Factors Increasing Physical Activity Levels in Diabetes Mellitus: A Survey of Patients after an Inpatient Diabetes Education Program

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Abstract. [Purpose] The aim of this study was to understand the factors involved in increasing physical activity levels in type 2 diabetes mellitus patients for improved glycemic control. [Subjects] The subjects were 101 type 2 diabetes mellitus patients who had completed an inpatient diabetes education program. [Methods] The survey evaluated physical activity levels on the basis of the International Physical Activity Questionnaire and a questionnaire listing physical and psychosocial factors. [Results] Four variables—participation or non-participation in farm work, presence or absence of a job, stage of change in attitude toward exercise behavior, and social support—accounted for 34% of physical activity levels in these diabetes mellitus patients. The Spearman’s rank correlation coefficient between physical activity level and HbA1c was −0.31. [Conclusion] Intervention in terms of practical use of living environments, promotion of exercise behavior, and social support may be effective in helping to improve glycemic control.

Key words: Type 2 diabetes mellitus, Physical activity, Exercise therapy

INTRODUCTION

There is a global trend toward an increase in the incidence of diabetes mellitus. This trend is particularly strong for type 2 diabetes mellitus and is a major public health issue for the 21st century1). The main treatments for glycemic control in diabetes mellitus are diet therapy, exercise therapy, and pharmacotherapy, among which the importance of exercise therapy is now fully recognized. Increasing physical activity levels through exercise reduces the incidences of ischemic heart disease and stroke3) in diabetes mellitus patients and decreases all-cause mortality rates and mortality rates from ischemic heart disease3, 4). Therefore, increasing physical activity levels in diabetes mellitus patients is the most critical issue in exercise therapy. Diabetes education programs and team medical care supporting such interventions are important. From this perspective, we are helping our patients to take advantage of our inpatient diabetes education program to formulate lifestyle-modification plans aimed at glycemic control and complication prevention and to gain motivation to put these plans into action. For this purpose, doctors, nurses, registered dietitians, pharmacists, clinical laboratory technologists, and physical therapists use their expertise to cooperate with specialists in other fields to support our patients. Since 2006, we have been using exercise therapy in group education sessions run by physical therapists. However, adequate guidance has not yet been provided for exercise therapy after discharge from the hospital, and this is a problem for our diabetes education program. The rate of implementation of exercise therapy is lower than that of other treatment methods5–7). Factors affecting physical activity in diabetes mellitus patients include physical factors8, 9) such as age, sex, body mass index (BMI); psychosocial factors9, 10); and life-related environmental factors11). Among these, the psychosocial factors (self-efficacy12), behavioral modification, and social support) needed to deal with barriers to physical activity are considered particularly important to intervention in exercise therapy13). Here, we examine the effects of physical and psychosocial factors on physical activity levels for glycemic control in diabetes mellitus patients who completed an inpatient diabetes education program. The aim of this fundamental study was to explore effective interventions in exercise therapy.
SUBJECTS AND METHODS

Subjects

Subjects were recruited from among type 2 diabetes mellitus patients who received outpatient treatment at the Department of Endocrinology, Tsuchiura Kyodo General Hospital (survey period, August 1, 2010, to September 30, 2011). Eligible cooperative subjects were selected from among those patients who had participated in the inpatient diabetes education program at our hospital more than 6 months before the start of the study, had not experienced any life events capable of greatly altering their lifestyle habits within the previous 6 months, and were not subject to any confirmable marked restrictions of physical activity, either physically or medically. A description of the purpose and method was provided to each subject, and the survey was conducted after participants had read and signed an informed consent form. The study protocol was approved by the Ethics Committee, Ibaraki Prefectural University of Health Sciences (acceptance number 393), and the Ethics Committee of Tsuchiura Kyodo General Hospital (acceptance number 201).

Methods

We prepared a questionnaire listing physical and psychosocial factors and conducted a survey of consenting subjects by using interview and mailing methods. Physical activity levels were evaluated by using the short Japanese version of the International Physical Activity Questionnaire (IPAQ)\(^{14}\). Energy consumption through exercise in 1 week (total physical activity-IPAQ; TPA-IPAQ) was calculated. The Japanese version of the IPAQ has been proved valid as a criterion for evaluating physical activity\(^{15, 16}\), not only in healthy young to elderly subjects but also in diabetes mellitus patients\(^{17}\). Glycemic control was assessed by using the hemoglobin A1c (HbA1c) value (National Glycohemoglobin Standardization Program value) as of the date of the survey. Physical factors were assessed by inquiring about age, sex, BMI, the presence or absence of body pain (arthralgia developing during exercise), and the presence or absence of an exercise habit. Psychosocial factors were assessed by inquiring about self-efficacy (SE), stage of change in attitude toward exercise behavior (SOC), marital status, number of household members, presence or absence of a job, participation or non-participation in farm work (ranging from home vegetable garden work to agriculture), and social support (SS).

Body pain during exercise was identified by recognizing the presence or absence of pain occurring in the limbs and trunk. A person who had an exercise habit was defined as “someone who does exercise for 30 min or more at least twice a week and continues that over 1 year”, as defined in the National Health and Nutrition Survey of Japan, 2009, conducted by the Office for Life-Style Related Diseases Control, General Affairs Division, Health Service Bureau, Ministry of Health, Labour, and Welfare, Japan. Farm work was identified by the presence or absence of work activities ranging from home vegetable garden work to agriculture in daily life. SE was assessed by using the SE scale for health behavior in chronic disease patients, developed by Kim et al\(^{18}\). This is a 24-item, 4-point scale (“not at all applicable,” “hardly applicable,” “somewhat applicable,” or “very applicable”). The maximum score is 96. The scale is divided into 2 subscales: “a. positiveness in disease-coping behavior (14 items)” and “b. feeling of control over health (10 items).” For SOC, responses were assessed by using a 5-stage scale with reference to the scales used by Shimomitsu et al\(^{19}\) and Oka et al\(^{20}\). That is, Precontemplation (“I don’t exercise currently, and I have no intention of exercising in the future”), Contemplation (“I’m thinking about starting exercise in the near future [in the next 6 months]”), Preparation (“I exercise currently, but not regularly”), Action (“I currently exercise regularly, but I only started within the past 6 months”), and Maintenance (“I currently exercise regularly, and I’ve been steadily exercising for more than 6 months”). Here, regular exercise was defined as “implementation of 20 to 30 min of exercise at least 3 times a week.” SS was assessed by using the social support scale developed by Kim et al\(^{21}\) for chronic-disease patients. This is a 20-item, 4-point scale (“not at all applicable,” “hardly applicable,” “somewhat applicable,” and “very applicable”). The maximum score is 80. The scale is divided into 2 subscales (“a. emotional support in daily life”, 12 items; and “b. behavioral support for disease”, 8 items).

Statistical analysis was performed as follows. For the correlation between the TPA-IPAQ and HbA1c, the Spearman rank correlation coefficient was used. For the correlation between the TPA-IPAQ and a total of 10 variables (age, BMI, number of household members, total SE, SE subscale a and SE subscale b, total SS, SS subscale a and SS subscale b, and SOC), we used the Spearman rank correlation coefficient (\(r_s\)). For sex, marital status, presence or absence of employment, presence or absence of body pain, presence or absence of an exercise habit, and participation or non-participation in farm work, each variable was dichotomized, and the differences in the TPA-IPAQ between the two groups for each variable were examined by using the Mann-Whitney U-test. On the basis of the results of these analyses, to examine the variables showing significant correlations with the TPA-IPAQ, we performed a stepwise multiple linear regression analysis using the TPA-IPAQ as the objective variable. In selecting explanatory variables, variable deletion was performed in consideration of multicollinearity after confirming the inner correlation between the variables. All the analyses were performed using IBM SPSS Statistics 18. Statistical significance was set at \(p < 0.05\).

RESULTS

Among the type 2 diabetes mellitus outpatients at our hospital who met the selection criteria and gave consent (n = 115), 3 who submitted incomplete questionnaire forms and 11 who gave no responses were excluded from the study. The final number of cooperative subjects was 101 (87.8%). The characteristics of the 101 subjects are shown in Table 1. A significant negative correlation was found between the TPA-IPAQ and HbA1c (\(r_s = -0.31;\) \(p < 0.01\)). Exami-
nation of the correlations between the TPA-IPAQ and each variable revealed no significant correlation with age, BMI, number of household members, total SE, or SE subscales a or b, whereas a significant positive correlation was found with SOC, total SS, and SS subscales a and b (Table 2). Comparison of TPA-IPAQ values among the two groups for each respective factor revealed significantly higher TPA-IPAQ values for male (vs. female) sex, married (vs. single) status, presence of employment (vs. absence), participation in farm work (vs. non-participation), absence of body pain (vs. presence), and presence of an exercise habit (vs. absence) (Table 3).

From a stepwise multiple linear regression analysis using the TPA-IPAQ as the objective variable, we selected participation or non-participation in farm work (β = 0.41, p < 0.01), presence or absence of employment (β = 0.31, p < 0.01), SOC (β = 0.20, p < 0.05), and SS (β = 0.17, p < 0.05) as significant variables (Table 4). The rate of explanation of the TPA-IPAQ by these variables was 34% (adjusted $R^2$ = 0.34).

DISCUSSION

We confirmed that the higher the physical activity level, the lower the HbA1c. This may have been explained by the fact that subjects with high physical activity levels had good glycemic control because exercise therapy promotes
glucose and free fatty acid utilization by skeletal muscles and ameliorates insulin resistance\(^{22, 23}\) in peripheral tissues (mainly skeletal muscle). However, the correlation between the TPA-IPAQ and HbA1c was weak, suggesting that glycemic control is affected partly by metabolic status and partly by other treatments (i.e., pharmacotherapy and dietary therapy).

Univariate analysis of the relationships between the TPA-IPAQ and each variable revealed that physical factors (sex, presence or absence of body pain, and presence or absence of an exercise habit) and psychosocial factors (SOC, marital status, presence or absence of employment, participation or non-participation in farm work, and SS) were significant variables. From the multiple linear regression analysis, we selected participation or non-participation in farm work, presence or absence of employment, SOC, and SS from among these factors as independent variables associated with physical activity level. Farm work can be readily adopted not only as an occupation but also as a leisure-time activity\(^{24, 25}\) and periodic participation in farm work, presence or absence of employment, SOC, and SS from among these factors as independent variables associated with physical activity level. Farm work can readily be adopted not only as an occupation but also as a leisure-time activity\(^{24, 25}\) and periodic participation in farm work, presence or absence of employment, SOC, and SS from among these factors as independent variables associated with physical activity level. Farm work can readily be adopted not only as an occupation but also as a leisure-time activity\(^{24, 25}\) and periodic participation in farm work, presence or absence of employment, SOC, and SS from among these factors as independent variables associated with physical activity level.

As the SOC advanced, physical activity levels tended to be enhanced. The SOC scale was developed by applying the transtheoretical model\(^{26}\) to the stages of change in health-maintaining behaviors such as physical activity and exercise\(^{27}\). This scale consists\(^{26}\) of practical behavioral modifications in the past and present and the items used to measure the status of motivational readiness for such exercise behaviors. According to Shimomitsu et al.\(^{19}\), as the SOC advances, subjective factors promoting exercise (e.g., stress relief, increased friend networks, recognition of the subject’s abilities by other people) are enhanced, whereas subjective factors inhibiting exercise (feelings of exhaustion, sedentary habits among friends, and laziness) are diminished. Thus in a person at a high SOC, the barriers to physical activity have been removed, leading to higher physical activity levels.

Physical activity levels tended to be enhanced as SS increased. According to Kim et al.\(^{21}\), support from the patient’s family and other surrounding people has three roles. The first is to enhance motivation for treatment, the second is to maintain that motivation for a long period, and the third is to alleviate mental stress. Increased physical activity levels hinge crucially upon the overcoming of barriers to conducting physical activity; involvement of support people during the therapy session so as to encourage the overcoming of these barriers; encouragement to do the physical activity; and enhancement of friends’ support and family involvement\(^{13, 29}\). The more helpful the friends, family, and surrounding medical professionals, the more highly motivated toward exercise therapy and thus the more physically active the patient is likely to be.

We concluded that those type 2 diabetes mellitus patients who were in a state of higher physical activity after having completed the inpatient education program were characterized by the following: a social environment in which physical activity could more readily be achieved after hospital discharge; greater understanding and expectation of the added value and therapeutic effects of physical activity; and satisfaction with the emotional and behavioral support behind this understanding and expectation. These findings indicate that education via exercise therapy during an inpatient education program is not sufficient if it merely takes the form of advice to develop exercise habits or guidance in understanding exercise methods and having more confidence in the process. Taking it a step further, we need to think about how to achieve physical activity levels that suit each patient’s lifestyle and foster subjective factors that promote exercise in individual patients, so that we are using as many such factors as possible as a means of education. Moreover, the patient’s family should be encouraged to understand the need for emotional and behavioral support.

There were some limitations to our study. First, our subjects with type 2 diabetes mellitus had received guidance...
on lifestyle modification during an inpatient education program; in addition, they had no physical or medical problems that restricted their activity. This suggests that our sample population had some level of knowledge of therapeutic behavior and thereby could actively adapt to exercise therapy. If interventions are to be based on our findings, then further investigations will be required using subjects who have just been diagnosed with diabetes mellitus, those who have not had adequate therapeutic guidance since diagnosis, or those whose physical activity is restricted. Second, we used farm work as an independent variable that was most likely associated with physical activity levels. This was probably because our subjects included many rural inhabitants. Because of the influence of such regional characteristics, other investigations need to be performed in other areas.

We identified four variables—participation or non-participation in farm work, presence or absence of employment, SOC, and SS—as independent variables strongly associated with physical activity levels. In conclusion, we suggest that, to increase physical activity levels and improve glycemic control in type 2 diabetes mellitus patients who have completed an inpatient education program, intervention in terms of practical use of the living environment, promotion of exercise behavior, and social support is effective. On the basis of the indices obtained here, we intend to plan a longitudinal study and to continue our survey to assess the effects of our program in the future. In addition, factors that were not extracted here in the multiple linear regression analysis need continuing investigation, on the assumption that they do have some association with increased physical activity levels.

REFERENCES

1) Hussain A, Clausen B, Ramachandran A, et al.: Prevention of type 2 diabetes: a review. Diabetes Res Clin Pract, 2007, 76: 317–326. [Medline] [CrossRef]
2) Hu FB, Stampfer MJ, Solomon C, et al.: Physical activity and risk for cardiovascular events in diabetic women. Ann Intern Med, 2001, 134: 96–105. [Medline] [CrossRef]
3) Wei M, Gibbons LW, Kampert JB, et al.: Low cardiorespiratory fitness and physical inactivity as predictors of mortality in men with type 2 diabetes. Ann Intern Med, 2000, 132: 605–611. [Medline] [CrossRef]
4) Gregg EW, Gerzoff RB, Caspersen CJ, et al.: Relationship of walking to mortality among US adults with diabetes. Arch Intern Med, 2003, 163: 1440–1447. [Medline] [CrossRef]
5) Kamiya A, Ohawa I, Fuji T, et al.: A clinical survey on the compliance of exercise therapy for diabetic outpatients. Diabetes Res Clin Pract, 1995, 27: 141–145. [Medline] [CrossRef]
6) Arnold-Wörmner N, Holle R, Rathmann W, et al.: The importance of specialist treatment, treatment satisfaction and diabetes education for the compliance of subjects with type 2 diabetes—results from a population-based survey. Exp Clin Endocrinol Diabetes, 2008, 116: 123–128. [Medline] [CrossRef]
7) Albright A, Franz M, Hornby G, et al.: American college of sports medicine position stand. Exercise and type 2 diabetes. Med Sci Sports Exerc, 2000, 32: 1345–1366. [Medline] [CrossRef]
8) Plotnikoff RC, Taylor LM, Wilson PM, et al.: Factors associated with physical activity in Canadian adults with diabetes. Med Sci Sports Exerc, 2006, 38: 1526–1534. [Medline] [CrossRef]
9) Delahanty LM, Conroy MB, Nathan DM: The diabetes prevention program research group psychological predictors of physical activity in the diabetes prevention program. J Am Dietetic Assoc, 2006, 106: 698–705. [CrossRef]
10) Korkiakangas EE, Alaluhta MA, Laitinen JH: Barriers to regular exercise among adults at high risk or diagnosed with type 2 diabetes: a systematic review. Health Promot Int, 2009, 24: 416–427. [Medline] [CrossRef]
11) De Greef K, Van Dyck D, Deforce B, et al.: Physical environmental correlates of self-reported and objectively assessed physical activity in Belgian type 2 diabetes patients. Health Soc Care Community, 2011, 19: 178–188. [Medline]
12) Bandura A: Self-efficacy: toward a unifying theory of behavioral change. Psychol Rev, 1977, 84: 191–215. [Medline] [CrossRef]
13) Van Dyck D, De Greef K, Deforce B, et al.: Mediators of physical activity change in a behavioral modification program for type 2 diabetes patients. Int J Behav Nutr Phys Act, 2011, 8: 105. [Medline] [CrossRef]
14) Craig CL, Marshall AL, Sjöström M, et al.: International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc, 2003, 35: 1381–1395. [Medline] [CrossRef]
15) Tomioka K, Iwamoto J, Saeki K, et al.: Reliability and validity of the International Physical Activity Questionnaire (IPAQ) in elderly adults: the Fujisawa-kyo Study. J Epidemiol, 2011, 21: 459–465. [Medline] [CrossRef]
16) Murano J, Asakawa Y, Mizukami M, et al.: Examination of the validity of the Japanese version of the IPAQ questionnaire for the evaluation of the physical activity of diabetes patients. Rigakuryoho Kagaku, 2013, 28: 101–104. [CrossRef]
17) Kim W, Hironori S, Yuji S: The relationship between self-efficacy on health behavior and stress responses in chronic disease patients. Psychosom Med, 1996, 36: 499–505.
18) Shimomitsu T, Ogadiri Y, Sawako W, et al.: Exercise behavior and psycho-behavioral factors: cross-sectional study of stage of change for exercise behavior. Descente Sports Sci, 1999, 20: 3–19.
19) Koichiro O, Kei H, Toshihiko T: Psychological factors associated with physical inactivity among middle-aged adults: decisional balance for exercise. Behav Med, 2003, 9: 23–30.
20) Delahanty LM, Conroy MB, Nathan DM: The diabetes prevention program research group psychological predictors of physical activity in the diabetes prevention program. J Am Dietetic Assoc, 2006, 106: 698–705. [CrossRef]