

RESEARCH ARTICLE

Psychophysiological effects of residential options on older people living in long-term nursing house

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Abstract

Background: Nursing home is critical for the elderly.

Methods: To investigate the effects of decision-making process in terms of choosing room type and roommates on cognitive and psychosocial conditions of the elderly, 174 eligible participants were randomly assigned into three groups. In the first two groups, participants were randomly assigned to single-person rooms (Group SPR, $n = 58$) and multi-person rooms (2–4 persons per room, Group MPR, $n = 58$), and the third group of participants were allowed to voluntarily choose to live in single-person room or with preferred roommates (Group VPR, $n = 58$).

Results: Participants who voluntarily choose room type and roommates (Group VPR) showed the least deterioration of cognitive function, psychosocial, and physical health, with Group MPR showing less deterioration than Group SPR. Allowing elderly people to voluntarily choose room type and roommate is better for preserving their cognitive, psychological, and physical health.

Conclusions: Voluntary choice of room type and roommates is beneficial to the cognitive, psychological, and physical health of elderly people.

Keywords: *elderly population; nursing home; residential option; cognitive function; psychological function; physical health*

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Increasing number of countries are having a growing elderly population and, thus, an increasing need for nursing homes, which provide community-based housing and care for elderly people (1). Cognitive disorders, such as a dementia, are common neurodegenerative diseases that place significant burden on families and society. Tremendous evidences have suggested that the elderly in nursing homes are vulnerable to decline in cognitive functions (2). Dementia alone affects about 47.5 million people worldwide. By 2050, as many as 131.5 million people will suffer from dementia (3). In China, 9.5 million people have dementia, accounting for about 20% of all patients with dementia around the globe (4). Ageing is one of the important factors contributing to the occurrence of dementia (5). As China's population continues to age, the number of patients with dementia in China will continue to increase. Early intervention is critical to

reducing the development from mild cognitive impairment (MCI) to dementia (6), as people with MCI have over 10 times chances than those of their peers to develop dementia. Currently, 10–20% of people over 65 years of age have MCI, and about 10% of them will eventually develop Alzheimer's disease (7).

Nursing home, as a common place where the elderly people are taken care of, therefore, serves as an important environment to reduce or delay the deterioration of cognitive function. There has always been a commitment to provide better accommodation and more convenient living facilities for the elderly in nursing homes. Despite efforts to improve living conditions and services of nursing homes, literature on what living environment and services are essential factors affecting occurrence of dementia is still scarce (8, 9). A good nursing home arrangement can reduce loneliness, improve self-control, improve mental state, and

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increase their life expectancy. However, clear guidelines on best residential options to accommodate elderly people to preserve cognitive functions of elderly people are still in lack. It is increasingly recognized that the decision-making process is an important determinant of the pleasure and health of elderly people, and more focus should be made on the decision-making process of the elderly (10, 11).

In this study, we focused on how arrangement of rooms affects the cognitive function of elderly people in nursing homes, which is an often overlook factor. Using a randomized trial, we investigated the effects of room types, i.e. single-person room or multi-person room, and how elderly people choose room type and roommates, i.e. mandatory or voluntarily, on their cognitive function and psychosocial and physical conditions. The results of the study could provide guidance on how to arrange room types and roommates in nursing homes.

Study design and methods

Study design

This study was approved by the ethics committee of Quanzhou First Hospital Affiliated to Fujian Medical University of China. The inclusion criteria were as follows: (1) adults aged ≥ 65 years and independently living in community; (2) exhibiting depressive symptoms (with a Geriatric Depression Scale-15 (GDS-15) score of over 5); and (3) mild memory problems. The exclusion criteria were (1) adults exhibiting dementia or with a Mini-Mental State Examination (MMSE) score of ≤ 18 , (2) with a history of psychiatric diseases or other severe neurological deficiencies, (3) with disability, and (4) inability to tests mandated by the study design. All participants provided written informed consent before enrollment.

During 2017–2019, 242 older adults were screened at multiple nursing homes, of which 174 were eligible and randomly divided into three groups: Group SPR: participants were assigned to single-person rooms; Group MPR: participants were randomly assigned to multi-person rooms (2–4 persons per room); Group VPR: participants were allowed to choose single-person room or multi-person room. If dropout of participants left one participant living in multi-person room, the participant was assigned to other groups according to the participant's wishes. Every 2–3 participants were assigned a nursing staff, and other conditions were the same for all groups. After 1 year, Group SPR had two dropouts, Group MPR had two dropouts, and Group VPR had three dropouts (56 participants in Group SPR, 56 participants in Group MPR, and 55 participants in Group VPR were assessed after 1 year).

Randomization

Participants were randomized to three groups at the ratio of 1:1:1 using a computer-generated sequence.

Nursing facilities

The elderly facilities included residential rooms, shared service rooms, medical rooms, fitness rooms, administrative support rooms, etc. for the elderly. The elderly residential rooms included bedrooms and bathrooms. The shared service rooms included kitchens, dining rooms, bathrooms, laundry rooms, etc. The medical rooms included medical offices, inquiry rooms, etc. The fitness rooms included activity rooms (including reading and chess rooms), health rooms, etc. The administrative support rooms included offices, storage rooms, reception rooms, and kiosks. The residential rooms for the elderly were mainly single bedrooms and double bedrooms, and the portion of bedrooms for three or more persons was no more than 40%. In addition to providing residential rooms that met the accommodation conditions of the elderly, the senior care institutions also provided services such as eating, dressing, toileting, bathing, and indoor and outdoor activities that met the daily needs of the elderly and were equipped with facilities, equipment, and utensils that were suitable for the safety and protection requirements. The facilities were regularly disinfected and cleaned. An admission assessment system was established to monitor the physical condition of the elderly, adjust the level of care and nursing, establish health records, and promote healthy habits and disease prevention. The elderly were offered three meals a day according to nutritionists' recommendations. Additionally, the facility was equipped with many recreational facilities and equipment, such as chess and card rooms for recreation, to ensure that the elderly had enough places and opportunities for exercise, and to carry out cultural, educational, sports, and recreational activities suitable for the elderly to enrich their spiritual and cultural life.

Assessment of cognitive function

Cognitive function served as the primary outcome of our study. Cognitive function was evaluated by MMSE (12), which includes questions to test orientation, attention, memory, language and visual-spatial skills, verbal fluency test (13), and Short-form Health Survey (Survery-12) (14), which examines physical, mental, and social health. MMSE is a practical method for grading the cognitive state of patients in clinical study and is a widely used to test the cognitive functions among the elderly. There are 30 questions in the test, which typically takes approximately 5–10 min to answer. The maximum score of all answers is 30 points, with one score to each correct answer. Patients scoring below 10 points are considered to be severely demented, between 10 and 19 are moderately demented, and between 20 and 26 are mildly demented (unless seen by a neurologist and declared not demented), and a score above 26 is regarded as cognitively normal. A neurology team reviewed each case and decided which category the

patient would be assigned into. Following MMSE, verbal fluency test was performed using the animal category. We asked participants to name animals over a period of 1 min and then separated answers in four periods of 15 s. A stopwatch was used to count the time, and the instruction ‘now please list as many animals as possible in one minute’ was given at the beginning of the test. The items listed by the patients were recorded in turn. To score the VFT, the total number of animals or words that the individual was able to produce was summed up.

Assessment of depression

The secondary outcomes of the study were evaluated by life-space assessment (LSA) (15), GDS-15 (16), Lubben Social Network Scale (LSNS) (17), and Functional Assessment of Communication Skills (FACS) (18) using standard procedures.

LSA19 is a self-reported measure of the frequency of independent mobility at five life space levels over the past 4 weeks. The first level refers to the interior area from the bedroom to the rest of the home. The second level is the distance from the front door to the garden boundary or public corridor. The third level is the local neighborhood, defined by the respondents. The fourth level is the town or city where the respondents are located. The fifth level is the area beyond the town or city. If necessary, mobilization assistance was recorded at each level (from another person and/or through the use of equipment). The LSA composite score, which may range from 0 to 120, is obtained by summing the life space level scores.

GDS-15 is the short form of GDS, including 15 items, 10 of which indicate the presence of depression when answered positively, while the rest (question numbers 1, 5, 7, 11, and 13) indicate depression when answered negatively. 0–4 points indicate normal; 5–8 points indicate mild depression; 9–11 points indicate moderate depression; 12–15 points indicate severe depression.

LSNS-6, as a self-report measure, is a 12-item questionnaire designed to measure the social isolation of the elderly by measuring the number and frequency of social contact with friends and family, and the perceived social support from these sources. It usually takes 5–10 min to complete the LSNS-6. Responses are scored on a 6-point scale. The total score of six items ranges from 0 to 30. Higher scores indicate larger the social networks and/or more frequent social contact.

Physical health assessment

The physical health of the participants was assessed in terms of serum brain-derived neurotrophic factor (BDNF) level, walking speed, daily steps, and activities of daily living (ADL) (19). ADL is evaluated by the physical function items in the hospital’s inpatient assessment tool. These items include 10 daily activities: dressing and

undressing, washing face, brushing teeth, bathing, eating, changing positions, sitting up, changing seats, getting out of the room, and using the bathroom. The score ranges from 0 (full independence) to 4 (full assistance required). Lower scores indicate stronger independence.

Statistical analysis

Data were analyzed based on the participants who completed the study using SPSS (IBM, v32). Changes in primary and secondary outcomes after 1 year in nursing homes compare to baseline were assessed using a paired *t*-test. Between-group analysis of the changes in outcomes was performed using Chi-square test. $P < 0.05$ was considered as significant difference in this study.

Results

Subject characteristics

Figure 1 shows the study flow. We recruited 242 participants, and 174 eligible participants were equally randomized to three groups (Group SPR-C, $n = 58$ per group). Participants in Group SPR were assigned to single-person rooms; participants in Group MPR were assigned to multi-person rooms (2–4 people per room); participants in Group VPR were allowed to choose single-person or multi-person room freely, and they are allowed to choose roommates. Assessments of cognitive function, psychological condition, and physical condition were performed after 1 year. Two people in the Group SPR and Group MPR dropped out and three people in the Group VPR dropped out during the study.

The baseline characteristics of each group are shown in Table 1. Approximately 60% of participants in each group were female, with the mean age of 72 years. Most participants have the education of primary school or lower and a good self-rated health.

Cognitive function

Cognitive function is the primary outcome of our study, and we assessed MMSE, verbal fluency, and 12-item short form survey (SF-12) scores of the participants at baseline and at 1 year after living in nursing homes (Table 2). T0 scores indicate the baseline test results after entering the group, and no significant differences between the groups were seen. T1 indicates the scores at 1 year after living in nursing homes, and in general, both Group SPR and Group MPR showed reduction in almost all scores (with the exceptions of verbal fluency score of Group SPR and SF-12 social health score of Group MPR). The reductions of MMSE score of Groups SPR and MPR, verbal fluency score of Group MPR, and SF-12 physical health and mental health scores of Groups SPR and MPR were statistically significant. On the contrary, no significant change was seen in all scores for Group VPR, and in some categories,

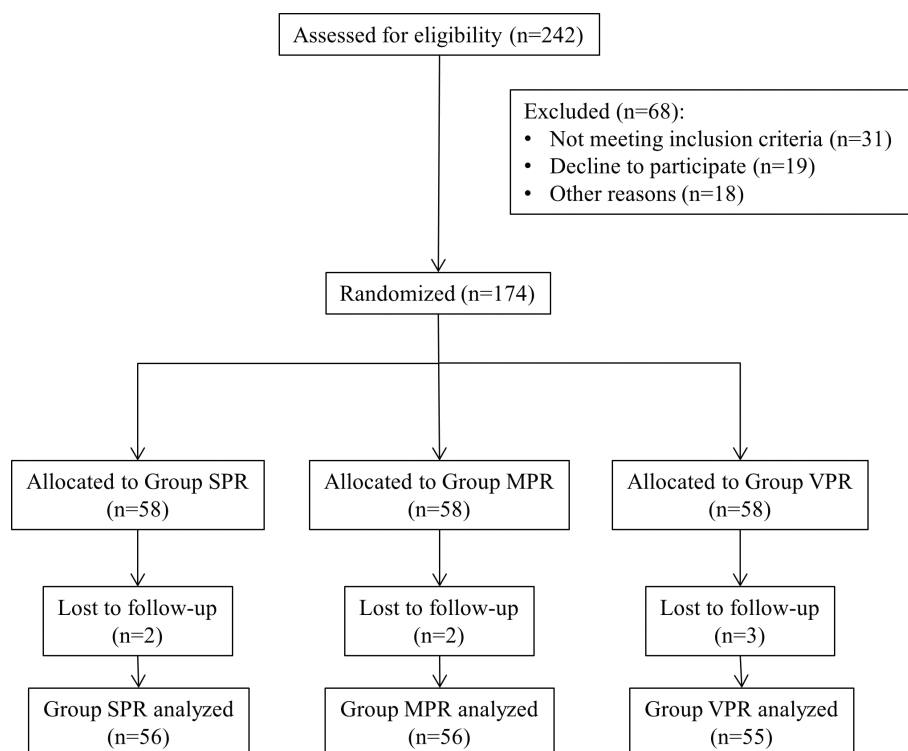


Fig. 1. Experimental flow graph.

Table 1. Clinical features of the participants

Primary outcomes	All (n = 167)	Group SPR (n = 56)	Group MPR (n = 56)	Group VPR (n = 55)
Sex (female), n (%)	102 (61.1)	34 (60.7)	33 (58.9)	35(61.4)
Age (years)	72.5 (6.2)	72.3 (6.0)	72.6 (5.7)	72.5(5.9)
Education level, n (%)				
None	62 (37.1)	21 (37.5)	20 (35.7)	21(38.2)
Primary	73 (43.7)	24 (42.9)	25 (41.1)	24(43.6)
Secondary and above	32 (19.2)	11 (19.6)	11(18.5)	10(18.2)
Self-rated health, n (%)				
Poor and fair	56 (33.5)	18 (32.1)	21 (37.5)	17(30.9)
Good	81 (48.5)	28 (50.0)	26 (46.4)	27(49.1)
Very good/excellent	30 (18.0)	10 (17.9)	9 (16.1)	11 (20.0)

Data are n (%) and mean (SD).

the MMSE score, verbal fluency score, SF-12 physical health and social health scores demonstrated improvement. Group VPR demonstrated significant differences compared to Groups SPR and MPR in all scores, while Group MPR only demonstrated significant difference in verbal fluency and SF-12 scores compared with Group SPR.

Psychosocial assessment

The evaluation of psychosocial conditions of the participants is performed using LSA, GDS-15, LSNS-6, and FACS analyses (Table 3). In terms of LSA score, a significant reduction was seen for Group SPR

($P = 0.006$) and Group MPR ($P = 0.032$) but not for Group VPR ($P = 0.145$). GDS-15, which refers to the level of depression, was increased for Groups SPR and MPR but decreased for Group VPR ($P = 0.002$). Similar results were observed for the LSNS-6 score. Group VPR also demonstrated the higher increase in the FACS social communication score (6.02 to 6.35) compared with Group MPR (6.13 to 6.22). Both Groups MPR and VPR showed increase in FACS communication of basic needs score. Between-group analysis shows that the changes in Group VPR were significantly different from those in Group SPR and MPR in terms of all scores.

Table 2. Changes in primary outcomes for participants who completed the trial (1 year from baseline)

Primary outcomes	T0, mean (SD)	T1, mean (SD)	Change (95% CI)	P
MMSE, score				
Group SPR	25.92 (2.49)	24.41 (2.66)	-1.51 (-2.97, 3.35)	0.039
Group MPR	26.13 (3.55)	24.79 (2.48)	-1.34 (-3.02, 1.46)	0.047
Group VPR	25.88 (3.27)	25.16 (3.42)	-0.72 (-2.89, 1.77)**	0.255
Verbal fluency (animal), score				
Group SPR	14.56 (3.19)	14.71 (3.45)	0.15 (-4.37, 2.02)	0.342
Group MPR	15.32 (3.08)	14.87 (4.01)	-0.45 (-3.12, 2.23)*	0.038
Group VPR	15.12 (2.89)	15.86 (3.14)	0.74 (-1.44, 2.55)**	0.021
SF-12, physical health (score), score				
Group SPR	44.9 (13.8)	42.5 (16.2)	-2.4 (-2.9, 0.9)	0.001
Group MPR	45.3 (10.6)	48.4 (9.7)	2.9 (-0.3, 2.2)**	0.014
Group VPR	46.6 (11.3)	47.5 (14.9)	0.9 (-0.8, 2.4)**	0.325
SF-12, mental health (score), score				
Group SPR	48.4 (9.7)	46.2 (8.9)	-2.2 (-2.7, 2.1)	0.015
Group MPR	51.5 (6.7)	49.9 (9.3)	-1.6 (-2.3, 2.9)*	0.027
Group VPR	50.3 (7.9)	49.7 (9.3)	-0.6 (-1.8, 2.3)**	0.401
SF-12, social health (score), score				
Group SPR	40.6 (18.1)	39.9 (16.8)	-0.7 (-2.8, 0.3)	0.306
Group MPR	42.4 (16.4)	43.1 (15.6)	0.7 (-0.7, 1.5)*	0.276
Group VPR	41.9 (16.8)	43.8 (15.9)	1.9 (0.3, 2.8)**	0.018

Data are mean (SD). MMSE, Mini-Mental State Examination; SF-12, Short-Form Health Survey-12. * $P < 0.05$, ** $P < 0.01$ vs Group SPR. * $P < 0.05$ vs Group MPR.

Physical assessment

We also performed physical tests of serum BDNF level, walking speed, daily steps, and ADL for participants of all groups. Participants in Group VPR generally showed better performance compared with other groups, and significant differences were shown in serum BDNF level, daily steps, and ADL compared with other groups (Table 4).

Discussions

As living conditions of nursing homes continue to improve, many of them are offering single-person rooms for elderly people. However, whether single-person rooms are beneficial for the cognitive functions of elderly people has yet to be ascertained, as multi-person rooms are thought to promote interpersonal communication, social interaction, etc., which is important to maintain the cognitive and psychosocial functions (20). Besides, how elderly choose room types and roommates, which is a psychological factor in room arrangement, has been overlooked, and currently nursing homes have not taken this factor into account and fail to give elderly people the choice to choose room types and roommates freely.

Our study conducted an analysis of changes in cognitive, psychosocial, and physical functions of the elderly

who were assigned to single-person room, multi-person room, or those who freely chose room types and roommates. Indeed, our study showed that the psychological factor of voluntary choice of room types and roommates outweighs the factor of room types alone. The Group SPR, which although potentially offers more privacy, personality, and convenience (21), have shown the worst primary and secondary outcomes in our study. Therefore, the following suggestions can be made in assigning rooms for elderly people in nursing homes.

First, allowing the voluntary choice of room type and roommates can most effectively preserve the cognitive function of elderly people. We used MMSE, which is a paper-based test, to assess dementia at baseline and 1-year after living in nursing homes. Those who freely chose room types and roommates showed the smallest decline in MMSE scores (-0.72 in Group VPR, vs. -1.34 in Group MPR and -1.51 in Group SPR). Similar observation was made for SF-12 mental health score. Those who were assigned to multi-person rooms (Group MPR) in general showed a better performance on MMSE, SF-12 mental health, and social health scores than those who were assigned to single-person rooms (Group SPR), but it was surprising to find that Group MPR did poorer on the verbal fluency test,

Table 3. Changes in secondary outcomes for participants who completed the trial (1 year from baseline)

Primary outcomes	T0, mean (SD)	T1, mean (SD)	Change (95% CI)	P
LSA, score				
Group SPR	79.3 (16.5)	74.9 (15.8)	-4.4 (-6.9, 2.3)	0.006
Group MPR	80.7 (16.7)	77.5 (16.1)	-3.2 (-6.2, -1.7)*	0.032
Group VPR	80.5 (16.7)	78.2 (16.1)	-2.3 (-4.2, -0.5)**&	0.145
GDS-15, score				
Group SPR	4.8 (2.3)	5.0 (2.4)	0.2 (-1.2, 0.5)	0.157
Group MPR	4.8 (2.2)	4.9 (2.4)	0.1 (-0.2, 1.1)	0.239
Group VPR	4.6 (2.6)	3.5 (2.5)	-1.1 (-1.3, 0.9)**&	0.002
LSNS-6, score				
Group SPR	14.6 (5.8)	14.3 (6.1)	-0.3 (-2.1, 0.6)	0.255
Group MPR	15.7 (5.1)	15.2 (5.6)	-0.5 (-1.8, 0.8)	0.159
Group VPR	15.4 (5.4)	16.9 (5.8)	1.5 (-0.1, 2.2)*&	0.014
FACS score				
Social communication				
Group SPR	5.97 (1.12)	5.48 (1.25)	-0.49 (-1.35, 0.12)	
Group MPR	6.13 (1.07)	6.22 (1.09)	0.09 (-0.27, 0.73)*	
Group VPR	6.02 (1.08)	6.35 (1.13)	0.33 (0.12, 1.53)**&	
Communication of basic needs				
Group SPR	6.21 (1.45)	6.05 (1.47)	-0.16 (-0.58, 0.33)	0.205
Group MPR	6.04 (1.33)	6.31 (1.42)	0.27 (-0.87, 0.62)*	0.012
Group VPR	6.09 (1.29)	6.27 (1.35)	0.16 (0.02, 0.84)*	0.036

Data are mean (SD). LSA, life-space assessment; GDS, Geriatric Depression Scale; LSNS, Lubben Social Network Scale; FACS, Functional Assessment of Communication Skills. * $P < 0.05$, ** $P < 0.01$ vs Group SPR, & $P < 0.05$ vs Group MPR.

Table 4. Changes in other outcomes for participants who completed the trial (1 year from baseline)

Primary outcomes	T0, mean (SD)	T1, mean (SD)	Change (95% CI)	P
Serum BDNF level, ng/dL				
Group SPR	18.87 (6.94)	15.73 (7.03)	-3.14 (-5.07, -1.04)	0.002
Group MPR	17.99 (8.02)	17.35 (8.13)	-0.64 (-3.08, -0.07)*	0.383
Group VPR	17.95 (7.99)	17.24 (8.01)	-0.71 (-2.45, 0.31)*	0.274
Walking speed, m/s				
Group SPR	1.1 (0.2)	0.9 (0.2)	-0.2 (-0.56, 0.44)	0.015
Group MPR	1.1 (0.2)	1.1 (0.2)	0 (-0.47, 0.73)	0.749
Group VPR	1.1 (0.3)	1.1 (0.2)	0 (-0.64, 0.68)	0.675
Daily steps, steps/day				
Group SPR	5216.3 (2218.6)	5036.2 (2367.8)	-180.1 (-230.5, 112.3)	0.017
Group MPR	5517.4 (2732.5)	5437.4 (2227.6)	-80 (-126.4, 65.3)*	0.035
Group VPR	5408.5 (2734.1)	5485.7 (2723.7)	77.2 (-103.3, 212.6)**&	0.026
ADL				
Group SPR	12.5 (2.3)	13.2 (2.4)	0.7 (-1.2, 1.4)	0.177
Group MPR	12.7 (2.5)	10.2 (2.4)	-2.5 (-3.2, -0.7)**&	0.031
Group VPR	12.8 (2.7)	9.8 (2.7)	-3.0 (-4.5, -1.2)**&	0.027

Data are mean (SD). BDNF, brain-derived neurotrophic factor; ADL, activities of daily living. * $P < 0.05$, ** $P < 0.01$ vs Group SPR, & $P < 0.05$ vs Group MPR.

which, in our study, examines semantic memory on the animal category. This observation conflicts with the better preservation of cognitive function in Group MPR assessed by other tests, and further studies are necessary to confirm

this finding. It is likely that the lack of personal space may worsen semantic memory of those people.

Voluntary choice of room type and roommates can promote the well-being of mood and communication skills

of the elderly. We first showed that the reduction of LSA scores was the smallest in Group VPR. LSA analyzes the extent of mobility of the elderly and, therefore, reflects the willingness and physical ability to move around (22). Higher LSA scores in Group VPR also suggested that those elderly people maintain a good psychological health. The GDS-15 score, which reflects depression, was the lowest in Group VPR, which, together with the improvement in social communication and communication of basic needs of Group VPR, supports that voluntary choice of room type and roommates is more important than room type alone in enhancing the psychosocial status of the elderly in nursing homes.

Voluntarily choosing room type and roommates can help preserve physical health. As another secondary outcome, physical conditions of the elderly measured by serum BDNF level, walking speed, daily speed, and ADL were assessed in three groups. We showed that except for ADL, Group SPR demonstrated the more severe decline in physical parameters. The improvement of ADL score in Group SPR could be attributed to the need for more daily chore when the elderly is living alone. Group VPR only showed the highest number of daily steps compared with Groups SPR and MPR, and no clear benefit in physical health can be seen compared with Group MPR. This result also suggests that the strong benefit of voluntary decision-making in choosing room type and roommates in cognitive and psychosocial function is not because of improvement of physical health.

Our study has several limitations. First, our study has a relatively small size ($n = 174$ in all three groups), and studies with a larger size can enhance the rigor of the conclusions. Second, considering that the mean onset age of MCI is 54.5 years (23), and the mean age of our participants is about 72 years, it is desirable to include some younger participants in future study to investigate the benefit of early intervention to reduce or delay dementia. Third, since all participants included in the study were Chinese, our conclusions may not apply to individuals of other nationalities who have different cultural background. Given that the nursing homes play an integral role in preserving the cognitive, psychosocial, and physical health of elderly people, our study elucidated the benefits of giving nursing home residents the freedom of decision-making in room arrangement, which is of important clinical significance in reducing healthcare burden for elderly people.

Conclusion

We have conducted a randomized clinical trial to evaluate effects of voluntary or involuntary choice of room type and roommates on the cognitive, psychological, and physical health status of nursing home residence at 1 year after moving in. Our study is the first instance to provide statistical data supporting that voluntary choice

of room type and roommates at the time of move-in can best preserve the cognitive, psychosocial, and physical health of the elderly in nursing homes. Multiple-person rooms are also beneficial for the residence of nursing homes. Therefore, it is desirable to give nursing home residents the freedom of decision-making in room arrangement and give higher priority for multiple-person rooms during assignment.

Conflict of interest and funding

The authors declare no conflict of interest and funding.

Disclosure

The authors report no conflicts of interest in this work.

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