



## Research article

# Effectiveness of a self-determination theory-based intervention for nursing home residents with depression: A randomized controlled trial

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## ABSTRACT

**Objective and rationale:** The prevalence of depression among older adults residing in nursing homes has risen. While physical activity interventions based on the self-determination theory have been shown to reduce depressive symptoms among students and middle-aged adults, research in nursing home residents is scarce. This study aimed to investigate whether physical activity can alleviate depressive symptoms in nursing home residents over an extended period.

**Methods:** Between September 2020 and August 2021, 46 nursing home residents in Shenyang were randomly assigned to either a control group (n = 23) or an intervention group (n = 23). The control group followed a standard physical activity programme, whereas the intervention group underwent a programme based on self-determination theory. Both groups were monitored for 24 weeks post-intervention. Depression scores were assessed using the Geriatric Depression Scale, sociodemographic data collected via a self-designed questionnaire, cognitive function evaluated using the Mini-Mental State Examination, and weight and body fat measured using the Omron KARADA Scan Body Composition and Scale.

**Results:** Depression scores were measured at five time points: baseline (T<sub>0</sub>), weeks 12 (T<sub>1</sub>), and 24 (T<sub>2</sub>) of the intervention, and weeks 12 (T<sub>3</sub>) and 24 (T<sub>4</sub>) during follow-up. Both groups exhibited a trend of decline by more than five points. The intervention group demonstrated more favourable pre-to-post changes in depression scores compared to the control group.

**Conclusions:** A physical activity intervention based on self-determination conceptual framework has been proven to be effective for nursing home residents with depressive symptoms, also aiding in the maintenance of their physical activity levels. This study offers a theoretical foundation for the development of intervention programmes by researchers and identifies potential intervention strategies for caregivers in nursing homes.

**Trial Registration:** The Chinese Clinical Trial Registry (ChiCTR2200060598) (June 5, 2022).

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### 1. Introduction

For decades, the Chinese government has been dedicated to the development of services for the elderly, continually advancing the construction of an elderly service system. According to the 2022 National Development Bulletin on Aging issued by the Ministry of Civil Affairs of the People’s Republic of China, by the end of 2022, there were a total of 387,000 various types of institutions and facilities for the elderly, providing a total of 8,294,000 beds [1]. With the development of the Chinese economy, changes in family structure, and evolving pension concepts, an increasing number of older adults are choosing nursing homes. A recent study in China found that the prevalence of depressive symptoms among older people living in nursing homes was 36.8 % [2]. These residents face various psychological challenges, with depression increasing the risk of all-cause and cardiovascular disease mortality, as well as contributing to increased suicidal behaviour, cardiovascular disease, and metabolic disorders. It is also a significant contributor to premature death among vulnerable groups, particularly older individuals [3–6], placing a heavy burden on families and the society. Therefore, addressing depressive symptoms in nursing home residents is crucial.

Physical activity is a primary intervention for depression, offering numerous physical and mental health benefits. Several meta-analyses have demonstrated the significant effect of exercise on depression in older adults [7–9]. However, studies have indicated a high rate of exercise withdrawal among older adults within six months, reaching as high as 37 % [10]. This dropout rate diminishes the mental health benefits of physical activity. Consequently, current research aims to determine strategies for maintaining persistence in physical activity and sustaining positive emotional states among older individuals.

Self-determination theory (SDT) [11] is a commonly used motivational theory for behavioural interventions and emotional enhancement. Numerous studies have shown that SDT-based interventions can sustain long-term behavioural changes (up to 12 months) [12]. SDT encompasses key concepts such as autonomy support, autonomy, competence, and relatedness. It suggests that an autonomy-supportive environment is conducive to engaging in integrative emotional regulation, thereby enhancing personal

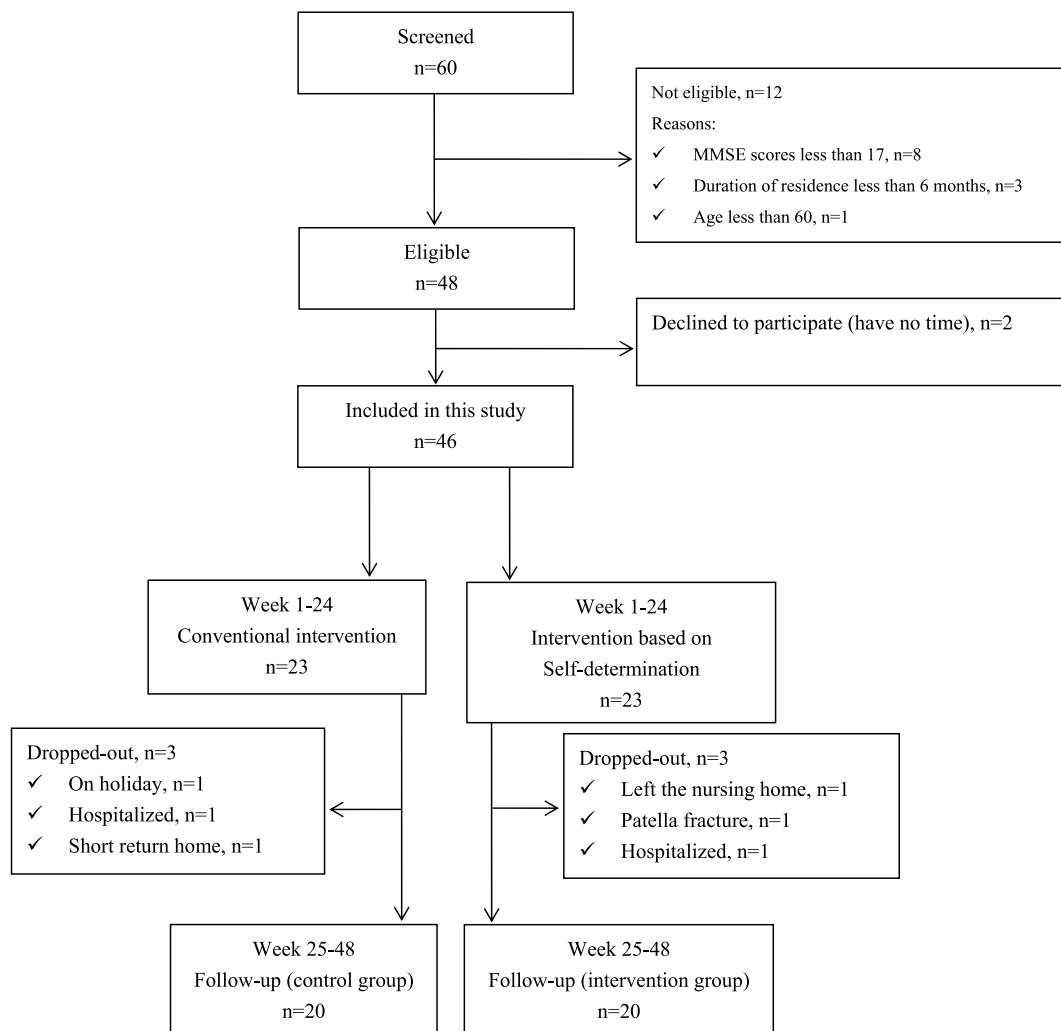


Fig. 1. Study flowchart.

well-being, reducing emotional dysregulation, and fostering high-quality relationships [13]. Fulfilling three fundamental psychological needs—autonomy, competence, and relatedness—is central to autonomous support. Autonomy involves a sense of personal initiative and the capacity to make decisions across various activities. Competence pertains to feeling effective in navigating one's environment and undertaking challenging tasks. Relatedness encompasses a sense of social inclusion and closeness [14]. Consequently, addressing these core psychological needs has been shown to reduce depressive symptoms [15]. Interventions grounded in autonomy support, autonomy, competence, and relatedness have proven effective in alleviating depressive symptoms among diverse populations [16], including patients with depression, postpartum individuals [17], and undergraduate students [18]. Nonetheless, there remains a dearth of research exploring the application of SDT principles among nursing home residents.

Therefore, this study aimed to investigate the impact of a physical activity programme based on the Self-determination conceptual framework on depressive symptoms among nursing home residents, as well as the effect of physical activity persistence levels.

## 2. Methods

### 2.1. Design and sample

This study employed a randomised, parallel, controlled intervention design adhering to the CONSORT statement criteria for reporting clinical trials [19]. Recruitment, intervention, and data collection took place at a nursing home in Shenyang, China. Using computer-generated randomisation, participants were allocated to either the control or intervention group at a 1:1 ratio following baseline assessment. Inclusion criteria were as follows: (1) nursing home residents aged  $\geq 60$  years, (2) residing in the facility for  $>6$  months, (3) exhibiting independent functioning, (4) absence of cognitive impairment (Mini-Mental State Examination score  $\geq 20$ ) [20], (5) ability to communicate, (6) absence of severe diseases, and (7) non-participation in other relevant studies that might influence this study's outcomes.

All participants provided written informed consent. Ethics approval was obtained from the Ethics Research Committee of Shenyang Medical College (approval number: SYMC-20220326-001).

### 2.2. Sample size calculation

The sample size was determined by comparing the differences between the mean values of the two samples using the following estimation formula [21]:  $N_1 = N_2 = 2 \times [\sigma(t_{\alpha} + T_{\beta}) / (\mu_1 - \mu_2)]^2$ . Based on data from Liu [22], the mean weekly walking time for the control group and the intervention group was 115.15 and 167.21 min, respectively. The maximum standard deviation for both groups was 53.42 ( $\alpha = 0.05$ ,  $\beta = 0.20$ ) with a 20 % factoring in a 20 % dropout rate. Consequently, the sample size for both the control and intervention groups was set at 20 individuals each (see Fig. 1). Recruitment commenced in September 2020, with data collection concluding in November 2020.

### 2.3. Outcome measures

Sociodemographic information, including age, sex, education level, marital status, pension status, body mass index (BMI), and chronic diseases, was gathered through face-to-face interviews using a self-designed questionnaire administered by our research team.

The cognitive functioning of participants was evaluated using the Mini-Mental State Examination (MMSE) [20], a 30-point questionnaire assessing ten dimensions such as registration, attention and calculation, recall, language, ability to follow simple commands, and orientation. A score of 20 points or above indicated no cognitive impairment. In our study, the MMSE was employed for screening elderly individuals. Among the elderly Chinese population, the MMSE demonstrated a sensitivity of 0.76, specificity of 0.93, and a Youden index of 0.6 for cognitive impairment screening [23].

Weight and body fat were measured using the Omron KARADA Scan Body Composition and Scale (HBF-214-PK, Tokyo, Japan), providing weight information with an accuracy of 0.1kg. Height was measured without shoes to the nearest 50 cm using a calibrated stadiometer. BMI was calculated using the formula weight (kg) divided by height squared ( $m^2$ ), following the World Health Organization standards: BMI  $\leq 18.5$ , underweight; BMI  $\leq 24.9$ , normal weight; BMI 25–29.9, overweight; and BMI  $\geq 30$ , obese.

Depression served as the primary outcome, and assessment was conducted using the Geriatric Depression Scale (GDS). Originally developed by American psychologists Brink and Yesavage in 1982, the GDS has been widely utilised globally to evaluate depression in older adults. Subsequently, in 1986, Sheikh and Yesavage [24] introduced a simplified version known as the Geriatric Depression Scale-15 (GDS-15), comprising 15 items derived from the original 30-item version. Responses are scored dichotomously, with "yes" assigned 1 point and "no" 0 points. Higher scores indicate more pronounced depressive symptoms, with scores  $\geq 5$  suggestive of depression. Tang [25] assessed the reliability and validity of the Chinese version of GDS-15 among elderly Chinese individuals, revealing a Cronbach's  $\alpha$  coefficient of 0.793 and a one-week retest reliability of 0.728.

### 2.4. Recruitment and screening

Recruitment took place at a nursing home in Shenyang, China, where a poster was prominently displayed by the dining room entrance. Interested older adults were invited to participate, provided they met the inclusion criteria. Eligibility was determined through face-to-face interviews conducted by a psychologist, in line with the GDS. Older adults without cognitive impairment (MMSE score  $\geq 20$ ) were deemed eligible for study enrolment.

## 2.5. Study procedure

### 2.5.1. Pre-intervention

Six elderly individuals residing in a nursing home in Shenyang were chosen to take part in this pilot study. The findings indicated that the content, delivery method, and duration of the knowledge-based lectures were well-received by older adults, who appreciated acquiring new skills and learning about physical activities. Following the activity sessions, they willingly engaged in discussions to share their feelings. Moreover, the participants expressed acceptance of the duration, intensity, frequency, and mode of the activities.

### 2.5.2. Interventions

**2.5.2.1. Typical physical activity programme.** The physical activity programme was developed based on existing literature and recommendations [26–28]. The intervention period spanned from 8 weeks to 6 months, with evaluation continuing for up to 12 weeks post-intervention [26–29]. The control group received physical activity interventions primarily comprising strength, balance, endurance, and flexibility training over a period of 24 weeks. Each training session lasted between 30 and 45 min, conducted twice weekly throughout the 24-week period. Participants performed the exercises under the supervision of a physical activity coach and were provided with an exercise prescription for independent workouts. The coach remained blinded to the group assignments.

**2.5.2.2. Self-determination conceptual framework-based physical activity program.** The intervention group participated in a physical activity intervention programme based on the self-determination conceptual framework. In addition to physical activity sessions, knowledge lectures, seminars, and group leader meetings were conducted. These sessions were led by one of our researchers.

**Table 1**  
Knowledge lectures for intervention group.

Time	Program Contents	Intervention Elements	Intervention Strategies
Week 1	<ul style="list-style-type: none"> <li>How to use the pedometer(20min)</li> <li>Physical activity skills (muscle strength, flexibility, balance and endurance training, 45min)</li> </ul>	Provide support Reduce the control	<ul style="list-style-type: none"> <li>Teaching physical activity knowledge and skills by using neutral language (can, could, not should, must) to provide supportive information to older adults</li> <li>Avoiding arguments when communicating with the elderly to reducing the feeling of control</li> <li>Minimizing the use of pressure, demands, and external rewards such as rewards, threats, deadlines, etc. to reduce feelings of control</li> </ul>
Week 2	<ul style="list-style-type: none"> <li>The reason of carrying activity(20min)</li> <li>Physical activity skills(45min)</li> </ul>	Provide Reasons Provide support Reduce the control	<ul style="list-style-type: none"> <li>Introduce the health benefits of suitable physical activities for the elderly (Tai Ji, Square dances, Brisk walking, Ba Duanjin, etc.) and the effects on various parts of the body, such as strengthening heart and lung function, improving muscle strength, improving flexibility, etc., to help them make the right choice</li> <li>Intervention strategies of provide support and reduce control as above</li> </ul>
Week 3	<ul style="list-style-type: none"> <li>Safety related to the activities of the elderly(20min)</li> <li>Venue selection(20min)</li> <li>Activity skills(45min)</li> </ul>	Provide options Provide support Reduce the control	<ul style="list-style-type: none"> <li>Provide a variety of activity venues, projects and methods for the elderly, Indoor gym, table tennis room, classroom and outdoor fitness venue are added to the nursing home</li> <li>Intervention strategies to provide support and reduce control as above</li> </ul>
Week 4	<ul style="list-style-type: none"> <li>How to manage the goal of activity(20min)</li> <li>How to handle the barriers of activity(20min)</li> <li>Activity skills(45min)</li> </ul>	Target setting Empathy Provide support Reduce the control	<ul style="list-style-type: none"> <li>Encourage and help seniors to establish activity goals and plans, such as completing 15,000 aerobic steps per week</li> <li>Ask the elderly if they feel pain or other health problems when carrying the activity, acknowledge their feelings and offer solutions</li> <li>Make the elderly feel understood and accepted</li> <li>Intervention strategies to provide support and reduce control as above</li> </ul>
Week 5~16	<ul style="list-style-type: none"> <li>Encourage and assist the elderly to choose the activity mode, venue and time they are interested in (1–2 elderly people, 20 min each time)</li> <li>Activity skills(45min)</li> </ul>	Provide support Empathy Provide support Reduce the control	<ul style="list-style-type: none"> <li>Encourage the elderly to choose their own activity venues, programs, time and methods</li> <li>Make the elderly feel understood when communicating with them</li> <li>Intervention strategies to provide support and reduce control as above</li> </ul>
Week 17~24	<ul style="list-style-type: none"> <li>Provide guidance and adjustment according to the feedback of the elderly to help establish a good habit (20min)</li> <li>Activity skills(45min)</li> </ul>	Provide support Empathy Provide Reasons Provide support Reduce the control	<ul style="list-style-type: none"> <li>Encourage the elderly to choose their own activity venues, programs, time and methods</li> <li>Make the elderly feel understood when communicating with them</li> <li>Encourage elderly to explain the benefits of physical activity and share them with other people to experience the reasons for physical activity</li> <li>Intervention strategies to provide support and reduce control as above</li> </ul>

**Table 2**  
Meeting of intervention group.

Theme	Intervention Elements	Intervention Strategies
How do you feel about your physical activities this week?	Empathy Provide support Reduce the control	<ul style="list-style-type: none"> <li>Acknowledge the feelings and perceptions of elderly, make them feel that the thoughts and feelings are understood and accepted</li> <li>Intervention strategies to provide support and reduce control as above</li> </ul>
Why do you take part in the physical activities?	Provide support Provide support Reduce the control	<ul style="list-style-type: none"> <li>The elderly was surveyed about their favorite activities and time, and helped to adjust according to the survey results at 12 and 24 weeks of intervention</li> <li>Encourage older people to explain the benefits of physical activity and share them with others</li> <li>Intervention strategies to provide support and reduce control as above</li> </ul>
What challenges or difficulties do you encounter during physical activities?	Empathy Provide support Reduce the control	<ul style="list-style-type: none"> <li>Ask the elderly if they have pain or other health problems during the activity, acknowledge their feelings and offer solutions</li> <li>Make the elderly feel understood when communicating with them</li> <li>Intervention strategies to provide support and reduce control as above</li> </ul>
What's the greatest benefit you get from physical activities?	Provide Reasons Provide support Reduce the control	<ul style="list-style-type: none"> <li>Encourage older people to enjoy the benefits of physical activity to experience the reasons for physical activity</li> <li>Intervention strategies to provide support and reduce control as above</li> </ul>
Who do you get support from in your physical activities?	Empathy Provide support Reduce the control	<ul style="list-style-type: none"> <li>Make the elderly feel understood when communicating with them</li> <li>Intervention strategies to provide support and reduce control as above</li> </ul>

Knowledge lectures took place once a week for 24 weeks, each lasting approximately 65–85 min. They covered various topics, including instructions on pedometer usage (week 1), reasons for engaging in physical activity (week 2), venue selection and activity safety (week 3), goal setting and barrier management (week 4), assistance in selecting activity patterns, venues, and timings (weeks 5–16), and providing guidance and individualised adjustments based on feedback to foster healthy activity habits (weeks 17–24). The autonomy-support strategies employed during these lectures are detailed in [Table 1](#).

Weekly meetings were held for 24 weeks, with each session lasting 60 min and involving all intervention group participants. The themes of these meetings, along with the autonomy-support strategies discussed, are outlined in [Table 2](#).

Additionally, group leader meetings occurred every 4 weeks for 30 min. Two active participants from the intervention group were selected as leaders, tasked with summarising and analysing participants' physical activities and addressing related barriers. Leaders also received training on developing autonomy-support strategies.

Data collection was conducted by our study group, independent of the intervention leadership. To minimise contamination risk, interventions for both groups were conducted at separate locations and time points.

**Table 3**  
Baseline comparison between intervention and control group.

Sample characteristics	Intervention group(n = 23)	Control group(n = 23)	T value/ $\chi^2$	P
Age (years)	79.70 ± 6.86	81.09 ± 5.83	−0.74	0.46
MMSE scores	26.26 ± 1.54	26.61 ± 1.56	−0.76	0.45
BMI	23.98 ± 3.88	24.80 ± 5.46	−0.59	0.56
income(yuan/month)	3836.96 ± 1182.47	3800.00 ± 1262.39	0.10	0.92
Resident period	12.78 ± 5.55	15.83 ± 5.13	−1.93	0.06
Gender				
male	12	13	0.09	0.77
female	11	10		
Education				
primary schools or below	6	4		
junior middle schools	10	8		
senior high schools	3	2		
university	4	9	2.75	0.43
Marital status				
Married or cohabiting	8	11		
Single	15	12	0.81	0.37
Chronic conditions				
none	5	4		
One	6	3		
Two	5	6		
Three or above	7	10	1.73	0.63
Depression symptoms (GDS-15 score)	6.96 ± 2.49	7.39 ± 2.71	−0.57	0.57

### 2.5.3. Follow up

Follow-ups led by the investigator were performed 12 and 24 weeks after the intervention.

## 2.6. Data collection and analysis

Data were collected at five time points: baseline ( $T_0$ ), weeks 12 ( $T_1$ ) and 24 ( $T_2$ ) of the intervention, and weeks 12 ( $T_3$ ) and 24 ( $T_4$ ) during follow-up. Face-to-face interviews were conducted for data collection using a self-designed questionnaire for sociodemographic information, the MMSE for cognitive function, Omron KARADA Scan Body Composition and Scale for weight and body fat, and the Geriatric Depression Scale (GDS-15) for depression levels. The research team received training prior to data collection, covering standardised interview procedures, time management, and questionnaire review. Completion of these questionnaires typically took around 20 min. To address potential cognitive decline among elderly participants and improve participation rates, advanced notifications, assistance in setting alarms, and door-to-door invitations were employed. Additionally, considering possible discomfort and lack motivation towards physical activities, an autonomy-support strategy was incorporated into the programme to enhance compliance.

A two-tailed test was utilised for all statistical procedures, with statistical significance set at  $P < 0.05$ . Statistical analyses were conducted using SPSS (version 12.0; IBM Corp., Armonk, NY, USA). Continuous data were presented as means and standard deviations (SD) for normally distributed data. Non-normally distributed data were represented by median (M) and interquartile ranges (P25, P75), while dichotomous data were expressed as frequencies and percentages (%).

For group comparisons, a  $t$ -test was conducted if data exhibited a normal distribution, while the Mann-Whitney  $U$  test was employed for non-normally distributed data. The chi-squared test was utilised for dichotomous data. In comparing participants between groups at baseline, weeks 12 and 24 during the intervention, and weeks 12 and 24 of follow-up, a repeated-measures analysis of variance (ANOVA) was applied for normally distributed data, and a generalised linear mixed effects model was used for non-normally distributed data. Intragroup comparisons at baseline, weeks 12 and 24 of the intervention, and weeks 12 and 24 of follow-up were conducted using a two-sample  $t$ -test for normally distributed data, and a nonparametric Mann-Whitney  $U$  test for non-normally distributed data.

## 3. Results

Between September 2020 and August 2021, 60 participants underwent screening, with 12 failing to meet inclusion criteria and two declining participation. Subsequently, 46 participants were randomly assigned: 23 to the control group and 23 to the intervention group. Three elderly individuals withdrew during the intervention and follow-up periods, leaving 20 participants in each group (see Fig. 1).

### 3.1. Comparison of baseline data between the intervention and control groups

A comparison of baseline data was conducted to assess general information between the groups, including sex, age, education level, income, marital status, chronic diseases, BMI, duration of residence, MMSE scores, and depression symptoms. Results revealed no significant differences in baseline data between the groups ( $P > 0.05$ ) (Table 3).

### 3.2. Pre-to post-change differences

The prevalence of depression among nursing home residents was 45.65 % at baseline and reduced to 10 % after 24 weeks of intervention. Table 4 illustrates the pre-to-post-change differences in depression between the intervention and control groups. First, both groups exhibited a tendency towards a decline of over five points ( $F = 19.31$ ,  $P < 0.001$ ). Second, the intervention group demonstrated more favourable pre-to-post-intervention changes in depression scores compared to the control group ( $F = 4.13$ ,  $P = 0.04$ ). A significant interaction between time and group was observed ( $F = 1.03$ ,  $P = 0.39$ ).

**Table 4**  
Generalised linear mixed model analysis.

	Time point/group	Average	Standard error	$F$	$P$
time	$T_0$	7.17	0.33	19.31	<0.001
	$T_1$	6.46	0.33		
	$T_2$	5.80	0.34		
	$T_3$	5.23	0.35		
	$T_4$	3.92	0.35		
group	Intervention group	5.14	0.40	4.13	0.04
	Control group	6.30	0.40		
time*group				1.03	0.39

**Table 5**  
Comparison of depression scores at five time points between the groups.

Depression	Time point	Intervention group	Control group	<i>t</i>	<i>P</i>
	T <sub>0</sub>	6.96 ± 2.49	7.39 ± 2.71	−0.57	0.57
	T <sub>1</sub>	5.91 ± 2.47	7.04 ± 2.60	−1.51	0.14
	T <sub>2</sub>	5.15 ± 1.90	6.35 ± 2.60	−1.67	0.11
	T <sub>3</sub>	4.35 ± 1.76	5.95 ± 2.68	−2.23	0.03
	T <sub>4</sub>	3.00 ± 1.12	4.70 ± 1.75	−3.65	<0.001

### 3.3. Comparison of depression scores at the five time points between the groups

As depicted in Table 5, there was no significant difference in depression scores between the two groups at T<sub>0</sub> ( $t = -0.57, P = 0.57$ ), T<sub>1</sub> ( $t = -1.51, P = 0.14$ ), and T<sub>2</sub> ( $t = -1.67, P = 0.11$ ). However, differences emerged from T<sub>3</sub>, 12 weeks after the intervention ( $t = -2.23, P = 0.03$ ).

## 4. Discussion

In this study, the incidence of depression among nursing home residents was 45.65 % at baseline and 10 % at 24 weeks after the intervention. Previous research indicates that the incidence of depression among nursing home residents in China ranges from approximately 16.4 %–40 % [30–32], consistent with our findings. International epidemiological studies highlight a higher incidence of depression among older adults residing in nursing homes (14–42 %) compared to those living in the community (1–10 %) [33]. These findings underscore the elevated risk of depression in this population. The complex aetiology of depression in nursing home residents involves various factors such as declining physical function, chronic illness, and cultural influences like the traditional concept of familial care for elders in China [34,35]. Our intervention, grounded in the self-determination conceptual framework, addresses feelings of powerlessness, nonbelonging, and helplessness commonly associated with depression in this context.

The findings of this study revealed that depression scores in both groups tended to decrease by over five points ( $F = 19.31, P < 0.001$ ), consistent with findings from numerous other studies. A meta-analysis conducted in the UK, comprising nine randomised controlled trials, similarly demonstrated that exercise significantly improves depression in older individuals (CI: 0.05 to −0.17) [36]. Many countries advocate exercise as a complementary treatment for depression [37]. However, the precise mechanism by which physical activity reduces depressive symptoms remains uncertain. Some research suggests that physical activity may facilitate positive cognitive changes, such as redirecting attention away from negative thoughts, thereby fostering a sense of purpose and alleviating depressive symptoms [38].

Compared to the control group, the intervention group exhibited favourable pre-to-post changes in depression scores ( $F = 4.13, P = 0.04$ ), suggesting that the Self-determination conceptual framework-based programme was more effective in alleviating depression among nursing home residents. Studies on college students have demonstrated that fulfilling their basic psychological needs, thereby enhancing their self-control, can mitigate depression levels [39]. This phenomenon extends to the elderly population. Leow [40] highlighted that older cancer survivors who received social support from family members reported greater social well-being. Similarly, hospitalised French older adults with lower levels of perceived autonomy support exhibited significantly higher levels of depressive symptoms [15]. In our study, providing autonomy support to the elderly, including offering choices, emotional support, and acknowledging their perspectives, fostered a sense of independence and competence, leading to increased engagement in physical activity and a greater sense of belonging. Research indicates that meeting these psychological needs promotes autonomously motivated behaviour, thus improving mental health. Therefore, our findings align with prior research emphasising the relationship between psychological satisfaction and mental well-being as an important area of investigation [14].

There was no significant difference in depression scores between the two groups at T<sub>0</sub> ( $t = -0.57, P = 0.57$ ), T<sub>1</sub> ( $t = -1.51, P = 0.14$ ), and T<sub>2</sub> ( $t = -1.67, P = 0.11$ ). Differences began to emerge at T<sub>3</sub>, 12 weeks after the intervention ( $t = -2.23, P = 0.03$ ), indicating that the Self-determination conceptual framework-based programme maintained behavioural change. Rahman's study [41] demonstrated that Self-determination conceptual framework interventions improved depression in 389 heart disease patients at week 12. Similarly, Sripada's [42] 14-week follow-up of 242 discharged patients found negative correlations between psychological variables in the SDT framework and depression. These findings support the notion that Self-determination conceptual framework-based physical activity interventions sustain behavioural changes over time (>6 months) [43,44]. Therefore, this study lends support to the idea that the Self-determination conceptual framework maintains behavioural changes and improves depression.

The programme implemented by the intervention group in this study was tailored according to the Self-determination conceptual framework. It comprehensively incorporates autonomous support and the fulfilment of psychological needs and autonomous motivation to encourage older adults to sustain an active lifestyle. Moreover, it facilitates their exploration of new interests and fosters active participation in activities to alleviate depressive symptoms. In conclusion, Self-determination-based physical activity interventions offer enduring enhancements in depressive symptoms among older adults.

## 5. Conclusion

This study not only proposed a pathway for improving depression based on the Self-determination conceptual framework but also



offered autonomy-support strategies throughout the intervention process. The intervention programme could serve as evidence for healthcare professionals to design, monitor, and evaluate their own studies. Furthermore, applying a pathway based on SDT could enhance researchers' understanding of how to derive and deliver maximum benefit during the intervention process.

## 6. Strengths and limitations

Although this study offers evidence of the effectiveness of our interventions, certain limitations need consideration. First, the research population should encompass community residents in its entirety to ensure the generalisation of research findings. Second, depression is influenced by various factors, and the pathways involved are highly complex. Apart from autonomy support, factors such as activity role confirmation and personal goal pursuit also impact depression. Therefore, future studies should integrate and analyse other influencing factors, employ interview and observation methods to gather evidence, explore the multi-factor model, and provide a more scientifically sound theoretical basis for Self-determination conceptual framework interventions in older adults with depression.

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## Data availability

The authors do not have permission to share data.

## CRediT authorship contribution statement

**Lei Liu:** Writing – original draft, Software, Methodology, Investigation, Data curation, Conceptualization. **Daqiu Wang:** Writing – original draft, Supervision, Software, Resources. **Wei Wu:** Software, Resources, Data curation, Conceptualization. **Mingqiang Xiang:** Methodology, Formal analysis, Conceptualization. **Xiaoxue Li:** Writing – review & editing, Validation, Software, Conceptualization. **Yudan Zhao:** Software, Data curation. **Jiayu Wang:** Resources, Methodology, Investigation. **Aiping Wang:** Writing – review & editing, Writing – original draft, Resources, Methodology, Data curation, Conceptualization.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.heliyon.2024.e33818>.

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