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ORIGINAL ARTICLE

Self-management behavior concerning physical activity of Japanese type 2 diabetes patients, characterized by sex, daily energy intake and body mass index

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Abstract

Objectives We assess differences in physical activity self-management behavior in association with dietary intake and BMI between the sexes in patients with type 2 diabetes.

Methods Patients with type 2 diabetes ($n = 145$) completed a self-administrated questionnaire. Patients were classified into four groups by BMI and dietary intake: non-obesity and non-overeating (NO/NOE); non-obesity and overeating (NO/OE); obesity and non-overeating (O/NOE); obesity and overeating (O/OE). Differences in physical activity self-management behavior between the four groups were determined by the analysis of variance using a Tukey–Kramer post hoc test.

Results Male O/OE group showed higher HbA1c ($p = 0.001$) than the other groups. Male NO/OE group had higher steps/day than O/NOE ($p = 0.036$) and score of “Exercising to stimulate the enjoyment of eating” was higher than O/OE ($p = 0.031$). Female NO/OE group showed higher HbA1c ($p = 0.001$) than NO/NOE and O/NOE.

Conclusions BMI and dietary intake were associated with frequencies of physical activity self-management strategies in men. Self-management behavior peculiar to male NO/OE group is “Exercising to stimulate the enjoyment of eating”. Health professionals should assess sex, BMI, and dietary intake of patients and endeavor to improve individuals’ ability to regulate their caloric balance based on physical activity level.

Keywords Type 2 diabetes mellitus · Diet · Physical activity · Weight control · Self-management

Introduction

Regular physical activity of moderate intensity is recommended for patients with type 2 diabetes for maintaining appropriate glycemic control and preventing cardiovascular disease (CVD) [1, 2]. Physical activity comprises not only vigorous exercise but also routine activities such as occupational and commuting activities, which may reduce the risk of developing type 2 diabetes as well as diabetes related complications [2–4]. However, patients may perceive barriers to exercise because of lack of self-efficacy, feelings of tiredness, distraction by television and so on [5, 6]. One study showed that only 28.2% of nondisabled adults with diabetes reported getting the recommended levels of physical activity [7]. Therefore, medical professionals must support patients by helping them to gain knowledge and skills about self-management, and to confront these barriers and then practice effective self-management in their daily lives [8]. It is essential to determine what kind of self-management behavior would be particularly important in

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educational sessions for individual patients to achieve and to maintain an adequate level of physical activity. We previously developed a tool to assess patients' individual self-management that is related to the physical activity in which they actually engage [9]. This self-administrated inventory enables educators to clarify actual self-management status and problems that need to be tackled in individual patients.

The importance of individualizing diabetes self-management education and support has been emphasized in recent years [10, 11]. In addition, because there are differences in self-management behavior between male and female patients with type 2 diabetes, self-management education needs to be considered separately with regards to sex [12–14]. Furthermore, the support for self-management of physical activity behavior should focus not only on physical activity but also on dietary habits and weight control as an outcome of energy balance, because it is important to maintain an appropriate balance between total dietary intake and energy consumption [1]. Patients with type 2 diabetes experience a significant loss of the freedom to choose what, where, or when to eat [15]. Exercising more than usual as a corrective behavior after temporarily overeating is known to be one of the coping behaviors of relapse episodes to diet regimens [16]. Assessment of the influence between self-management behaviors of dietary intake and physical activity on body weight is essential for integrated self-management support for patients with type 2 diabetes. However, research that has assessed factors related to self-management have mainly focused on the relationship between self-management and psychosocial status or metabolic control status [17–19], and not on appropriate energy balance in individuals.

To offer effective education to patients with type 2 diabetes, it is important to make clear the influence of self-management behavior as it relates to dietary intake and exercise upon weight control. In this study, we assessed physical activity behavior of Japanese male and female patients with type 2 diabetes from the viewpoint of dietary intake and weight control, using our previous study of evaluation scale [9].

Methods

Patients and procedure

Patients with type 2 diabetes who were being treated at the diabetes clinic of an educational hospital located in Hyogo prefecture were enrolled. Inclusion criteria were as follows: (1) more than 6 months after the diagnosis of diabetes, (2) without exercise restriction, and (3) diabetes treatment had not changed for at least 6 months. Patients were excluded if they were unable to complete the questionnaire because of linguistic problems or severe mental disorder. The study was conducted between February and June 2006.

Details of the study were explained by one of the researchers using a written exposition of the study to eligible patients visiting the clinic. After written consent was obtained from patients, the following information was collected.

Measurements

Physical activity self-management behavior was assessed using the Evaluation Scale for Self-Management Behavior Related to Physical Activity of Type 2 Diabetic Patients (ES-SMBPA-2D), which has been shown to be reasonably reliable and valid [9]. The ES-SMBPA-2D can assess patients' self-management skills that was related to the individual's physical activity in which they actually engaged. This self-administrated inventory enables educators to clarify the actual self-management status and problems that need to be tackled in individual patients. The ES-SMBPA-2D consists of two domains: (I) self-management behavior to enhance daily physical activity (16 items including 4 factors, Cronbach's $\alpha = 0.73$–0.89) and (II) self-management behavior to maintain the level of physical activity (16 items including 5 factors, Cronbach's $\alpha = 0.56$–0.9). The first domain of ES-SMBPA-2D consists of the following four factors: (I-1) increasing the number of steps through shopping activities, (I-2) increasing the frequency of household activities, (I-3) deliberately increasing the amount of exertion required in daily activities, and (I-4) increasing the number of steps through commuting activities. The second domain of ES-SMBPA-2D consists of the following five factors: (II-1) selecting a suitable place or time for physical activities, (II-2) self-monitoring of physical activities, (II-3) making active behavior a habit, (II-4) exercising to stimulate the enjoyment of eating, and (II-5) creating situations to enhance active behavior. Responses to the items of this scale were rated on a 5-point Likert scale (0 = never, 1 = occasionally, 2 = sometimes, 3 = usually, 4 = always). A higher subscale score means that the patient engages more frequently in the self-management behavior for that subscale.

Mean daily physical activity was assessed with a Lifecorder EX (Suzuken Co., Ltd., Nagoya, Japan), a portable pedometer with an acceleration measurement function [20, 21]. Patients were asked to put on the Lifecorder EX from the day after the survey until the day when the patient consulted a doctor again (an interval of approximately 1 month). The mean level of daily physical activity (steps/day) was calculated for approximately 1 month.

Mean daily dietary intake, calculated from the intake during the previous 1 year (total energy), was assessed through an individual interview using the validated Japanese 122-item food frequency questionnaire (FFQ) [22, 23]. The FFQ consists of a list of 122 food items with full-scale photographs, and the patient can indicate the frequency and amount of their dietary intake. The mean daily dietary intake was calculated on the basis of the dietary intake per year. Furthermore, to ensure the accuracy of the data, the patients were asked to provide detailed information on the cooking method they used (i.e., whether the food was eaten raw, boiled, baked, or fried), any additional seasoning used (e.g., sauce or dressing) just before eating a dish, and the disposal of leftovers. The dietary intake of the patient calculated with the aid of the FFQ was reconfirmed by showing the patient full-scale photographs of meals and various sizes of real dishes (e.g., a rice bowl, a large bowl, a plate, and a glass).

Age, sex, treatment of diabetes, and mean HbA1c values for the past 6 months were collected from the medical records. Patients were asked to complete a self-administrated questionnaire which assessed physical activity self-management behavior. Various background characteristics, such as occupation and living situation, were obtained through interviews. Body mass index (BMI, kg/m^2) was also examined.

Data analysis

Patients were classified into four categories by obesity (BMI) and eating habit profiles (dietary intake per standard body weight of each patient, kcal/kg/day). Categorization was based on a guideline that recommended an dietary intake for patients with type 2 diabetes of 25–35 kcal/kg and obesity with BMI $\geq$ 25 [1]. The 4 categories were as follows: (A) non-obesity and non-overeating (NO/NOE; BMI < 25 and dietary intake $\leq$ 35 kcal/kg), (B) non-obesity and overeating (NO/OE; BMI < 25 and total dietary intake > 35 kcal/kg), (C) obesity and non-overeating (O/NOE; BMI $\geq$ 25 and total dietary intake $\leq$ 35 kcal/kg), and (D) obesity and overeating (O/OE; BMI $\geq$ 25 and total dietary intake > 35 kcal/kg). Differences in background characteristics and physical activity self-management behavior between the four groups were determined by analysis of variance using a Tukey–Kramer post hoc test. For analyses, IBM SPSS Statistics version 22.0 was used. The level of significance was defined as 5%.

Ethical considerations

The Ethics Committee of Kobe University approved the protocol of this study (date of 26 July 2004; approval no. 236). All the participants signed written informed consent forms.

Results

Background characteristics

Table 1 presents the background characteristics of the subjects. One hundred forty-five (93.6%) of the 155 eligible patients gave consent for participation. Ten patients were excluded, nine who did not have enough time to complete the questionnaire and one who was in poor health.

Comparisons of four groups classified by BMI and eating habit

Comparisons of age, HbA1c value, daily number of steps, and ES-SMBPA-2D scores among the four groups are shown in Table 2.

In male patients, the four groups differed in age ($p = 0.028$) and HbA1c value ($p = 0.001$). The mean age was significantly older in the (A) NO/NOE group than in the (D) O/OE group (65.1 ± 8.7 vs 56.6 ± 9.3, respectively, $p = 0.028$). The patients of the (D) O/OE group had significantly higher HbA1c values (8.5 ± 1.2%) than the other groups ($p = 0.001$ in all 3 comparison). With the subscale II-4 scores of ES-SMBPA-2D, the (B) NO/OE group had significantly higher behavior scores than the (D) O/OE group (35.1 ± 28.8 vs 9.4 ± 12.1, respectively, $p = 0.031$), which suggests that exercising to stimulate the enjoyment of eating or doing exercise to satisfy the pleasure of eating was often seen in the (B) NO/OE group. The male (B) NO/OE group had significantly higher steps/day than the (C) O/NOE group (11,431.6 ± 6864.3 vs 7218.9 ± 3465.5, respectively, $p = 0.036$). Although the male patients in the (B) NO/OE group were overeating (42.3 ± 5.7 kcal/kg/day), they performed more steps than patients categorized in other groups. Although scores of the other behaviors described in ES-SMBPA-2D were examined, there were no statistically positive differences among the four male groups.

In the female patients with type 2 diabetes (see lower column in Table 2), the (B) NO/OE group had significantly higher HbA1c levels than the (A) NO/NOE group and (C) O/NOE (9.0 ± 1.2% vs 7.8 ± 0.9% and 7.6 ± 0.7%, respectively, $p = 0.014$). However, no significant differences in daily steps were detected among the four female groups.

Discussion

In male patients, the four groups differed in age, HbA1c value, and ES-SMBPA-2D scores for "Exercising to stimulate the enjoyment of eating". Male patients categorized in the (D) O/OE group had higher HbA1c values than those in other groups. Though there were differences in BMI and dietary intake among the four groups, the average number of steps/day in the (D) O/OE group was not significantly higher than other group. Therefore, it might be suggested that male patients categorized in the (D) O/OE group should maintain a higher level of daily physical activity and reduce dietary intake to achieve suitable glycemic control.

Table 1 Patient characteristics

	Male (*n* = 88)	Female (n = 57)
Medical treatment		
Only diet and exercise	8 (9.1)	7 (12.3)
Oral medication	61 (69.3)	39 (68.4)
Insulin injection	5 (5.7)	7 (12.3)
Oral medication and insulin injection	14 (15.9)	4 (7.0)
Duration of diabetes		
< 3 years	21 (23.9)	13 (22.8)
3–10 years	34 (38.6)	23 (40.4)
> 10 years	33 (37.5)	21 (36.8)
Employment status		
Employed	49 (55.7)	14 (24.6)
Unemployed	39 (44.3)	41 (71.9)
Unknown	0 (0)	2 (3.5)
Living situations		
Living with another or others	74 (84.1)	37 (64.9)
Living alone	14 (15.9)	19 (33.3)
Unknown	0 (0)	1 (1.8)
Academic background		
Secondary or less	31 (35.2)	38 (66.7)
Tertiary or more	37 (42.0)	14 (24.6)
Unknown	20 (22.8)	5 (8.7)
Age (years)	63.6 ± 8.9	63.7 ± 10.4
HbA1c [NGSP] (%)	7.9 ± 1.0	8.0 ± 1.0
BMI (kg/m^2)	23.7 ± 3.4	23.2 ± 4.0
Number of daily steps (steps/day)	9021.4.0 ± 4399.2	7195.2 ± 3052.7
Daily calorie intake/SBW (kcal/kg/day)	32.5 ± 7.8	30.6 ± 9.0

Data are presented as number of patients (prevalence). Data are given as mean ± SD

NGSP National Glycohemoglobin Standardization Program

In males categorized in the (B) NO/OE group, the average number of steps/day was significantly higher than the (C) O/NOE group. This result seemed to be beneficial for avoiding obesity since the average dietary intake in males categorized in the (B) NO/OE group was 42.3 kcal/kg, which was 1.4 times higher than the recommended intake (30 kcal/kg) [1]. Our previous study showed that male patients with type 2 diabetes had significantly positive correlations between "Exercising to stimulate the enjoyment of eating" and physical activity levels [24]. Physical activity self-management behavior in males in this group was also characterized by higher scores for "Exercising to stimulate the enjoyment of eating" compared with males categorized in the (D) O/OE group. It has been pointed out that there is relationship between the level of physical activity and dietary intake [25], and cognitive forces affect the relationship between physical activity and dietary intake [26]. Patients who engage in exercise to stimulate the enjoyment of eating probably expect to be able to consume more food if they exercise enough. This expectation may be related to overeating.

Though there was no difference in the number of steps between the (B) NO/OE and (D) O/OE groups, which had different results in "Exercising to stimulate the enjoyment of eating" scores, the level of physical activity of patients categorized in the (B) NO/OE was adequate to control their metabolism and resulted in appropriate weight control (BMI < 25) and HbA1c values. This probably confirmed to them their expectation of being able to consume more food if they exercised enough. However, nutrition therapy is recommended for all people with type 2 diabetes as an effective component of the treatment plan [27]. It might be suggested that patients categorized in the (B) NO/OE should follow instructions for appropriate energy intake.

Conventionally, it is recommended that medical staff should evaluate each dimension of self-management behavior in patients, such as diet, exercise, and medication [28]. However, the results of our study suggest that medical staff should assess the self-management behavior of patients not only in each dimension, but also in terms of the interaction of individual self-management behaviors, such as diet and exercise, and the expectations of patients that influence

Table 2 Comparison of four groups classified by body mass index and eating habit profile

	(A) NO/NOE mean ± SD	(B) NO/OE mean ± SD	(C) O/NOE mean ± SD	(D) O/OE mean ± SD
Male	*n* = 46	*n* = 16	*n* = 14	*n* = 12
BMI[a]	21.7 ± 2.2	23.0 ± 1.3	26.6 ± 1.9	29.0 ± 2.4
Daily calorie intake/SBW[a]	27.9 ± 4.5	42.3 ± 5.7	29.9 ± 3.4	40.9 ± 6.1
Age	65.1 ± 8.7*	64.2 ± 8.2	63.9 ± 7.5	56.6 ± 9.3*
HbA1c [NGSP] (%)	7.7 ± 0.7*	7.8 ± 1.0†	7.9 ± 0.5‡	8.5 ± 1.2*†‡
Daily number of steps	9084.4 ± 3463.1	11,431.6 ± 6864.3*	7218.9 ± 3465.5*	7529.2 ± 2969.2
ES-SMBPA-2D[b]				
ES-SMBPA-2D I-1	29.2 ± 26.9	30.5 ± 32.3	23.2 ± 22.8	20.8 ± 28.9
ES-SMBPA-2D I-2	35.2 ± 22.4	32.8 ± 23.0	32.6 ± 21.0	27.1 ± 18.9
ES-SMBPA-2D I-3	46.2 ± 20.2	48.4 ± 20.9	30.4 ± 22.3	33.3 ± 24.3
ES-SMBPA-2D I-4	43.1 ± 25.3	55.9 ± 26.7	33.5 ± 21.0	35.9 ± 19.4
ES-SMBPA-2D II-1	50.2 ± 35.6	50.3 ± 23.9	39.7 ± 28.0	32.1 ± 25.8
ES-SMBPA-2D II-2	31.5 ± 34.9	40.7 ± 32.6	38.1 ± 38.2	28.5 ± 26.9
ES-SMBPA-2D II-3	51.3 ± 31.9	60.4 ± 31.8	44.1 ± 25.0	42.3 ± 38.8
ES-SMBPA-2D II-4	19.3 ± 26.3	35.1 ± 28.8*	14.3 ± 15.0	9.4 ± 12.1*
ES-SMBPA-2D II-5	20.1 ± 20.7	23.4 ± 25.1	26.8 ± 26.6	21.5 ± 19.3
Female	*n* = 32	*n* = 7	*n* = 10	*n* = 8
BMI[a]	20.8 ± 1.9	22.7 ± 1.7	28.6 ± 4.2	26.6 ± 1.7
Daily calorie intake/SBW[a]	25.8 ± 4.9	44.3 ± 8.0	29.0 ± 3.5	41.4 ± 8.2
Age (years)	65.5 ± 9.7	64.3 ± 7.5	58.4 ± 14.4	62.6 ± 9.0
HbA1c [NGSP] (%)	7.8 ± 0.9*	9.0 ± 1.2*†	7.6 ± 0.7†	8.3 ± 1.0
Daily number of Steps	6719.1 ± 3309.3	8862.7 ± 1769.0	7085.1 ± 2130.3	7658.6 ± 3739.8
ES-SMBPA-2D[b]				
ES-SMBPA-2D I-1	40.4 ± 28.1	58.1 ± 34.5	40.6 ± 26.2	52.4 ± 26.9
ES-SMBPA-2D I-2	55.3 ± 28.6	61.6 ± 25.9	47.5 ± 31.1	43.8 ± 14.6
ES-SMBPA-2D I-3	45.7 ± 27.4	44.6 ± 20.9	40.0 ± 30.1	35.9 ± 23.3
ES-SMBPA-2D I-4	54.1 ± 22.9	63.4 ± 23.8	48.8 ± 20.4	59.4 ± 18.0
ES-SMBPA-2D II-1	46.0 ± 27.2	60.7 ± 21.1	38.0 ± 33.2	41.3 ± 25.9
ES-SMBPA-2D II-2	25.5 ± 28.3	23.8 ± 25.7	35.0 ± 39.1	32.3 ± 32.6
ES-SMBPA-2D II-3	52.8 ± 28.4	66.7 ± 34.4	44.2 ± 38.5	26.1 ± 21.6
ES-SMBPA-2D II-4	19.1 ± 14.8	26.8 ± 29.3	21.3 ± 20.5	31.3 ± 18.9
ES-SMBPA-2D II-5	17.4 ± 21.9	30.9 ± 17.2	31.7 ± 15.6	27.1 ± 33.3

Data given as mean ± SD. Each value with same symbol means the presence of statistically significant difference

BMI body mass index, *SBW* standard body weight, *NGSP* National Glycohemoglobin Standardization Program, *NO/NOE* non-obesity and non-overeating, *NO/OE* non-obesity and overeating, *O/NOE* obesity and non-overeating, *O/OE* obesity and overeating, *ES-SMBPA-2D* evaluation scale for self-management behavior related to physical activity of patients with type 2 diabetes

[a]Not tested

[b]All ES-SMBPA-2D measures are scored at percentage (from 0 to 100). Responses to the items of this scale were rated on a 5-point Likert scale (0 = never, 1 = occasionally, 2 = sometimes, 3 = usually, 4 = always)

ES-SMBPA-2D I-1: increasing the number of steps through shopping activities

ES-SMBPA-2D I-2: increasing the frequency of household activities

ES-SMBPA-2D I-3: deliberately increasing the amount of exertion required in daily activities

ES-SMBPA-2D I-4: increasing the number of steps through commuting activities

ES-SMBPA-2D II-1: selecting a suitable place or time for physical activities

ES-SMBPA-2D II-2: self-monitoring of physical activities

ES-SMBPA-2D II-3: making active behavior a habit

ES-SMBPA-2D II-4: exercising to stimulate the enjoyment of eating

ES-SMBPA-2D II-5: creating situations to enhance active behavior such interactions. Though patients who engaged in exercise to stimulate the enjoyment of eating achieved the recommended level of physical activity, they were actually overeating and were unable to estimate their dietary intake accurately enough. In a previous study, HbA1c value was worse among patients who could not adequately estimate their dietary intake and expenditure [29]. Therefore, it might be suggested that education for physical activity self-management should incorporate a training procedure to improve the individuals' ability to estimate their daily dietary intake and regulate their caloric balance. The primary consideration in education for physical activity self-management may be in medical staff having a good grasp of the fact that eating is an important motivation in maintaining an appropriate level of physical activity for patients with type 2 diabetes.

In female patients, unlike the males, patients in the (B) NO/OE category showed higher levels of HbA1c than patients in other groups, and there was no relationship between physical activity self-management behavior, dietary intake, and BMI. Though there were differences in HbA1c values, BMI and dietary intake among the four groups, there was no difference among them in the number of steps/day taken. Therefore, medical staff should support female patients with type 2 diabetes to enable them to assess HbA1c values, BMI and their daily dietary intake and to take steps to regulate their caloric balance.

Limitations of the study include the research design (cross-sectional design), the small sample size, and convenience sampling of the patients who were recruited from a university hospital. We were unable to provide a widely acceptable set of data and examine the causation. Further studies with larger populations are now required to clarify the relationship between physical activity self-management behavior and their correlates. In addition, a longitudinal study is needed to confirm the relationships among physical activity self-management behavior, metabolic control, and dietary intake.

Conclusions

Weight and dietary intake were associated with different frequencies of physical activity self-management strategies in men but not in women. Male patients who engage in exercise to stimulate the enjoyment of eating probably expect to be able to consume more food if they exercise enough. Medical staff should assess the self-management behavior of patients not only in each dimension, but also in terms of the interaction of individual self-management behaviors, such as diet and exercise and the expectations of patients that influence such interactions and endeavor to improve individuals' ability to estimate their daily dietary intake and regulate their caloric balance based on levels of physical activity.

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Compliance with ethical standards

Conflict of interest The authors have no conflict of interest to declare.

Ethical approval All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1964 and later version.

Informed consent Informed consent or a substitute for it was obtained from all patients included in the study.

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