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EXAMINATION OF CHARACTERISTICS OF DIABETIC PATIENTS REQUIRING FREQUENT EXERCISE INTERVENTION BASED ON THE TRANSTHEORETICAL MODEL

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ABSTRACT

Background: Frequent intervention has been strongly recommended for diabetic patients undergoing exercise therapy. However, high-frequency interventions for all patients are inefficient. The purpose of this study is to examine the characteristics of groups divided based on changes in exercise behaviors.

Methods: The participants comprised 42 diabetic patients who completed a two-week program to improve their glycemic control and receive diabetes education. Their change in exercise behavior, self-efficacy of exercise, and diabetes and social statuses were collected at the time of discharge and 12 and 24 weeks after discharge. Based on such data, the participants were divided into five groups: (1) the IW12 group whose exercise habits were interrupted within 12 weeks; (2) the IW24 group whose exercise habits were interrupted within 24 weeks; (3) the CO24 group who continued exercising after 24 weeks; (4) the Action group that actively exercised at the time of discharge; and (5) the Maintenance group that maintained same level of exercise at the time of discharge.

Results: The total score of self-efficacy of exercise at the time of discharge was 13.7 ± 2.1 (the IW12 group), 11.3 ± 2.5 (the IW24 group), 16.2 ± 3.2 (the CO24 group), 16.7 ± 3.1 (the Action group), and 15.9 ± 2.3 (the Maintenance group). The scores for the IW24 group were significantly lower compared with the Action and Maintenance Patients groups ($p < 0.01$).

Conclusion: Our findings suggest that intervention should be performed frequently, especially in a diabetic patient who is the preparation stage under low self-efficacy of exercise.

Keywords: self-efficacy; diabetic patients; exercise; transtheoretical model; education.

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INTRODUCTION

Treatment for diabetes consists of diet, exercise, and medications. Exercise improves not only glycemic control [1–4] and insulin resistance [3] but also various functions, such as lipid metabolism, blood pressure [4], anti-inflammatory actions [5], arterial stiffness [6], and cardiorespiratory fitness [7]. It also directly affects the psychological quality of life [8] and total mortality risk [9]. However, few diabetic patients can achieve the recommended level of physical activity [10], maintaining exercise habits is more difficult than undergoing diet therapy [11]. Therefore, some studies examined the effects of an exercise intervention using the transtheoretical model (TTM) of behavior change in diabetic patients [12, 13]. TTM mainly focuses on the stage of change, processes of change, decision-making, and self-efficacy [14], which is the belief in one's ability to achieve certain goals [15].

The TTM is strongly recommended for diabetic patients undergoing exercise therapy [16]. Previous studies have noted that stage-matched intervention improves exercise behavior and glycemic control among diabetic patients [17]. On the other hand, the effect of a lifestyle modification program comprising counseling, education, and practice does not continue until six months after the intervention [18], it is necessary to check the implementation status of the exercise every six months and intervene again for those who have been unable to continue the exercise. Alternatively, the physical activity promotion program including weekly telephone support, maintains physical activity level and improvement of HbA1c levels, even 12 months after the intervention [19]. Patients may be able to continue the exercise by providing frequent support. However, it is unrealistic to intervene once a week for all patients owing to cost reasons. Therefore, it is important to identify patients who require frequent support. Although the changes in exercise behaviors may be useful for identifying these patients, its usefulness has not yet been verified. The purpose of this study is to examine the characteristics of groups divided based on changes in exercise behaviors.

METHODS

Participants comprised 64 diabetic patients (aged 20 and above) admitted to the Japanese Red Cross Kanazawa Hospital between March 2015 and February 2017. All of the patients completed a two-week program to improve their glycemic control and receive diabetes education, after which follow-ups were performed for 42 patients at 12 and 24 weeks after discharge.

The two-week intervention program was performed by a doctor, a nurse, a dietician, a medical technologist, a pharmacist, and two physical therapists. The exercise and educational portions, performed by the two Certified Diabetes Educators of Japan qualified physical therapists, consisted of three parts: (1) instructions on exercise, (2) tailored individual guidance, and (3) practical exercise activities. More specifically, the lectures presented the effects of different exercise methods, whereas the counseling sessions were performed by the individual's self-reflection and previous lifestyle habits. Finally, the practical exercise activities, which included aerobic exercise and resistance training, highlighted the importance of continuing such activities after discharge from the program.

Change in the patients' exercise behaviors, the self-efficacy of exercise which has been related to change in the patients' exercise behaviors [20][21], diabetes status, and social status were collected. Also, diabetic polyneuropathy was specified as an abnormality in the nerve conduction velocity or the attenuation of protective sensation measured by the 4.56 Semmes–Weinstein monofilament test, whereas retinopathy was specified as an exacerbation beyond simple retinopathy. Moreover, diabetic nephropathy was specified as urinary albumin/creatinine with a ratio of above 30 mg/g creatinine, whereas HbA1c levels were determined at the time of admission and 12 weeks after discharge, as indices of glycemic control.

Changes in exercise behaviors were classified into six stages: pre-contemplation, contemplation, preparation, action, maintenance, and terminal. According to such changes after discharge, the participants were grouped as follows. The participants in the preparation stage were divided into three groups: (1) the IW12 (interruption within 12 weeks) group, (2) the IW24 (interruption within 24 weeks) group, and (3) the CO24 (continuation over 24 weeks) group. The participants in the action stage were included in the Action group, whereas the participants in the maintenance and terminal stage were included in the Maintenance group.

The self-efficacy of the exercise was evaluated using a scale from a previous study, which was modified for Japanese patients [22]. This self-administered questionnaire consisted of four items: (1) I can participate in regular exercise when I am physically tired, (2) I can participate in regular exercise when I am in a bad mood or stressed, (3) I can participate in regular exercise when I do not feel that I have enough time, and (4) I can participate in regular exercise when the weather is poor. All of the items were rated on a five-point Likert scale, ordering from 1 (I am not at all confident) to 5 (I am very confident). The total possible score ranged from 4 to 20 points were taken at the time of discharge, and 12 and 24 weeks after discharge. The investigations were carried out by the physical therapists, whereas the doctor and the nurse performed the follow-up consultations. Written informed consent was obtained from all of the participants. The Ethics Committee approved this study of the Japanese Red Cross Kanazawa Hospital.

The Kolmogorov–Smirnov test was used to confirm the normality of each variable. The exercise behavior changes were compared among the time discharge and at 12 and 24 weeks after discharge using the Friedman test. The total scores for the self-efficacy of exercise and other variables at the time discharge and 12 and 24 weeks after discharge were compared among the five groups. A one-way analysis of variance was used for the parametric data, whereas the Kruskal–Wallis test was conducted for the nonparametric data. For post hoc analysis, the Bonferroni test was employed, whereas the chi-squared test was conducted to compare the nominal data. Overall, the significance level was set at $p < 0.05$, and the statistical analyses were performed using SPSS software for Windows (IBM Corp., Armonk, NY, USA).

RESULTS

As shown in Figure 1, since follow-ups could not be performed for 22 out of the 64 patients, they were excluded from the analysis. The basic status, diabetic status, social status, and self-efficacy of exercise scores for all of the participants are presented in Table 1. The changes in the participants' exercise behaviors at the time discharge and at 12 and 24 weeks after discharge are shown in Table 2. The score at the time of discharge for the IW24 group was significantly lower than the scores for the Action and Maintenance groups ($p < 0.01$). The score at 12 weeks after discharge for the IW12 group was significantly lower than the scores for the Action and Maintenance groups ($p < 0.01$), whereas the score for the IW24 group was significantly lower than the scores for the Action, Maintenance, and CO24 groups ($p < 0.01$). The scores at 24 weeks after discharge for the IW12 and IW24 groups were significantly lower than those for the Action, Maintenance, and CO24 groups ($p < 0.01$).

Moreover, there were no significant differences between the groups about basic status, diabetes status, and social status (see Table 3).

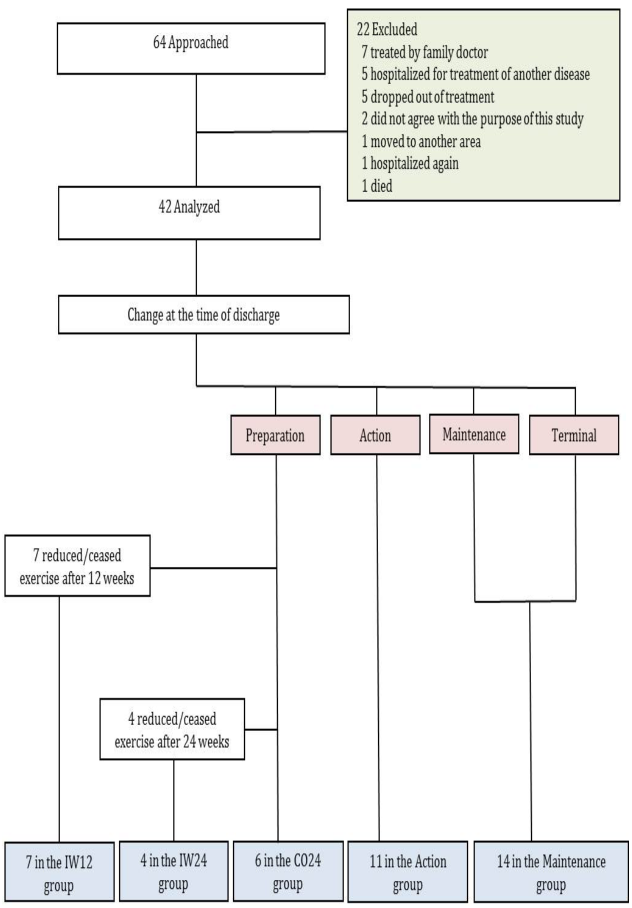

Figure 1: Flowchart of the number of participants that were excluded in the analysis, and the number that was assigned to each group. (Notes: IW12: interruption within 12 weeks; IW24: interruption within 24 weeks; CO24: continuation over 24 weeks.)

Table 1: The participants' characteristics and their self-efficacy of exercise scores.

Characteristic	n=42
Basic status	
Age (years)	60.5 ± 11.8
Gender (male/female)	20/22
Body weight at admission (kg)	66.4 ± 11.7
Male (kg)	71.4 ± 17.4
Female (kg)	61.8 ± 17.1
Body mass index (kg/m^2)	25.9 ± 6.5
Male (kg/m^2)	25.5 ± 5.9
Female (kg/m^2)	26.3 ± 7.1
Diabetes status	
Duration of diabetes (years)	8.1 ± 7.5
Diabetic polyneuropathy (%)	45.2
Diabetic retinopathy (%)	16.7
Diabetic nephropathy (%)	11.9
History of cerebrovascular disease (%)	11.9
History of coronary artery disease (%)	11.9
Injecting insulin (%)	40.5
First educational hospitalization (%)	52.4
HbA1c levels (%)	
At admission	9.5 ± 1.9
At 12 weeks after discharge	7.1 ± 0.9
At 24 weeks after discharge	7.2 ± 1.1
Self-efficacy of exercise scores	
At admission	15.3 ± 3.0
At 12 weeks after discharge	13.8 ± 3.6
At 24 weeks after discharge	13.9 ± 4.1
Social status	
Living with family (%)	85.7
Working full-time or part-time (%)	47.6

Notes: HbA1c: glycated hemoglobin (hemoglobin A1c).

Table 2: The participants' changes in exercise behaviors.

Change in exercise behaviors	At the time of discharge	At 12 weeks after discharge	At 24 weeks after discharge
Precontemplation	0%	9.5%	4.8%
Contemplation	0%	7.1%	11.9%
Preparation	40.5%	2.4%	4.8%
Action	26.2%	54.8%	31.0%
Maintenance	19.1%	9.5%	31.0%
Terminal	14.3%	16.7%	16.7%

Table 3: Comparison of the participants' characteristics and their self-efficacy of exercise scores.

	IW12 group (n or Means ± SD)	IW24 group	CO24 group	Action group	Maintenance group	p-value
n	7	4	6	11	14	
Age (years)	57.7 ± 11.7	63.8 ± 13.9	63.2 ± 12.2	57.2 ± 14.2	62.5 ± 9.7	0.704

Gender (male/female)	4/3	1/3	2/4	5/6	8/6	0.718
Body weight at admission (kg)	67.3 ± 20.3	62.8 ± 20.0	76.2 ± 23.1	66.3 ± 19.6	62.8 ± 11.8	0.648
Body mass index (kg/m²)	25.6 ± 6.8	25.8 ± 4.2	29.7 ± 10.6	26.3 ± 6.8	24.2 ± 4.5	0.575
Duration of diabetes (years)	7.4 ± 6.6	8.9 ± 8.8	2.8 ± 4.6	6.9 ± 8.4	11.4 ± 7.2	0.200
Diabetic polyneuropathy (%)	57.1	0	33.3	36.4	64.3	0.168
Diabetic retinopathy (%)	14.3	0	16.7	18.2	21.4	0.898
Diabetic nephropathy (%)	14.3	0	16.7	9.1	14.3	0.929
History of cerebrovascular disease (%)	0	25.0	16.7	0	21.4	0.351
History of coronary artery disease (%)	28.6	0	16.7	9.1	7.1	0.573
Living with family (%)	85.7	100	100	72.7	85.7	0.528
Working full-time or part-time (%)	57.1	25.0	50.0	45.5	50.0	0.888
Injecting insulin (%)	57.1	50.0	16.7	54.5	28.6	0.393
First educational hospitalization (%)	57.1	25.0	66.7	63.6	42.9	0.588
HbA1c levels (%)						
At admission	9.7 ± 2.2	8.5 ± 0.4	9.8 ± 2.2	9.8 ± 2.4	9.3 ± 1.7	0.763
At 12 weeks after discharge	6.7 ± 0.4	7.1 ± 0.7	6.9 ± 0.9	7.0 ± 1.3	7.3 ± 0.7	0.625
At 24 weeks after discharge	6.7 ± 0.5	7.1 ± 0.9	7.3 ± 1.4	6.9 ± 1.3	7.7 ± 0.9	0.275
Self-efficacy of exercise scores						
At admission	13.7 ± 2.1	11.3 ± 2.5 *,†	16.2 ± 3.2	16.7 ± 3.1	15.9 ± 2.3	0.008
At 12 weeks after discharge	10.6 ± 2.4 *,†	8.8 ± 2.5 *,†,‡	14.8 ± 2.6	15.1 ± 2.9	15.4 ± 3.3	0.000
At 24 weeks after discharge	9.1 ± 3.3 *,†,‡	8.3 ± 2.8 *,†,‡	15.8 ± 2.9	14.5 ± 2.2	16.6 ± 2.6	0.000

IW12: interruption within 12 weeks; IW24: interruption within 24 weeks; CO24: continuation over 24 weeks.

*: $p < 0.01$ vs Action group, †: $p < 0.01$ vs Maintenance group, ‡: $p < 0.01$ vs CO24 group.

DISCUSSION

There were several findings in our study. First, the patients who were in the preparation stage at the time of discharge were divided into IW12, IW24, and CO24 groups. Within each group, IW24 had important characteristics. The total score for the self-efficacy of exercise at the time of discharge in the IW24 group was significantly lower than the scores of the Action and Maintenance groups. Previous research has shown that the effects of lifestyle modification programs are not apparent until six months after discharge [18]. In another study regarding self-management education for adults with type 2 diabetes, improvements in the HbA1c levels decreased between one and three months after discharge [23]. The findings of the present study are in line with these studies, suggesting that patients with low self-efficacy tend to interrupt their exercise behaviors six months after discharge. There are four influential efficacy information: personal mastery experience, vicarious experience, verbal persuasion, and states of physiological arousal [15]. It is unclear whether this information can explain the self-efficacy decrease in this study. However, Kirk et al. (2004) [24] reported that in addition to counseling once every six months, contact with the patients between one and three months after discharge helped them continue their exercise activities, whereas DiLorrent et al. (2003) [25] reported that telephone contact once every three months motivated the diabetic patients to continue their exercise behaviors. Thus, to help diabetic patients who are preparation stage under low self-efficacy of exercise continue their exercise routines six months after discharge, contact might be made at least once every three months. In this regard, such contact can include face-to-face meetings, telephone consultations, and Internet-based communication technologies [26, 27].

The second result is that there was no difference in the total score for the self-efficacy of exercise at the time of discharge among the IW12 group, the IW24 group, the CO24 group, and the Action and Maintenance groups. Moreover, in the IW12 group, there was no statistically significant difference between the other groups with regard to basic status, diabetes status, and social status. This indicates that, at the time of discharge, it is difficult to distinguish between the IW12 group and the CO24 group, and it is difficult to predict whether a patient with high self-efficacy will continue to exercise 12 weeks after discharge. Resnick et al. (2006) [28] reported that not only the patient's medical history but also his/her race and educational background impact exercise behaviors. As for the present study, since the participants' racial and educational backgrounds were not obtained, the investigation was inadequate.

The third result is that in the CO24, Action, and Maintenance groups, the participants were able to continue their exercise behaviors after 24 weeks. For these groups, it may be appropriate for doctors and nurses to confirm and praise the exercise behaviors of their patients at the time of their regular outpatient visits. Moreover, when changes in exercise behaviors are observed, physical therapists can intervene and help the patients continue such behaviors over the long term.

Despite these findings, there are several limitations that should be noted. First, in older patients, the purpose of exercise therapy shifts to maintaining and improving the ability to daily living. In obese patients, the main influential efficacy information may be different because it is easy to check the effects of exercise using weight scales. Therefore, these results do not apply to older and/or obese patients. Second, this research utilized a single facility and a relatively small number of participants. As a result, it was difficult to examine confounding factors such as age and the duration of the disease using logistic regression analyses. Also, since five patients stopped visiting the hospital during this research, the true proportion of patients that did not continue their exercise activities could have been somewhat higher.

Furthermore, examining the changes in exercise behaviors and the self-efficacy of exercise at 12 and 24 weeks after discharge may have inadvertently influenced or even enhanced the patients' exercise behaviors. Finally, the effective intervention frequency for each group is not fully considered. Therefore, future studies should use a larger sample of participants across multiple facilities, expand the timeframe from six months to one year, and consider different methods of intervention.

CONCLUSION

Our findings suggest that intervention should be performed frequently, especially in a diabetic patient who is the preparation stage under low self-efficacy of exercise.

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Conflicts of Interest: The authors declare no conflict of interest.

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