

Net-step exercise and depressive symptoms among the community-dwelling elderly in Japan

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ABSTRACT

Introduction: Leisure-time physical activity (LTPA) and exercise have attracted attention as potential preventive factors against depression in the elderly. The net-step exercise (NSE) was developed in Hokkaido, Japan to assist elderly people with decreased physical functions. NSE is a non-aerobic, low-intensity, and slow balance motion LTPA. In the present study, the relationship between NSE and depressive symptoms among the community-dwelling elderly is examined.

Methods: This study employed a cross-sectional design with community-dwelling elderly participants, aged 72–81 years ($n = 672$; mean age = 76.4 years). Participation in NSE and other LTPA, including walking, jogging, and park golf, a sport popular in Hokkaido, particularly among the elderly, was assessed. Depressive symptoms were measured using the 15-item Geriatric Depression Scale (GDS-15).

Results: Univariate analysis showed that those participating in NSE more than once a month and those who reported engaging in walking or park golf more than once a week were less likely to report symptoms of depression. Multivariate analysis showed that NSE and walking had marginally significant (odds ratio (OR) = 0.53; 95% CI: 0.27–1.02) and significant (OR = 0.61; 95% CI: 0.40–0.93) inverse associations, respectively, with reports of depressive symptoms even after adjustments for age, sex, years of education, continuous walking for 15 min, experience of a fall in the past year, utilization of various long-term care services provided for the elderly, stroke, frequency of jogging, and park golf.

Discussion: This study showed that participants engaging in NSE, which is a non-aerobic, low-intensity, and low frequency activity, had a marginally significantly inverse association with depressive symptoms. Longitudinal research should be conducted in the future.

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Key words: elderly, depression, exercise, Japan, leisure activities

1. Introduction

Depression is one of the most serious mental health problems observed in the elderly. The prevalence of clinically significant depressive symptoms among community-dwelling elderly people ranges from 8% to 16%. Further, the prevalence of major depression is believed to be between 1% and 4%¹⁾. Depression in the elderly is associated with poor self-rated health²⁾, a higher risk of mortality^{3,4)}, limited ability to perform activities of daily living (ADL) and difficulties in mobility⁵⁾, and cognitive decline⁶⁾. It is also associated with significantly higher health care utilization and costs⁷⁾ and higher levels of informal caregiving⁸⁾.

Recent studies have focused on the potential role

of leisure-time physical activity (LTPA) and exercise in the prevention and management of depression. Several observational studies report that various types of LTPA, such as walking and jogging and sports, are associated with decreased depressive symptoms⁹⁻¹²⁾ and are protective factors against depression in the elderly¹³⁻¹⁵⁾. Several intervention studies have also demonstrated the positive effects of physical activity¹⁶⁻¹⁸⁾. Blumenthal et al.¹⁹⁾, for example, demonstrated that a 16-week group exercise program for elderly patients with major depressive disorders was as effective as treatment with antidepressant medication. In addition, previous studies have found an inverse relationship between non-aerobic light exercise (i.e., flexibility and resistance exercise, yoga, and Tai Chi) and depressive

symptoms in the elderly²⁰⁻²³). Therefore, recommending LTPA may be a useful approach for managing depression in the elderly.

In order to encourage more participation in LTPA among the elderly, it is necessary to consider forms of LTPA that are easy to perform, because physical function declines as people age, and the elderly often suffer from various disabilities. In Hokkaido, the Net-Step Exercise (NSE) was developed for elderly people with decreased physical functions. NSE uses a net called the “Fumanet.” This name is derived from “net” and the Japanese word “fumanai,” which means “to stride over something” (Figure 1)²⁴. The Fumanet is a 4 m x 1.5 m net with 50-cm squares arranged in a 3 x 8 grid. Participants are asked to walk over the Fumanet slowly using a stepping motion taught by a volunteer trained in exercise safety. NSE is a non-aerobic, low-intensity, and slow balance motion LTPA. It is primarily performed in neighborhood association units in local public facilities.

In Ikeda, a small town in Hokkaido, NSE events are held once or twice a month in each neighborhood association unit throughout the town. This study examines the relationship between NSE and depressive symptoms among the community-dwelling elderly, and compares NSE with other physical activities such as walking, jogging, and park golf, a popular sport in Hokkaido.

2. Methods

This study was approved by the Ethics Committee of Sapporo Medical University (January 24, 2012) and conforms to the provisions of the Declaration of Helsinki (Edinburgh, 2001).

A cross-sectional study design was used for this

study. In Ikeda, a questionnaire was mailed in 2011 to 1,180 community-dwelling individuals aged 70–79 years. 921 individuals (78.1%) initially agreed to participate in the study and were targeted in a second (2012) and third (2013) follow-up survey. Informed consent was obtained from each person. Among the 921 individuals, 18 died, 17 became too frail to perform LTPA, 11 moved away, and 139 dropped out during the two-year follow-up period. The remaining 736 who were available for the third follow-up survey were sent structured questionnaires, of which 693 were returned. After excluding 21 individuals due to incomplete questionnaires, the data of 672 (56.9%) people were analyzed in the present study.

The information gathered included age, sex, years of education, past medical history (hypertension, diabetes, heart disease, stroke, cancer, pneumonia) and depressive symptoms. Subjects were also asked if they normally walked continuously for 15 minutes, had experienced a fall in the past year, or utilized available long-term care services.

To evaluate the frequency with which participants exercised, we asked the individuals if they engaged in activities such as walking, jogging or park golf more than once a week. To evaluate their participation in NSE, we asked the individuals if they engaged in it more than once a month. The differences in the frequency of participation criteria reflect the differences in opportunities available for individuals to participate in the two activities. Namely, although participants could theoretically walk, jog or play park golf at any time, NSE events are held only once or twice a month in each neighborhood association unit. For the sake of consistency (and to avoid possible confusion due to daily activities changing in accordance with the seasons), we assessed the frequency of participation in LTPA in three months from autumn to winter.

Depressive symptoms were assessed using the 15-item Geriatric Depression Scale (GDS-15). The scale uses a yes/no format²⁵. In previous studies using the GDS-15, a cut-off value of 5 or 6 was used²⁶⁻²⁸. In the present study, to minimize the number of false positives, a 6-point value was selected as the cut-off value. The cut-off of 6 points or more was used to divide participants into two groups. The “depressive group” was designated as the group with points above the cut-off value and the “non-depressive group” was that with points below the cut-off.



Figure 1. Photograph of a participant performing the net-step exercise using the Fumanet®.

Statistical Analysis

Analysis was conducted using SPSS version 19.0 for Windows (SPSS Inc., Chicago, IL, USA). Univariate analyses were conducted to assess differences in the frequencies and means of each variable according to the presence of depressive symptoms. Mann-Whitney tests were used for the between-group comparison of age and years of education due to non-normal distributions. A chi-square test was used to investigate the association between categorical variables.

Three logistic regression models were used to assess the associations between NSE, other LTPA, and depressive symptoms. The first model was unadjusted and resulted in crude odds ratios (OR) and 95% confidence

intervals (CI). The second model included only LTPA and covariates that had a significant relationship with depressive symptoms in the univariate analyses. The third model included all LTPA. The significance level was set at 0.05.

3. Results

The mean age of the 672 individuals was 76.4 years ($SD = 2.7$, range: 72–81 years). The mean GDS-15 score was 3.65 ($SD = 3.35$) and 169 participants (25.1%) had depressive symptoms (6 points or more on the GDS-15).

Table 1 presents the results of the univariate analysis for the presence of depressive symptoms and background characteristics. Individuals with depressive symptoms were older than those without ($P < 0.001$). Those with

Table 1. Results of univariate analysis on status of depressive symptoms with regard to background characteristics

Variables	Total <i>n</i> (%)	Non-depressive group <i>n</i> (%)	Depressive group <i>n</i> (%)	<i>P</i>
All	672	503 (74.9)	169 (25.1)	
Age (mean \pm SD)				
years	76.4 \pm 2.7	76.1 \pm 2.7	77.3 \pm 2.6	<0.001
Sex				
Male	307 (45.7)	238 (77.5)	69 (22.5)	0.143
Female	365 (54.3)	265 (72.6)	100 (27.4)	
Years of Education				
<9 years	122 (18.2)	73 (59.8)	49 (40.2)	<0.001
9–10 years	274 (40.8)	206 (75.2)	68 (24.8)	
>11 years	276 (41.1)	224 (81.2)	52 (18.8)	
Continuous walking for 15 min				
No	58 (8.6)	24 (41.4)	34 (58.6)	<0.001
Yes	614 (91.4)	479 (78.0)	135 (22.0)	
Experience of a fall in the past year				
No	515 (76.9)	395 (76.7)	120 (23.3)	0.037
Yes	155 (23.1)	106 (68.4)	49 (31.6)	
Various long-term care services provided for the elderly				
No	646 (96.3)	491 (76.0)	155 (24.0)	<0.001
Yes	25 (3.7)	11 (44.0)	14 (56.0)	
Past medical history				
Hypertension				
No	212 (31.5)	162 (76.4)	50 (23.6)	0.526
Yes	460 (68.5)	341 (74.1)	119 (25.9)	
Diabetes				
No	496 (73.8)	371 (74.8)	125 (25.2)	0.958
Yes	176 (26.2)	132 (75.0)	44 (25.0)	
Heart disease				
No	501 (74.6)	380 (75.8)	121 (24.2)	0.308
Yes	171 (25.4)	123 (71.9)	48 (28.1)	
Stroke				
No	600 (89.3)	460 (76.7)	140 (23.3)	0.002
Yes	72 (10.7)	43 (59.7)	29 (40.3)	
Cancer				
No	526 (78.4)	397 (75.5)	129 (24.5)	0.452
Yes	145 (21.6)	105 (72.4)	40 (27.6)	
Pneumonia				
No	586 (87.2)	445 (75.9)	141 (24.1)	0.090
Yes	86 (12.8)	58 (67.4)	28 (32.6)	

more years of education, and the ability to perform continuous walking for 15 min were less likely to have depressive symptoms ($P < 0.001$). A history of stroke, utilization of various long-term care services provided for the elderly, and experiencing a fall in the past year were associated with the presence of depressive symptoms ($P = 0.002$, $P < 0.001$, and $P = 0.037$, respectively).

Table 2 shows the results of the univariate analysis for the presence of depressive symptoms with regard

to participation in NSE, walking, jogging, and park golf. Participation in NSE, walking and park golf were inversely associated with depressive symptoms ($P = 0.012$, $P < 0.001$, $P = 0.023$, respectively). However, jogging was not associated with depressive symptoms ($P = 0.142$).

The results of the unadjusted logistic regression model (Model 1) are presented in Table 3. The crude OR of depressive symptoms was significantly lower

Table 2. Results of univariate analysis on status of depressive symptoms with regard to leisure-time physical activity(LTPA)

Variables	Total <i>n</i> (%)	Non-depressive group <i>n</i> (%)	Depressive group <i>n</i> (%)	<i>P</i>
All	672	503 (74.9)	169 (25.1)	
NSE*				
(more than once a month)				
No	582 (86.6)	426 (73.2)	156 (26.8)	0.012
Yes	90 (13.4)	77 (85.6)	13 (14.4)	
Walking				
(more than once a week)				
No	387 (57.6)	266 (68.7)	121 (31.3)	<0.001
Yes	285 (42.4)	237 (83.2)	48 (16.8)	
Jogging				
(more than once a week)				
No	600 (89.3)	444 (74.0)	156 (26.0)	0.142
Yes	72 (10.7)	59 (81.9)	13 (18.1)	
Park Golf				
(more than once a week)				
No	601 (89.4)	442 (73.5)	159 (26.5)	0.023
Yes	71 (10.6)	61 (85.9)	10 (14.1)	

*NSE: Net-Step Exercise

Table 3. Crude and adjusted odds ratio (OR) and 95% confidence interval (CI) for status of depressive symptoms with regard to leisure-time physical activity (LTPA)

	Model 1 † OR (95% CI)	Model 2 ‡ OR (95% CI)	Model 3 § OR (95% CI)
NSE*			
(more than once a month)			
No	1.00 (reference)	1.00 (reference)	1.00 (reference)
Yes	0.46 (0.25-0.85)	0.48 (0.25-0.91)	0.53 (0.27-1.02)
Walking			
(more than once a week)			
No	1.00 (reference)	1.00 (reference)	1.00 (reference)
Yes	0.45 (0.31-0.65)	0.59 (0.39-0.88)	0.61 (0.40-0.93)
Jogging			
(more than once a week)			
No	1.00 (reference)	1.00 (reference)	1.00 (reference)
Yes	0.63 (0.34-1.18)	0.72 (0.37-1.38)	1.06 (0.53-2.15)
Park Golf			
(more than once a week)			
No	1.00 (reference)	1.00 (reference)	1.00 (reference)
Yes	0.46 (0.23-0.91)	0.51 (0.25-1.05)	0.58 (0.28-1.20)

† Model 1: Unadjusted

‡ Model 2: Adjusted for age, years of education, continuous walking for 15 min, experience of a fall in the past year, utilization of various long-term care services provided for the elderly, history of stroke

§ Model 3: Adjusted for age, years of education, continuous walking for 15 min, experience of a fall in the past year, utilization of various long-term care services provided for the elderly, history of stroke, other LTPA

*NSE: Net-Step Exercise

in NSE (OR = 0.46; 95% CI: 0.25–0.85), walking (OR = 0.45; 95% CI: 0.31–0.65), and park golf (OR = 0.46; 95% CI: 0.23–0.91). However, no significant association was found between jogging and depressive symptoms (OR = 0.63; 95% CI: 0.34–1.18).

The results for Model 2, which is adjusted for age, years of education, continuous walking for 15 min, experience of a fall in the past year, utilization of various long-term care services provided for the elderly and history of stroke, showed that NSE and walking were significantly inversely associated with depressive symptoms (OR = 0.48; 95% CI: 0.25–0.91, OR = 0.59; 95% CI: 0.39–0.88, respectively). No significant association with depressive symptoms was found for park golf (OR = 0.51; 95% CI: 0.25–1.05) or jogging (OR = 0.72; 95% CI: 0.37–1.38).

The results of Model 3, adjusted by adding other LTPA, indicated that walking was still significantly inversely associated with depressive symptoms (OR = 0.61; 95% CI: 0.40–0.93). NSE had a marginally significantly inverse association with depressive symptoms (OR = 0.53; 95% CI: 0.27–1.02).

4. Discussion

In the present study, 25.1% of the 672 participants showed depressive symptoms. This figure is comparable to those observed in previous studies of the community-dwelling elderly in Japan, which have reported the prevalence of depressive symptoms to be between 12.5% to 30.4% using the GDS^{29–33)}.

The results of this study showed that participation in NSE more than once a month had a marginally significantly inverse association with depressive symptoms. These findings indicated that people engaging in NSE, which is a non-aerobic, low-intensity, and low frequency exercise consisting of slow balance motions, were less likely to report depressive symptoms. To our knowledge, no previous study has demonstrated the relationship between NSE and depressive symptoms in the elderly. Our results may have been due to participants' improvements in physical function (e.g., balance and ADL) or psychological changes (e.g., enjoyment, sense of mastery, sense of self-esteem). Similar results have been reported in previous studies, in which a link between non-aerobic light exercise and depressive symptoms in the elderly could be observed^{20,23)}. Furthermore, the social aspect of performing NSE in a group may have been influential. Previous studies have suggested that depressive symptoms are negatively related to social participation, social support, and the quality of

social relationships^{34–37)}.

However, jogging, which is an aerobic exercise, was not significantly inversely related to depressive symptoms. This result supports a previous intervention study that found no association between high-intensity exercise and a reduction in depression³⁸⁾. In this study, Moses et al.³⁸⁾ suggested that those participating in the high-level exercise conditions may have found the training too demanding, and that the rigor of the schedule mitigated against any improvements in well-being. Also, they considered the possibility that the moderate exercise conditions may have been more enjoyable, permitting subjects to achieve goals of physical activity that had previously seemed beyond them, without exerting undue effort. In the present study, jogging, a high-intensity exercise, was not significantly inversely associated with depressive symptoms, and NSE of low-intensity exercise had a marginally significantly inverse association with depressive symptoms. Therefore, NSE may be useful as an activity to prevent depression in the elderly.

This study demonstrated that aerobic walking was significantly inversely related to depressive symptoms. Walking may be useful in preventing depression in the elderly as indicated in previous studies^{11,39)}. However, participation in NSE has several additional advantages. Compared to walking or jogging, NSE is a low-intensity program that can be conducted in a small indoor space, which eliminates potential weather problems. Because participant movement in NSE is slow and merely involves striding over a net in a manner that will not lead to physical pain or injury, it is suitable for the elderly with reduced physical functions. Therefore, it may be easier for these individuals to continue participating in NSE than in activities that may lead to pain or injury. Additionally, even in areas where certain exercises have become unavailable or unviable due to a decreasing and ageing population, with minimal training it is still possible for anyone, including the elderly, to teach proper techniques of NSE to their peers. Moreover, NSE might contribute to maintaining and improving social relationships. Previous studies that examined exercise settings reported that group exercise was more beneficial for the mental health of the elderly than an individual exercise program performed at home⁴⁰⁾. NSE should therefore be considered an ideal choice to be implemented as a community-based exercise program.

There are of course limitations to this study. First, causal relationships cannot be determined in the cross-sectional design the study utilized. Additionally, we did

not consider the influence of other physical activities such as yoga, Tai chi, and light gymnastics. Finally, selection bias might exist because some subjects did not participate in this study.

In conclusion, the result of our research showed that participation in NSE at least once a month had a marginally significantly inverse association with reported depressive symptoms. A physical activity that has few requirements, such as NSE, may thus be an effective protective strategy against depression in the elderly. Future longitudinal studies should be conducted to clarify the social context of physical activity.

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日本の地域在住高齢者における Net-step exercise と抑うつ状態

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背景：余暇身体活動（Leisure-time physical activity, LTPA）や運動は高齢者におけるうつの予防要因として注目されている。Net-step exercise (NSE) は、北海道における身体機能の低下を伴う高齢者のために開発された。本研究では、地域在住高齢者におけるNSEと抑うつ状態との関係を調査した。

方法：本研究は 72 歳から 81 歳 (N=672; 平均年齢 76.4 歳) の地域在住高齢者を対象とした断面研究とした。NSE やその他北海道で人気である LTPA (ウォーキングやジョギング, パークゴルフ) への参加状況を調査した。抑うつ状態は 15 項目の Geriatric Depression Scale (GDS-15) を用いて調査した。

結果：単変量解析の結果, 月 1 回以上 NSE へ参加したものと週 1 回以上ウォーキングまたはパークゴルフ

を行っているとは回答したものは抑うつ状態の報告が少ない傾向であった。多変量解析の結果, NSE とウォーキングは年齢, 性, 教育年数, 15 分以上の連続歩行, 過去 1 年間の転倒経験, 介護サービスの利用, 脳卒中, ジョギング及びパークゴルフ及びNSE またはウォーキングへの参加を調整後, それぞれ抑うつ状態がないことと, 境界有意 (odds ratio (OR) = 0.53, 95% CI: 0.27–1.02) で, そして有意 (OR = 0.61, 95% CI: 0.40–0.93) に逆の関係が示された。

考察：本研究では, 非有酸素性で低強度, 少ない頻度の運動である NSE への参加と抑うつ状態との間に境界有意で負の関連が示された。今後は縦断的研究が必要である。