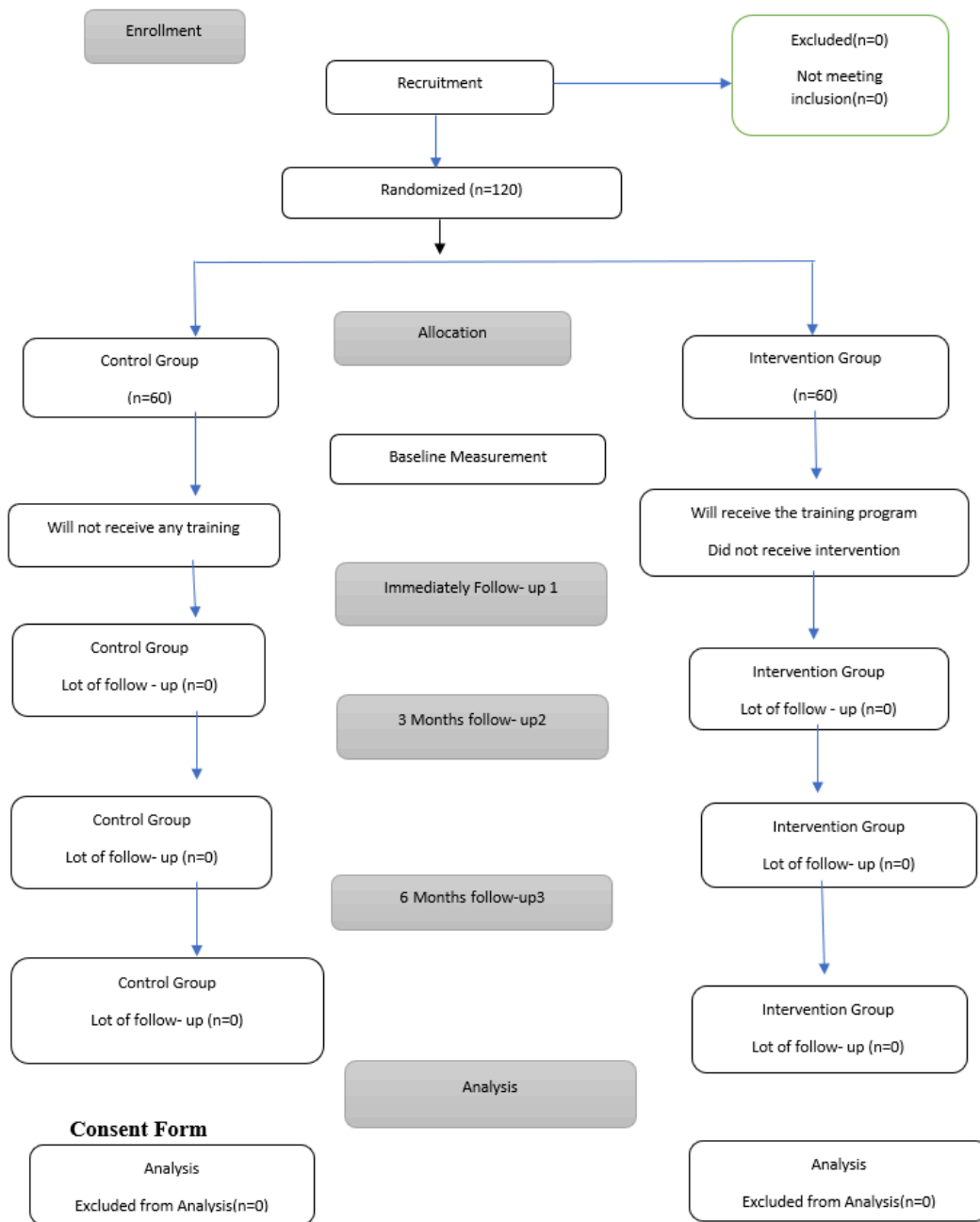


Figure 1

CONSORT Flowchart of randomized controlled trials

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

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