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Follow-up Study of Continuation versus Discontinuation of Home Exercise in Type 2 Diabetes Patients

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Abstract. [Purpose] The purposes of the present study were to understand and to analyze the current situation, including lifestyle and environmental factors, of type 2 diabetes patients receiving treatment, in order to identify factors facilitating the continuation of exercise therapy and thereby determine the optimal focus of care instructions. [Methods] The subjects were patients with type 2 diabetes admitted to Hachinohe City Hospital for instructional purposes, for whom individual exercise therapies were prescribed. All the subjects were discharged from the hospital 3 years or more before participating in the study. The subjects were asked via telephone interview whether they were still exercising after discharge from hospital. Based on the results of the telephone survey, a univariate analysis (bivariate logistic regression analysis of parameters affecting the continuation or discontinuation of exercise) was performed to determine the significance of each parameter. [Results] The following factors were identified as facilitating the continuation of exercise therapy: 1) goal setting, 2) absence of impeding factors, 3) operant conditioning, 4) self-monitoring, 5) presence of someone providing instruction on how to exercise, 6) confidence in exercising even when busy doing household duties or working, 7) suffering no disadvantage from exercising, 8) use of exercise facilities and 9) age (advanced age was associated with a higher continuation rate). [Conclusion] To our knowledge, no previous study has focused on which instruction method is optimal based on follow-up survey results. Targeted care instruction can be provided by statistically analyzing differences between patients who continue exercising and those who do not and incorporating the results of the analysis into exercise instruction.
Key words: Diabetes mellitus, Exercise therapy, Follow-up survey

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INTRODUCTION

The Japanese Certification Board for Diabetes Educator has reported that the exercise continuation rate among Japanese type 2 diabetes patients is very low, ranging from 40% to 60%. Nevertheless, no study has aimed at establishing guidelines for promoting the continuation of exercise therapy. In several countries other than Japan, community health centers are utilized to promote the continuation of exercise therapy by diabetic patients[1,2]. On the other hand, in Japan, diabetes exercise therapy is performed at medical institutions. In addition, the fee for diabetes exercise therapy is included in the basic medical fee and cannot be calculated as a separate medical treatment fee. These background factors appear to preclude improvements in exercise instruction for Japanese diabetic patients. At Hachinohe City Hospital, physical therapists have actively been involved in diabetes exercise therapy. In our previous study, designed to examine the effectiveness of an intervention by physical therapists in diabetes exercise therapy, we interviewed a total of 101 patients with type 2 diabetes to assess the exercise therapy continuation rate 1 year after the prescription of the therapy. We performed a telephone interview with patients who had been prescribed step exercise, which can be done even in winter, and confirmed that 88% of these patients were still exercising throughout the year. The most common types of continuously performed exercises were walking and the step exercise. Most of the patients who maintained their exercise regimen showed good glycemic control while most of those

patients who had ceased exercising had poor glycemic control. These findings suggest that prescribing exercise therapy at an appropriate intensity that can be performed indoors, even when there is snow outside, results in a high exercise continuation rate. The present study was designed to identify lifestyle and environmental factors affecting patients who continued to exercise after discharge from the hospital and those who did not, to clarify the differences between these two groups of patients, and thereby establish a new instruction method based on lifestyle and environmental factors.

SUBJECTS AND METHODS

Subjects

The subjects were patients with type 2 diabetes who were admitted to Hachinohe City Hospital for instructional purposes, for whom individual exercise therapies were prescribed. All the subjects were discharged from the hospital 3 years or more before participating in the study.

Detailed information about the subjects is shown in Table 1. There were 49 men and 38 women. The men had a mean age of 49.4 ± 12.8 years, mean height of 168.5 ± 8.1 cm, mean body weight of 70.7 ± 18.0 Kg and mean body mass index (BMI) of 24.3 ± 5.3. Their mean HbA1c level as a measure of glycemic control was 10.7 ± 2.2% at the time of physical therapy (PT) prescription, 6.9 1.4% at 1 year post-discharge and 7.7 ± 2.0% at 3 years post-discharge.

The women had a mean age of 54.1 ± 15.0 years, mean height of 153.4 ± 7.1 cm, mean body weight of 62.4 ± 16.0 Kg and mean BMI of 26.5 ± 7.0. Their mean HbA1c level as a measure of glycemic control was 10.1 ± 1.7% at the time of PT prescription, 7.5 ± 1.5% at 1 year post-discharge and 8.1 ± 1.6% at 3 years post-discharge. Details of medications prescribed to both men and women are also shown in the table.

Table 1. Physique · Pharmacotherapy · HbA1c

	Men (n=49)	Women (n=38)
Anthropometrics		
Age (years)	49.4 ±12.8	54.1 ± 15.0
Height (cm)	168.5 ± 8.1	153.4 ± 7.1
BMI	70.7 ± 18.0	62.4 ± 16.0
	24.8 ± 5.3	26.5 ± 7.0
Medication (oral hypoglycemic agents)		
Medication(–)	5	1
Medication(+)	36	29
Insulin	4	1
Medication and insulin	4	7
HbA1c		
At start of PT (%)	10.7 ± 2.2	10.1 ± 1.7
1 year post-discharge (%)	6.9 ± 1.4	7.5 ± 1.5
3 years post-discharge (%)	7.7 ± 2.0	8.1 ± 1.6

Methods

Informed consent was obtained from each subject by sending an informed consent document by mail. Subsequently, a telephone interview was carried out.

1) Objective evaluation of the status of continuation: Interviewers asked about the subjects' daily activities and objectively determined whether exercise therapy had been continued or discontinued.

2) Evaluation of factors contributing to the success or failure (including lack of full compliance with the prescribed regimen) of exercise continuation during the maintenance period:

Patients items associated with success or failure of exercise continuation during the maintenance period were surveyed by telephone interview. Specific survey items were adapted from "A study on the development and utilization of teaching materials based on behavioral scientific approaches for the acquisition and continuation of exercise habits", a general health science research project sponsored by a grant-in-aid for scientific research provided by the Ministry of Health, Labour and Welfare.

After completion of steps 1) and 2) above, multivariate analysis was performed to statistically determine factors affecting the continuation and discontinuation of exercise. Statistical analyses were performed to identify factors facilitating and impeding the continuation of exercise. The method of instruction, i.e. how to exercise, was then devised based on the analysis results. The details of the survey items used in the present study were not described in the informed consent document sent to the subjects, as there was concern that thse subjects might give biased responses if they were provided with such information. As a first step, univariate analysis was performed to test the significance of each parameter. Then, in the second step, only the significant parameters were subjected to logistic regression analysis for determination of the significance of differences.

RESULTS

The informed consent document was sent by mail to 101 subjects who were involved in the previous study. Eighty-seven of them agreed to participate in the present study and were then interviewed by telephone as described above. The results of the univariate analysis to determine the significance of each parameter are summarized in Table 2. The subsequent logistic regression analysis identified the following factors as facilitating the continuation of exercise therapy (Table 3):

1) goal setting (P = 0.000), 2) absence of impeding factors (P = 0.000), 3) operant conditioning (P = 0.000), 4) self-monitoring (P = 0.002), 5) presence of someone providing instruction on how to exercise (P = 0.002), 6) confidence in exercising even when busy doing household duties or working (P = 0.003), 7) suffering no disadvantage from exercising (P = 0.003), 8) use of exercise facilities (P = 0.025) and 9) age (advanced age was associated with a higher continuation rate) (P = 0.039). These 9 factors were statistically significant according to the analysis of psychological, behavioral and environmental factors 3 years after hospital discharge, although age was shown to be an invariable factor (probably because older subjects were less

Table 2. Results of univariate analysis

		Continuation	Discontinuation	Total
Age	Mean	52.62	42.6	
	SE	1.505	5.319	
Gender	Male	43	6	49
	Female	34	4	38
Knowledge about exercise (exercise intensity)	Yes	76	10	86
	No	1	0	1
Knowledge about exercise (exercise type)	Yes	77	10	87
Daily amount of exercise is sufficient	Yes	63	0	63
	No	14	10	24
Goal setting	Yes	75	5	80
	No	2	5	7
Knowing the locations of exercise facilities	Yes	69	7	76
	No	8	3	11
Use of exercise facilities	Yes	53	3	56
	No	24	7	31
Self-monitoring	Yes	66	4	70
	No	11	6	17
Benefiting from exercise	Yes	77	10	87
Suffering a disadvantage from exercise	Yes	16	7	23
	No	61	3	64
Presence of factors impeding exercise	Yes	6	9	15
	No	71	1	72
Stimulation control method	Yes	77	4	81
	No	0	6	6
Operant conditioning	Yes	72	2	74
	No	5	8	13

		Continuation	Discontinuation	Total
Presence of someone aware of the goal	Yes	70	7	77
	No	7	3	10
Presence of someone to talk with	Yes	66	7	73
	No	11	3	14
Presence of someone the subject can invite to exercise together	Yes	68	7	75
	No	9	3	12
Presence of someone inviting the subject to exercise together	Yes	68	8	76
	No	9	2	11
Presence of someone providing instruction on how to exercise	Yes	67	4	71
	No	10	6	16
Presence of someone who cares about the subject	Yes	74	8	82
	No	3	2	5
Presence of someone critical of the subject	No	77	10	87
Confidence in exercising even in hot summer weather (a larger number indicates higher confidence)	1	11	3	14
	2	0	7	7
	3	36	0	36
	4	18	0	18
	5	12	0	12
Confidence in exercising even in cold winter weather (a larger number indicates higher confidence)	1	13	6	19
	2	0	4	4
	3	58	0	58
	4	2	0	2
	5	4	0	4
Confidence in exercising even when it is raining (a larger number indicates higher confidence)	1	13	7	20
	2	2	3	5
	3	58	0	58
	4	1	0	1
	5	3	0	3
Confidence in exercising even when busy doing household duties or working (a larger number indicates higher confidence)	1	15	2	17
	2	2	7	9
	3	34	1	35
	4	5	0	5
	5	21	0	21
Change(s) in living environment	Yes	72	9	81
	No	5	1	6
Change(s) in diabetes treatment regimen	Yes	69	9	78
	No	8	1	9

likely to have jobs and thus had more time to exercise than younger subjects). Thus, it was statistically confirmed that those meeting criteria 1) to 8) above after hospital discharge were more likely to continue exercise than those who did not.

Meanwhile, the results of the analysis of psychological, behavioral and environmental factors revealed that the following 14 factors did not affect the continuation or discontinuation of exercise in type 2 diabetes patients: 1) gender, 2) knowledge about exercise, 3) knowing the locations of exercise facilities, 4) stimulation control method, 5) being aware of the goal, 6) presence of someone to talk with, 7) presence of someone the subject can invite to exercise together, 8) presence of someone inviting the subject to exercise together, 9) presence of someone who cares about the subject, 10) confidence in exercising even in summer, 11) confidence in exercising even in winter, 12) confidence in exercising even when it is raining, 13) change(s) in the living environment and 14) change(s) in the diabetes treatment regimen.

DISCUSSION

One guideline recommends that diabetes be diagnosed based on a comprehensive assessment of the presence of chronic hyperglycemia, symptoms, clinical findings, family history, body weight change and other evidence[3]. Diagnostic criteria for diabetes have been changed over time. While the WHO guideline is basically followed, various criteria are reviewed and proposed in different countries by such organizations like the Diabetes Diagnosis Criteria Review Committee. Type 2 diabetes is caused by interactions between genetic and acquired factors, such as overeating and insufficient exercise, and is characterized by hyperglycemia due to relative insulin insufficiency and insulin resistance. According to the current Japanese diagnostic criteria for diabetes, a patient is diagnosed as "diabetic type" if any of the following criteria are met: 1) early morning fasting blood glucose level of 126 mg/dl or more, 2) non-fasting blood glucose level of 200 mg/dl or more, and 3) 2-hour glucose level during oral glucose tolerance test of 200 mg/dl or more. Patients diagnosed as "diabetic type" on two different testing days are then diagnosed as having "diabetes". In addition, a patient diagnosed as "diabetic type" can be confirmed to have diabetes based on a single test if any of the following criteria are met: 1) presence of a typical symptom of diabetes (e.g. thirst, polydipsia, polyuria and weight loss), 2) HbA1c

Table 3. Results of logistic regression analysis

		Odds ratio	95% CI	
Age		1.049	1.002	1.098
Gender		0.843	0.220	3.229
Knowledge about exercise (exercise intensity)				
Knowledge about exercise (exercise type)				
Daily amount of exercise is sufficient				
Goal setting		37.500	5.762	244.068
Knowing the locations of exercise facilities		3.696	0.794	17.206
Use of exercise facilities		5.153	1.226	21.659
Self-monitoring		9.000	2.182	37.124
Benefiting from exercise				
Suffering a disadvantage from exercise		0.112	0.026	0.484
Presence of factors impeding exercise		0.009	0.001	0.087
Stimulation control method				
Operant conditioning		57.600	9.568	346.773
Someone aware of the goal		4.286	0.901	20.391
Presence of someone to talk with		2.571	0.576	11.473
Presence of someone the subject can invite to exercise together		3.238	0.708	14.816
Presence of someone inviting the subject to exercise together		1.889	0.346	10.322
Presence of someone providing instruction in how to do exercise		10.050	2.407	41.955
Presence of someone who cares about the subject		6.167	0.893	42.578
Presence of someone critical of the subject				
Confidence in exercising even in hot summer weather (a larger number indicates higher confidence)	1 2 3 4 5			
Confidence in exercising even in cold winter weather (a larger number indicates higher confidence)	1 2 3 4 5			
Confidence in exercising even when it is raining (a larger number indicates higher confidence)	1 2 3 4 5	2.786	0.373	20.819
Confidence in exercising even when busy doing household duties or working (a larger number indicates higher confidence)	1 2 3 4 5	26.250	3.041	226.604
Change(s) in living environment		1.600	0.168	15.273
Change(s) in diabetes treatment regimen		0.958	0.107	8.579

≥6.5%, and 3) presence of confirmed diabetic retinopathy. For patients who are diagnosed as having "diabetes" based on meeting the above diagnostic criteria, treatment regimens focusing on glycemic control will be initiated. One of the glycemic control measures used in the course of treatment is HbA1c, which is also included in the diagnostic criteria. The HbA1c level varies in proportion to blood glucose levels during the period from the emergence of a red blood cell (carrying hemoglobin) to the time of measurement and thus reflects the mean blood glucose level during the prior 1 to 2 months. The lower and upper limits of the normal range of HbA1c are 4.3% and 5.8%, respectively, which are used as references for HbA1c evaluation. More specifically, HbA1c values of <5.8% are classified as "excellent", 5.8% to <6.5% as "good", 6.5% to <8.0% as "fair" and ≥8.0% as "poor". The goal of diabetes treatment is to control the HbA1c level to a maximum of 6.5%, which is based on the finding of the Kumamoto Study[4] that patients with HbA1c levels below 6.5% and 2-hour postprandial blood glucose below 180 mg/dl have a lower risk of developing capillary complications[5].

Treatment regimens for type 2 diabetes patients have been assessed in large-scale studies conducted in different countries, including the 1) Diabetes Control and Complications Trial (DCCT)[6], conducted with 1,441 patients between 1983 and 1993, which demonstrated that better glycemic control is effective for preventing complications; 2) Epidemiology of Diabetes Interventions and Complications (EDIC)[7], conducted with 1,375 patients between 1994 and present, which demonstrated that maintenance of good glycemic control for a certain period of time is followed by a prolonged treatment effect (based on examining the incidences of capillary complications and cardiovascular diseases); 3) Diabetes Prevention Program (DPP)[8], conducted with 3,234 patients between 1996 and 1999, which demonstrated that lifestyle improvement is more effective than medication in preventing the development of diabetes; 4) Kumamoto Study[4], conducted with 110 Japanese type 2 diabetes patients between 1987 and 1988, which demonstrated the rationale for glycemic control parameters; and 5) United Kingdom Prospective Diabetes Study (UKPDS)[9], conducted with 4,297 patients between 1988 and 1997, which demonstrated that strict control of blood glucose levels and blood pressure prevents complications in not only type 1 but also type 2 diabetes patients.

Diabetes treatment regimens vary depending on the type and condition of diabetes and the degree of metabolic disturbance. For patients with non-insulin dependent type 2 diabetes, adequate diet and exercise therapies should be prescribed for 2-3 months. If good glycemic control is not obtained with these therapies, oral hypoglycemic agents and, eventually, insulin therapy should be prescribed. Type 2 diabetes patients who are pregnant, undergoing surgery requiring systemic management, or suffering from a serious infectious disease, should also be prescribed insulin therapy. Depending on the degree of metabolic disturbance, insulin and/or oral hypoglycemic agents, in addition to diet and exercise therapies, may be prescribed when treatment is initiated.

The effectiveness of exercise therapy as evidence-based medicine has been established by meta-analyses. In type 2 diabetic patients, decreased cardiopulmonary function and physical activity are considered to be related to cardiovascular manifestations and to mortality. A meta-analysis of studies examining the effects of exercise therapy on cardiopulmonary function in type 2 diabetes patients showed that exercising at an intensity of 50–75% of maximum oxygen uptake for about 50 minutes, 3–4 times weekly for 20 weeks, significantly increased maximum oxygen uptake[10]. In addition, although type 2 diabetes patients often show insulin resistance, obesity, hypertension and abnormal lipid metabolism, exercise therapy can improve these abnormalities as well as glycemic control[11]. A meta-analysis of studies employing exercise therapy over a period of 8 weeks or more showed that approximately 50 minutes of moderate-intensity exercise, 3–4 times weekly for 18 weeks, resulted in a significant HbA1c improvement without weight loss[12]. More specifically, a study examining the insulin sensitivity improving effect of exercise[13] demonstrated that the effect of a single exercise session continues for 2–3 days. A study examining the cumulative effect of exercise[14] demonstrated that repeated exercise increases the expression of glucose transporter (GLUT)-4, which transports glucose in response to signals from insulin and exercise (GLUT types 1 to 9 have been identified, to date).

The present study was designed to demonstrate the objectivity of the survey methods used for Japanese subjects to determine exercise continuation rates and, on the basis of these survey results, to statistically identify important factors that should be considered when prescribing exercise therapy. Previous studies did not examine the nature of differences observed between patients who continued exercise therapy and those who did not. The study methods were not standardized and only whether or not exercise was continued was examined. With the methods employed in the previous follow-up surveys, variable results can be obtained via subjective interpretations made by investigators. In the present study, to avoid such subjectivity, survey items were adapted from "A study on the development and utilization of teaching materials based on behavioral scientific approaches for the acquisition and continuation of exercise habits", a general health science research project sponsored by a grant-in-aid for scientific research provided by the Ministry of Health, Labour and Welfare. This study compared patients who continued exercise therapy and those who did not to identify differences between the two groups. In the present study, we selected objective, rather than subjective, qualitative questions and employed a comprehensive method.

In Japan, with the aim of improving the quality of medical professionals involved in diabetes care, the qualification system for certified diabetes educators has recently been established in a co-medical area. In view of this current trend, we believe the present findings to be of major significance. As mentioned above, we did not draw the usual conclusion that "such-and-such percent of patients

continued exercise after discharge from the hospital and therefore exercise instruction is important". Instead, the present study statistically analyzed differences between patients who continued exercise and those who did not with the ultimate goal of incorporating the results of the analysis into exercise instruction, which we believe is the merit of the present study.

The only currently available finding regarding the continuation rate of exercise therapy in diabetes care is that exercise instruction increases the continuation rate. To the best of our knowledge, no previous study has focused on which instruction method is optimal based on follow-up survey results. We previously conducted a similar study in the past, but did not go into as much detail, such as analysis of patient demographics. What previous studies have shown is that there is no organization set up to follow diabetes exercise therapy and patients are left unattended once they are given exercise instruction. Previous studies have conducted follow-up surveys and simply determined the percentage of patients who continued exercise, but did not address solutions to qualitative problems. In this sense, the present study was able to scientifically elucidate what types of psychological, mental and environmental factors impact the continuation or discontinuation of exercise, allowing the results to be incorporated into the method of exercise instruction. The specific methods of instruction identified in the present study include 1) setting a clear goal, 2) identifying impeding factors and considering how to solve the problem, 3) starting operant conditioning during the teaching period, 4) making self-monitoring a habit, 5) providing instruction to someone able to teach the patient how to exercise (e.g. the patient's family members), 6) providing instruction allowing the patient to gain confidence in doing exercise even when he or she is busy doing household duties or working, 7) determining whether or not the patient suffers any disadvantage from exercise and discussing how to solve the problem, and 8) encouraging the patient to use nearby exercise facilities, if available.

While selected instruction methods were identified in the present study, no significant correlations were found between the exercise continuation rate and the following 14 factors: 1) gender, 2) knowledge about exercise, 3) knowing the locations of exercise facilities, 4) stimulation control method, 5) being aware of the goal, 6) presence of someone to talk with, 7) presence of someone the subject can invite to exercise together, 8) presence of someone inviting the subject to exercise together, 9) presence of someone who cares about the subject, 10) confidence in exercising even in summer, 11) confidence in exercising even in winter, 12) confidence in exercising even when it is raining, 13) change(s) in living environment and 14) change(s) in the diabetes treatment regimen. These factors were not statistically significant in the present study, but are still considered important in diabetes care. However, the present results were utilized in the development of a new instruction method focused on the 8 aforementioned factors found to be particularly important contributors to the continuation of exercise, rather than the above 14 factors. We consider it useful to identify particularly important instruction items and to provide appropriate instruction to patients within the limited time available during inpatient or outpatient instructional sessions on diabetes exercise therapy.

REFERENCES

1) Chin MH, Cook S, Jin L, et al.: Links barriers to providing diabetes care in community health centers. Diabetes Care, 2001, 24: 268–274.
2) Dunstan DW, Vulikh E, Owen N, et al.: Links Community center-based resistance training for the maintenance of glycemic control in adults with type 2 diabetes. Diabetes Care, 2006, 29: 2586–2591.
3) The expert committee on the diagnosis and classification of diabetes mellitus: Report of the expert committee on the diagnosis and classification of diabetes mellitus. Diabetes Care, 1997, 20: 1183–1197.
4) Shichiri M, Kishikawa H: Long-term results of the Kumamoto Study on optimal diabetes control in type2 diabetic patients. Diabetes Care, 2000, 23: B21–B29.
5) Ohkubo Y, Kishikawa H, Araki E,et al.: Intensive insulin therapy prevents the progression of diabetes mellitus: A randomized prospective 6-year study. Diabetes Res Clin Pract, 2000, 28: 225–230.
6) The diabetes control and complications trial research group: The effect of intensive treatment of diabetes on the development and progression of long-term complications in insulin-dependent diabetes mellitus. N Engl J Med, 1993, 329: 977–986.
7) The diabetes control and complications trial/epidemiology of diabetes interventions and complications research group: retinopathy and nephropathy in patients with type 1 diabetes four years after a trial of intensive therapy: N Engl J Med, 2000, 342: 381–389.
8) Knowler WC, Barrett-Connor E, Fowler SE, et al.: Diabetes prevention program research group: Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin: N Engl J Med, 2002, 346: 393–403.
9) United Kingdom Prospective Diabetes Study (UKPDS) Group. Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). Lancet, 1998, 352: 837–853.
10) Boulé NG, Kenny GP, Haddad E, et al.: Meta-analysis of the effect of structured exercise training on cardiorespiratory fitness in Type 2 diabetes mellitus.Diabetologia. Epub, 2003, 46: 1071–1081.
11) Alam S, Stolinski M, Pentecost C, et al.: The effect of a six-month exercise program on very low-density lipoprotein apolipoprotein B secretion in type 2 diabetes. J Clin Endocrinol Metab, 2004, 89: 688–694.
12) Boulé NG, Haddad E, Kenny GP, et al.: Effects of exercise on glycemic control and body mass in type 2 diabetes mellitus: a meta-analysis of controlled clinical trials. JAMA, 2001, 12: 1218–1227.
13) Devlin JT: Effects of exercise on insulin sensitivity in humans. Diabetes Care, 1992, 34: 1960–1693.
14) Etgen Jr GJ, Jensen J, Wilson CM, et al.: Exercise training reverses insulin resistance in muscle by enhanced recruitment of GLUT-4 to the cell surface. Am J Physiol Endocrinol Metab, 1997: E864–E869.