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Original Article

Related factors associated with exercise behavior in patients with peripheral arterial disease

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Abstract. [Purpose] This study aimed to identify the factors associated with exercise behavior in patients with peripheral arterial disease. [Participants and Methods] The study included 43 patients with peripheral arterial disease (mean age, 75.2 ± 5.6 years) who were admitted for endovascular treatment from January 2020 to June 2021. Participants were surveyed through questionnaires to assess their physical function for determining their exercise behavior and the presence of physical, personal, and environmental factors that might have affected their stage of change regarding exercise behavior. [Results] A comparison of physical, personal, and environmental factors between the two groups classified by the presence or absence of exercise behavior showed that subjective health and exercise self-efficacy were significantly lower in the group without exercise. Furthermore, a difference was noted in the presence or absence of work. The adjusted binomial logistic regression analysis results using each of the factors differing between the groups, plus the walking impairment questionnaire total score as explanatory variables, showed a significant relationship with exercise self-efficacy only. [Conclusion] The results of this study showed that exercise self-efficacy presented a useful predictive relationship with the presence of exercise behavior in patients with peripheral arterial disease.

Key words: Peripheral arterial disease, Behavior modification, Transtheoretical Model

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INTRODUCTION

Chronic diseases such as peripheral arterial disease (PAD) are difficult to cure because they often develop over a long period of time due to lifestyle-related diseases. The treatment of chronic diseases requires that the disease be controlled on a daily basis with continuous care. However, the shortening of hospitalization periods and increase in the number of patients in a super-aging society who require hospitalization have imposed a human burden on medical care[1)]. In the field of rehabilitation, there has been a movement toward home-based exercise (HE) to meet the needs of patients. Previous studies on the effects of HE on patients with PAD have reported positive effects such as prolongation of the 6-minute walking distance (6MWD)[2)] and improvement of vascular endothelial function[3)]. The Guidelines for the Treatment of Peripheral Arterial Occlusive Disease (revised in 2015) recommend HE therapy with oral medication when supervised exercise therapy is difficult

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to perform (evidence level B)[4]. However, since HE is performed independently by the patients, in practice, the continuation rate of HE is often poor. Mouser et al.[5] reported a 6-month HE completion rate of 34.2% in PAD patients. We believe that a change in intrinsic awareness, including behavioral change approaches, is necessary from the time of hospitalization for HE to be successfully introduced for PAD patients.

In recent years, educational interventions based on the Transtheoretical Model (TTM) have become widespread, especially in the United States[6]. The TTM divides the psychological progression of a patient's behavior into five stages: "precontemplation", "contemplation", "preparation", "action", and "maintenance". Guidelines for approaching each stage have been provided, and the effects of using this model for smoking cessation and dietary guidance have been reported[7, 8]. In Japan, the model has also been used for nutritional guidance for diabetic patients[9], and it is expected to become more versatile with the spread of HE. However, to apply this model to effect behavioral change in clinical practice, it is necessary to clarify the factors that influence the exercise behavior of patients and investigate the related factors in consideration of the characteristics of each disease.

In previous studies, the factors related to exercise behavior in middle-aged and older adults have been reported as intrinsic, such as one's own health status and lack of interest, and extrinsic, such as lack of time and lack of transportation[10, 11]. Recently, Nakano et al.[12] reported that the factors related to elderly people who attend nursing care prevention classes continuing to exercise were the incorporation of exercise into their lives and the confidence to resume exercise after several breaks (called recovery self-efficacy [Re-SE]). Furthermore, physical discomfort, lower extremity muscle strength, time constraints, and SE have been reported to be related to exercise behavior in patients with diabetes, who are thought to have similar lifestyles as PAD patients[13–15]. The same tendency may be observed in PAD patients, many of whom have diabetes mellitus (DM) as a disease background. Moreover, PAD patients may have a lifestyle of reduced activity due to intermittent claudication (IC), which contributes synergistically as a psychological and physical inhibitor to exercise behavior. The present study was conducted to investigate the psychological and physical inhibitors of exercise behavior. Based on previous studies and hypotheses, this study aims to identify the factors related to exercise behavior in PAD patients by dividing the factors into physical, personal, and environmental factors.

PARTICIPANTS AND METHODS

From January 2020 to May 2021, 58 patients with PAD were admitted to the International University of Health and Welfare Hospital for endovascular treatment and bypass surgery of peripheral blood vessels. Of these, we excluded those who (1) had pain at rest, (2) had limitations in walking for reasons other than IC, and (3) had a Mini-Mental State Examination score of <23[16]. In addition, 2 patients with missing data were excluded, leaving 43 patients for inclusion in the final analysis. In the classification of patient attributes, IC was defined as exertional pain in the lower extremities that was not painful at rest but resolved within 10 minutes after interruption of walking[17]. Patients with a resting Ankle Brachial Pressure Index (ABI) of >0.90 were included if the vascular surgeon judged from the angiographic results that the patient had vascular stenosis.

The age of the participants was 75.2 ± 5.6 years (mean ± standard deviation), and the disease severity was Fontaine II for all participants. Participants were grouped into one of 4 groups, based on their minimum ABI values: I, severe stenosis (>1.30 or <0.40); II, moderate stenosis (0.40–0.69); III, mild stenosis (0.70–0.90); and IV, normal (0.91–1.30) groups, respectively. There were 6 (14.0%), 12 (27.9%), 15 (34.9%), and 10 (23.3%) patients in groups I, II, III, and IV, respectively.

This study was conducted with the approval of the ethics review board of the International University of Health and Welfare Hospital (approval No. 20-Io-8-2). All patients provided written informed consent before their inclusion in this study.

A survey was conducted through self-administered questionnaires and function measurements of physical, personal, and environmental factors that were expected to be related to exercise performance. Three physical therapists performed the measurements, and information about measurement methods and questionnaire survey methods was shared in advance with the participants. All questionnaires and measurements of physical functions were conducted on the same day at any time between admission and revascularization.

The primary endpoint for this study was the presence or absence of exercise behavior. The patients' stage of change (SOC) for exercise behavior was assessed using a questionnaire based on the TTM. The content of the questionnaire was based on the SOC for exercise behavior scale devised by Prochaska et al.[6], which has been reported to be reliable and valid by Oka[18]. The content of each item was based on five stages of exercise behavior: "maintenance", in which participants continue to exercise regularly for >6 months; "action", in which participants exercise regularly but within 6 months of their first exercise; "preparation", in which participants exercise but not regularly; "contemplation", in which participants intend to start exercising in the near future; and "precontemplation", in which individuals do not intend to exercise in the future. Respondents were asked to select one of these five items that applied to their current thoughts and actions. The definition of "regular exercise" in the questionnaire was based on the National Health and Nutrition Survey conducted by the Ministry of Health, Labour and Welfare[19]. Regular exercise was defined as ≥30 minutes per session twice or more per week during leisure time, other than work or housework, for the purpose of improving health and physical fitness. In this study, participants in the "contemplation" and "precontemplation" stages were assigned to the no-exercise group, and patients in the "preparation", "action," and "maintenance" stages were assigned to the exercise group.

Physical activity, 6MWD, and walking impairment questionnaire (WIQ) were used to evaluate physical factors.

Physical activity was assessed using the Japanese short version of the International Physical Activity Questionnaire, which is widely used for assessing the level of physical activity. The reliability and validity of the questionnaire have been reported[20]. In this questionnaire, only "activities performed for at least 10 minutes at a time" were counted in an average week, and the activity intensity was divided into high intensity, medium intensity, and walking. In this assessment, the total activity volume—which is the sum of the activity volumes at all intensities—was used to indicate the patient's physical activity.

The 6MWD was measured using the American Thoracic Society guidelines[21]. For this measurement, all participants were instructed to walk as fast and as far as possible within 6 minutes. Walking was performed on a 40-m flat straight course with no slope in the rehabilitation room and back, and gait evaluation was performed once when the participant was walking at maximum speed. The evaluation was stopped when dyspnea, chest pain, or pallor appeared. It was explained to participants in advance that they could take a break if they felt strong dyspnea or pain in the lower limbs and that the time would not be stopped.

WIQ is a disease-specific assessment of PAD that evaluates the degree of lower extremity pain, walking distance, walking speed, and stair climbing ability during walking. It has been validated against treadmill walking in patients with IC, and a Japanese version has been prepared, which has been reported to have sufficient reliability and responsiveness[22]. Scores range from 0 to 100, and the higher the score, the higher the community-based walking ability. The survey was conducted face-to-face, and the therapist-in-charge was available to respond to participants immediately if there were any unclear points in the questionnaire.

As individual factors of the participants, subjective health, exercise self-efficacy (exercise SE), and Re-SE were included in the questionnaire.

In response to the question, "How do you usually feel about your health?" the subjective health perception was surveyed using a four-point scale: "very healthy", "fairly healthy", "not so healthy", and "not healthy". Kanda et al.[23] stated that subjective health is a subjective evaluation of one's own health status and that it is a health indicator that captures the overall health status, which cannot be expressed by objective indicators such as mortality or prevalence. It is also one of the questions in the National Survey on Living Standards in Japan[24], and walking ability has been reported as a relevant factor in the variation of subjective health perception[25].

The Exercise SE Scale[26] was used to evaluate exercise SE. This scale indicates the degree of continuation of exercise when an individual exercises regularly and takes into consideration the climate and cultural background of Japan. Each question consists of four items: "physical fatigue", "mental stress", "lack of time", and "bad weather". The contents are "I am confident in exercising even when I am a little tired (physical fatigue)", "I am confident in exercising even when I am not feeling so much (mental stress)", and "I am exercising even when I am busy and have no time". For each item, participants used a five-step ordered scale from "I do not think so at all" to "I think so a lot" to evaluate their exercise SE. The answers were based on the five-option method—1, I do not think so at all; 2, I do not think so much; 3, Either no; 4, I think so a little; 5, I think so a lot—and the higher the score, the higher the exercise SE.

For the evaluation of Re-SE, we referred to Schwarzer's[27] confidence to resume exercise and asked the participants to answer the question "Are you confident of resuming exercise even if you take several breaks?" using a five-point scale from 1, "Do not agree at all" to 5, "Strongly agree".

Environmental factors that may have affected a participant's exercise behavior were assessed through questions regarding the presence or absence of a job, ownership of a car, and ownership of a farm in a questionnaire using a two-option "yes" or "no" response.

In this study, we used binomial logistic regression analysis to transform the potential confounders into synthetic variables and incorporate the propensity score and each factor into the regression equation, one factor each. To calculate the sample size, we used the explanatory variable ×10, as per a previous study[28]. In a survey on SOC of diabetic patients in Japan, 43% of patients were reported to categorized under the "precontemplation" or "contemplation" stages[29], and we hypothesized that in PAD patients, pain in the lower limbs would act synergistically, and approximately 50% would fall into the no-exercise group. Therefore, the necessary sample size for this study was calculated to be 40 persons, since the analysis was conducted with two factors, the explanatory variables and the propensity score estimated from the confounding factors, and 45 persons were measured based on the missing data.

Statistical analysis was performed using IBM SPSS Statistics for Windows, Version 24.0 (IBM Corp., Armonk, NY, USA) to compare the disease background of patients, and the physical, personal, and environmental factors between the exercise and no-exercise groups. Proportional and ordinal scales were compared using the Mann–Whitney U test, and Fisher's exact test was used to compare the occurrence rates of nominal scales. The adjusted odds ratios and their 95% confidence intervals were calculated using the logistic regression model to clarify the relationship between the factors that showed differences between the two groups and the factors that were predicted to be related to exercise behavior from previous studies. To adjust for confounding factors between exercise behavior and each factor, propensity scores were calculated by logistic regression analysis with age, gender, and presence of DM as covariates and were incorporated into the regression equation as synthetic variables. In addition, ABI, comorbidities, and site of vascular stenosis were noted from medical records to clarify the severity of disease and complications. The significance level for all variables was set at 5%.

RESULTS

The results of the comparison of the disease background of PAD patients between the two groups (Table 1) showed that 22 (51%) participants were in the precontemplation, 4 (9%) in the contemplation, 8 (19%) in the preparation, 2 (5%) in the action, and 7 (16%) in the maintenance SOC. A significant difference in background factors was only noted for the incidence of DM, indicating that the incidence of this disease was higher in the group without exercise behavior. The results of the comparison of physical, personal, and environmental factors between the two groups (Table 2) showed that there was no difference in physical factors between the two groups, but there were significant differences in personal factors such as subjective health (p=0.015) and exercise SE (p=0.006). There was a significant difference in the environmental factor of presence of employment (p=0.032), indicating that more patients in the no-exercise group were employed.

Table 1. Disease background of each group

Characteristic	No exercise behavior (n=26)	With exercise behavior (n=17)
Basic information		
Gender		
Male, n (%)	23 (88)	14 (82)
Female, n (%)	3 (12)	3 (18)
Age, year	73 [52–87]	76 [61–87]
BMI, kg/m²	23.1 [17.1–32.9]	21.7 [18.3–24.7]
MMSE, point	27 [23–30]	27 [23–27]
Behavior change stage, n (%)		
Pre contemplation	22 (84)	
Contemplation	4 (16)	
Preparation		8 (47)
Action		2 (12)
Maintenance		7 (41)
ABI, n (%)		
Severe stenosis (0.40< or 1.30>)	5 (19)	1 (6)
Moderate stenosis (0.40–0.69)	6 (23)	6 (35)
Mild stenosis (0.70–0.90)	10 (38)	5 (29)
Normal (0.91–1.30)	5 (19)	5 (29)
Comorbidities, n (%)		
Diabetes mellitus	20 (77)	7 (41)*
Hypertension	18 (69)	12 (71)
Hyperlipidemia	13 (50)	4 (24)
Chronic kidney disease	7 (27)	1 (6)
Medications, n (%)		
Common iliac artery	1 (4)	3 (18)
External Iliac Artery	3 (12)	7 (41)
Superficial Femoral Artery	16 (62)	6 (35)
Below the popliteal artery	3 (12)	0
Drug therapies, n (%)		
BB	5 (19)	5 (29)
Ca channel blocker	10 (38)	10 (59)
Antiplatelet agents	19 (73)	17 (100)
Statin	4 (15)	5 (29)
Warfarin	3 (12)	1 (6)
NOAC	1 (4)	2 (12)

*p<0.05.
Median [Max–Min].
BMI: Body mass index; ABI: Ankle-brachial index; BB: Beta-blocker; NOAC: Novel oral anticoagulant.

Next, we conducted a binomial logistic regression analysis using each factor (subjective health perception, exercise SE, and work status plus WIQ total score) as explanatory variables. Table 3 shows the results of adjustment of each factor by the propensity score (C statistic 0.733) with age, gender, and presence of diabetes as composite variables. In the adjusted analysis, only exercise SE was related to the presence of exercise behavior, and the adjusted odds ratio was 1.328 (95% confidence interval 1.031–1.12, p=0.028).

Table 2. Comparison between two groups for each factor

Characteristic	No exercise behavior (n=26)	With exercise behavior (n=17)
Physical factors		
IPAQ, METs·min/week	333.5 [0–4,380]	960 [0–5,760]
6MWD, m	300 [40–540]	390 [120–560]
WIQ score, Point		
Pain	25 [0–100]	50 [0–100]
Distance	28 [7–100]	34 [6–100]
Speed	31 [0–100]	33 [3–89]
Steps	37.5 [0–100]	62 [8–100]
Total	136.5 [10–400]	200 [31–389]
Individual factors, point		
Subjective health	3 [1–4]	4 [1–5]*
Exercise SE	8 [4–17]	11 [6–19]*
Re-SE	3 [1–5]	4 [2–5]
Environmental factors, n (%)		
Working	13 (50)	3 (18)*
Ownership of the field	8 (31)	11 (65)
Car ownership	10 (38)	7 (41)

*p<0.05.
Median [Max–Min].
IPAQ: International physical activity questionnaire; 6MWD: 6-minute walk distance; WIQ: Walking impairment questionnaire; Exercise SE: Exercise self-efficacy; Re-SE: Recovery self-efficacy; Exercise SE: The answers were based on the five-option method—1, I do not think so at all; 2, I do not think so much; 3, Either no; 4, I think so a little; 5, I think so a lot—and the higher the score, the higher the exercise SE.

Table 3. Logistic regression with or without exercise as the objective variable

Explanatory variable	Coeff	OR	95% CI Lower–Upper	Significance (p)
Unadjusted model				
Exercise SE	0.232	1.262	0.983–1.619	0.068
Subjective health	0.466	1.594	0.697–3.646	0.270
Working	−1.832	0.160	0.030–0.869	0.034*
WIQ total score	0.006	1.006	0.996–1.015	0.245
Adjusted model				
Explanatory variable	Coeff	OR	95% CI Lower–Upper	Significance (p)
Exercise SE	0.284	1.328	1.031–1.12	0.028*
Subjective health	0.587	1.798	0.897–3.607	0.098
Working	−1.282	0.278	0.057–1.352	0.113
WIQ total score	0.006	1.006	0.998–1.013	0.139

*p<0.05.
Exercise SE: Exercise self-efficacy; WIQ: Walking impairment questionnaire; OR: Odds ratio; CI: Confidence interval.

DISCUSSION

Recent studies have shown that regular exercise is important for extending healthy life expectancy for middle-aged and elderly individuals. In Japan, 27.1% of males and 23.9% of females in the age group of 50–59 years were engaged in "continuous exercise for 30 minutes or more twice a week", as were 46.2% of males and 39.0% of females in the age group of ≥65 years [19]. In the present study, 21% of patients with symptomatic PAD were in the active and maintenance SOC, and the rate of exercise was lower in patients with PAD than in the general middle-aged and elderly population. Furthermore, the proportion of patients with exercise behavior was low compared with that in previous studies 29) that investigated the exercise behavior stage of DM patients. This suggests that PAD patients tend to be less likely to engage in exercise behavior than patients with other chronic diseases. To clarify the factors related to exercise behavior in PAD patients, we compared the two groups of patients (exercise and no-exercise) and found that the percentage of diabetic patients was significantly higher in the no-exercise group. The results suggest that PAD patients may have similar behavioral characteristics to DM patients.

In addition, when physical, personal, and environmental factors were compared between the two groups, no significant differences were found in any of the physical factors of physical function. This may be because patients in the exercise group who were in the preparation stage or later were aware of the decline of their physical function in their daily lives, which caused them to change their behavior. Conversely, patients in the no-exercise group were unaware of the decline in their physical function, which reflected their lack of motivation to exercise, and therefore, there was no behavioral change. As a result, we believe that the presence or absence of exercise behavior did not match the hierarchy in physical function.

Furthermore, the hypothesis of this study was that the decrease in walking ability due to IC, which is a symptom specific to PAD, would be synergistically involved as an inhibitor of exercise behavior; however, we did not find a significant relationship between the WIQ score and exercise behavior. We believe that this factor may have been influenced by the fact that IC was a trigger for exercise behavior and not only an inhibitor of the patients' behavior. Future studies are necessary to investigate factors that promote and inhibit patients' exercise behaviors and to examine how encouraging patients' awareness of their own physical decline affects their exercise behaviors.

In terms of individual and environmental factors, our results show that subjective health and exercise SE were significantly higher in the exercise group, and the number of participants who were working was significantly higher in the no-exercise group; however, adjusted logistic regression analysis showed that there was a significant relationship only for exercise SE. A previous study[15] on DM patients reported a similar finding that exercise SE was related to exercise habit, suggesting that patients with PAD show a similar trend to patients with DM. This may be due to changes in motor function and psychological stress associated with IC, which are disease characteristics of PAD patients. Baloch et al.[30] reported decreased exercise tolerance in PAD patients, and McDermott et al.[31] reported an association between PAD and depression, and these factors were reported to be related to the decrease in physical activity associated with IC. The physical activity and 6MWD of patients in the present study were lower than those of community-dwelling elderly people in Japan[32, 33], suggesting that the decline in physical activity and exercise tolerance associated with IC contributed to depression, which in turn caused the decline in SE.

The results of the present study revealed that self-efficacy is related to the motor behavior of PAD patients. Therefore, in adapting TTM to PAD patients, it is suggested that incorporating "success experience" and "proxy experience", which are considered to improve self-efficacy, may have a positive effect on the change of motor behavior. On the other hand, one of the limitations of this study is that the time series of exercise behavior and exercise SE are not clear, and therefore, the effect of intervention on motor SE cannot be mentioned in this study. In addition, the mechanism of the decrease in motor SE is only discussed in the literature. A longitudinal study on the effects of interventions focusing on motor SE on exercise behavior would be a useful focus of future investigations and to structure educational interventions in the introduction of HE.

The present study revealed that exercise SE is an associated factor of exercise behavior in patients with PAD. The results of this study will play an auxiliary role in assessing the motor behavior of PAD patients and contribute to the construction of basic information for future intervention studies.

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Conflicts of interest

There are no conflicts of interest to disclose.

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