Development of an Evaluation Scale for Self-Management Behavior Related to Physical Activity of Type 2 Diabetic Patients

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OBJECTIVE — The aim of this study was to assess the reliability and validity of an evaluation scale for self-management behavior related to physical activity of type 2 diabetic patients (ES-SMBPA-2D).

RESEARCH DESIGN AND METHODS — Outpatients with type 2 diabetes ($n = 146$) completed a self-administered questionnaire supported by a semistructured interview based on a literature review. The content, factor, and concurrent validity and internal consistency and reproducibility of the scale were analyzed. Pearson's correlation coefficients for the ES-SMBPA-2D and International Physical Activity Questionnaire (IPAQ) subscale scores were calculated to evaluate the concurrent validity.

RESULTS — The ES-SMBPA-2D was divided into two parts, the first dealing with self-management behavior to enhance physical activity in daily life and the second with behavior to maintain the level of physical activity. Factor analysis showed that the first part comprised four factors and the second five. The ES-SMBPA-2D correlated with the IPAQ subscales. Cronbach's α coefficient was between 0.56 and 0.90, and the intraclass test-retest correlation coefficient of the subscales was between 0.60 and 0.88.

CONCLUSIONS — The ES-SMBPA-2D is reasonably reliable and valid and is expected to prove useful for the assessment of patients' self-management behavior and for individualized instruction.

Diabetes Care 30:2843–2848, 2007

Regular physical activity is recommended for type 2 diabetic patients, as it is commonly known to improve metabolic disorders and prevent complications such as cardiovascular disease (1). Even moderately intense physical activity through daily activities is beneficial for management of this condition (2,3). However, many patients fail to achieve the recommended level of physical activity (4) because of barriers such as the commonly given reason of "perceived difficulty in exercising" (5). The aim of self-management education is to enable patients to acquire knowledge and skills to improve their diabetic state, identify barriers that hinder improvement, and attain problem-solving and coping skills to achieve effective self-care behavior (6). Thus, medical personnel need to provide patients with strategies to enhance and maintain the required level of physical activity.

Self-management education also involves individualized instruction, based on assessment of patients' psychosocial factors and self-management skills and behaviors (7) and strategies to enhance and maintain the required level of physical activity. Most scales designed for this purpose evaluate environmental and psychosocial factors (8–11), the frequency of diabetes self-care behaviors (12), and perceived adherence to patients' self-care recommendations (13). No tools exist, however, to evaluate self-management behavior related to patients' physical activity. Therefore, the aim of this study was to develop an evaluation scale for self-management behavior related to physical activity of type 2 diabetic patients (ES-SMBPA-2D).

RESEARCH DESIGN AND METHODS

— The Ethics Committee of Kobe University approved the protocol of this study, which was conducted from February to June 2006. Patients were selected from the outpatient clinic of Kobe University Hospital's Department of Internal Medicine with these selection criteria: type 2 diabetes, performance of any kind of required physical activity, completion of the self-administered instrument, and receipt of the same clinical diabetes treatment for at least 6 months. After written consent had been obtained, detailed information about the clinical course was collected from hospital records. To evaluate the reproducibility of the scale, the instrument was again administered to the same 59 subjects 1 month later.

Measures

The ES-SMBPA-2D is based on the "Outcome Measurement Process" proposed by the American Association of Diabetes Educators (6). Semistructured interviews were conducted with 21 diabetic individuals selected from the outpatient clinic

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Received for publication 8 April 2007 and accepted in revised form 16 July 2007.

Published ahead of print at http://care.diabetesjournals.org on 20 July 2007. DOI: 10.2337/dc07-0685.

Abbreviations: AIC, Akaike's information criterion; CFI, comparative fit index; ES-SMBPA-2D, evaluation scale for self-management behavior related to physical activity of type 2 diabetic patients; IPAQ, International Physical Activity Questionnaire; RMSEA, root mean square error of approximation.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

Table 1—*Characteristics of study population*

Sex	
Male	88 (59.6)
Female	58 (40.4)
Employment status	
Employed	62 (42.5)
Unemployed	82 (56.1)
Unknown	2 (1.4)
Education	
Secondary or less	70 (47.9)
Tertiary or more	51 (34.9)
Unknown	25 (17.2)
Living situation	
Living with another or others	122 (83.6)
Living alone	23 (15.8)
Unknown	1 (0.6)
Treatment	
Diet and exercise	16 (11.0)
Tablets	100 (68.5)
Insulin	30 (20.5)
Duration of diabetes	
<3 years	19 (13.0)
3–10 years	40 (27.4)
>10 years	84 (57.5)
Unknown	3 (2.1)
Age (years)	63.7 ± 9.4 (31–83)
A1C (%)	7.1 ± 1.0 (5.7–11.6)
BMI (kg/m^2)	23.5 ± 3.7 (15.6–40.1)

Data are *n* (%) or means ± SD (range). *n* = 146.

files. Responses to the following two questions were sought from the standardized interview: *1*) What do you do to enhance physical activity? and *2*) What do you do to maintain your level of physical activity? The responses were then analyzed to generate a pool of definite items, from which only those that reflected self-management behavior related to the enhancement and maintenance of daily physical activity were selected for inclusion in the ES-SMBPA-2D. The result was a 38-item scale with two parts. Part 1 deals with self-management behavior to enhance physical activity in daily life (17 items), and part 2 deals with self-management behavior to maintain the level of physical activity (21 items).

Four specialists examined the content validity of the scale, and all of them concluded that the items were relevant and representative samples of possible self-management behaviors of diabetic patients. Responses to the items were rated on a 5-point Likert scale (1 = never to 5 = always), with the higher subscale score indicating a higher frequency of self-management behavior as a regimen. To examine the concurrent validity of part 1, the Japanese version (long version) of the International Physical Activity Questionnaire (IPAQ) (14–16) was used. The IPAQ is useful for assessing physical activity across various life domains and during leisure time. Various background factors, such as age, sex, occupation, academic background, living situation, treatment of diabetes, mean value of A1C for the past 6 months, and BMI at the time of examination, were also examined.

Data analysis

Because most clinical scales are based upon traditional psychometric theory (17), the reliability and validity of this scale were therefore thoroughly evaluated. Exploratory factor analysis using the principal factor method and promax rotation was performed for each part to test the validity of models based upon postulated constructs, i.e., whether all the items for a single factor loaded >0.35, and to confirm that the item loadings were theoretically coherent. Initial factor selection was based on eigenvalues >1.0. After items that did not load >0.35 for a given factor had been removed, factor analysis was performed followed by confirmatory factor analysis to test the models for items that loaded <0.35. The ratio of χ^2 to the degrees of freedom (df), Akaike's information criterion (AIC), the comparative fit index (CFI), and the root mean square error of approximation (RMSEA) were used to evaluate the fit of the models to the data. For the AIC, the smallest value represented the best classification. Moreover, RMSEA values of ≤0.05 reportedly indicate a close fit of the model, and those between 0.05 and 0.08 indicate a reasonable error in approximating a given structure (18). A χ^2-to-df ratio <2.0 and a CFI value >0.9 were considered to indicate an adequate fit. Selection of the final measurement model was then determined by examining the four indexes of fit and choosing the model with the best indexes. To evaluate concurrent validity, Pearson's correlation coefficients for the ES-SMBPA-2D and IPAQ subscales were calculated, and Cronbach's α coefficient was calculated for each of the subscales to assess their internal consistency. Intraclass correlation coefficients, which measure the strength of agreement between repeated measurements (19), for test and retest were calculated to evaluate test-retest reliability. SPSS 14.0 and Amos 6.0 for Windows were used for the analysis, and the level of significance was defined as 5% (two-sided test).

RESULTS

Subjects' backgrounds

Of the 156 patients invited to participate in the study, 146 agreed (response rate: 93.6%) and gave valid responses to the questionnaire. The reasons given by the 10 patients who did not agree to join this study were lack of time (9) and poor health (1). The instrument for the test-retest was collected from 44 of 59 of the original subjects (response rate: 74.6%), and all 44 gave valid responses. Table 1 presents the subjects' background characteristics.

Factor validity

Part 1: Self-management behavior to enhance daily physical activity. Factor analysis of part 1 generated 4 factors for a total of 16 items (Table 2). These factors were "Increasing the number of steps through shopping activities," "Increasing the frequency of household activities," "Deliberately increasing the amount of exertion required in daily activities," and "Increasing the number of steps through commuting activities" with an eigenvalue of >1.0 (χ^2-to-df ratio 1.77, AIC 249.73, CFI 0.93, RMSEA 0.073). All of the variables contributed to any one factor with a factor loading of >0.35.

Part 2: Self-management behavior to maintain the level of physical activity.

Table 2—*Factor analysis of self-management behavior to enhance daily physical activity*

	Factor 1	Factor 2	Factor 3	Factor 4
Factor 1: Increasing the number of steps through shopping activities				
Spending a large amount of time on shopping	0.85	–0.03	0.03	–0.06
Shopping at various stores	0.82	0.12	–0.03	–0.06
Increasing the number of days for going shopping	0.82	0.07	–0.01	0.04
Going shopping several times a day	0.59	0.12	0.02	0.10
Factor 2: Increasing the frequency of household activities				
Cleaning the house carefully	0.03	0.87	–0.11	0.02
Cleaning the house frequently	0.15	0.70	–0.15	0.06
Doing the housework oneself instead of asking someone else to do it	0.06	0.44	0.05	0.07
Standing on tiptoe while cooking or washing one's face	0.04	0.42	0.26	–0.12
Factor 3: Deliberately increasing the amount of exertion required in daily activities				
Standing while taking a train or bus	0.03	–0.05	0.83	–0.21
Taking the stairs instead of the elevator	0.12	–0.11	0.64	0.01
Picking up the pace from leisurely to brisk when walking or cycling	–0.21	0.08	0.53	0.24
Stretching or walking while watching TV	–0.03	0.26	0.41	0.15
Factor 4: Increasing the number of steps through commuting activities				
Walking or cycling to a place instead of driving	–0.07	–0.02	−0.03	0.82
Choosing a hilly route when walking or cycling	–0.07	0.10	0.22	0.66
Making detours when going somewhere	0.33	–0.21	0.11	0.66
Wearing good shoes while walking	–0.01	0.19	–0.22	0.46

$n = 146$.

Factor analysis of part 2 generated 5 factors for a total of 16 items (Table 3). These factors were "Selecting a suitable place or time for physical activities," "Self-monitoring of physical activities," "Making active behavior a habit," "Exercising to stimulate the enjoyment of eating," and "Creating situations to enhance active behavior" with an eigenvalue of >1.0 (χ^2-to-df ratio 1.89, AIC 261.94, CFI 0.91, RMSEA 0.078). Although "Keeping daily activity records to stay motivated" showed a loading of <0.35 for factor 2 ("Self-monitoring of physical activities"), confirmatory factor analysis results prompted us to include this item as a factor.

Concurrent validity

Pearson's correlation coefficients for the ES-SMBPA-2D and IPAQ subscale scores are shown in Table 4. As was hypothe-

Table 3—*Factor analysis of self-management behavior to maintain the level of physical activity*

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Factor 1: Selecting a suitable place or time for physical activities					
Exercising during the daytime (warmer temperature) in winter	0.93	–0.03	–0.15	–0.08	–0.01
Exercising during the evening (cooler temperature) in summer	0.81	–0.02	0.04	–0.03	0.02
Exercising in a cool place (such as in the shade or indoors) in summer	0.78	0.01	0.07	0.02	0.12
Choosing places with a pleasant environment and interesting sights for walking, jogging, or cycling to increase the enjoyment in the activity	0.46	0.00	0.32	0.02	–0.14
Exercising in various places depending on one's mood	0.36	0.06	0.17	0.20	–0.12
Factor 2: Self-monitoring of physical activities					
Using a pedometer to set a goal	0.00	1.00	0.02	–0.02	–0.07
Using a pedometer to count the number of steps	–0.02	0.95	–0.09	–0.03	–0.01
Keeping daily activity records to stay motivated	0.08	0.30	0.10	0.14	0.19
Factor 3: Making active behavior a habit					
Making time to enjoy favorite physical activities	0.01	–0.02	0.92	–0.17	–0.09
Setting a date to enjoy favorite physical activities	–0.13	0.01	0.67	0.09	0.08
Performing the same exercise routine daily be able to monitor physical condition	0.03	–0.07	0.60	0.07	0.05
Factor 4: Exercising to stimulate the enjoyment of eating					
Feeling encouraged to snack more often after engaging in more exercise	0.02	–0.07	0.00	0.94	–0.08
Feeling encouraged to eat more food after engaging in more exercise	–0.04	0.04	–0.04	0.92	0.05
Factor 5: Creating situations to enhance active behavior					
Keeping exercise equipment at an accessible and highly visible place	–0.08	–0.03	0.00	–0.07	0.65
Asking family members or friends to remind one to exercise	0.07	–0.08	–0.05	0.02	0.54
Setting goals for exercise (such as weight loss)	0.09	0.09	0.25	0.00	0.43

$n = 146$.

Table 4—*Correlations between the scale and IPAQ subscales*

	IPAQ subscales			
	Self-powered transport	Household and yardwork activities	Leisure time physical activities	Total
Factor 1: Increasing the number of steps through shopping activities	0.23*	0.26*	–0.19†	0.16*
Factor 2: Increasing the frequency of household activities	0.21†	0.29*	–0.10	0.15
Factor 3: Deliberately increasing the amount of exertion required in daily activities	0.07	0.12	0.16	0.14
Factor 4: Increasing the number of steps through commuting activities	0.22*	0.14	0.11	0.15

$n = 146$. *$P < 0.01$; †$P < 0.05$.

sized, "Increasing the number of steps through shopping activities" correlated with the domains of the three activities shown in Table 4, and "Increasing the frequency of household activities" with the domains of "household and yard work activities" and "self-powered transport." Furthermore, "Increasing the number of steps through commuting activities" correlated with the domain of "self-powered transport" but "Deliberately increasing the amount of exertion required in daily activities" showed no significant correlation with any of the subscales of the IPAQ.

Internal consistency

Cronbach's α coefficient for all the subscales was between 0.56 and 0.90 (Table 5).

Reproducibility

The intraclass correlation coefficient for each of the subscales, calculated from data for the 44 subjects who returned the test-retest responses, was between 0.60 and 0.88 (Table 5).

CONCLUSIONS — For type 2 diabetic patients who require long-term self-management care, medical personnel should consider not only what type of self-management behaviors patients should engage in but also what type of self-management behaviors patients can engage in in their daily lives. Because all of the items of the scale represent self-management behavior that patients can perform in their daily lives and easily incorporate into their lifestyles to maintain their activity levels, we believe that medical personnel can instruct their patients in this regimen in addition to what they conventionally teach about the type, frequency, duration, and intensity of physical activity.

Because most clinical scales are based upon traditional psychometric theory (17), the reliability and validity of the scale were therefore thoroughly evaluated. The benefits of moderately intense daily physical activity for preventing and managing type 2 diabetes and preventing cardiovascular disease are becoming well known (2,3). "Increasing the number of steps through shopping activities," "Increasing the frequency of household activities," and "Increasing the number of steps through commuting activities" are included in what patients can do to increase their daily physical activity, although these activities have recently been found to be decreasing (20). An increase in walking pace is reportedly associated with a reduction in mortality for type 2 diabetic patients (21). Factor 3, "Deliberately increasing the amount of exertion required in daily activities" is included in such activities in general. Therefore, part 1 constitutes a valid method for incorporating daily physical activity into patients' lifestyles.

Although regular physical activity is essential for type 2 diabetes, numerous barriers need to be overcome (4). When diabetic patients face such barriers, they find it difficult to maintain their level of physical activity, and many relapse into a sedentary lifestyle (22). They may then feel guilty and consequently get discouraged from exercising further (22,23). It is therefore important for medical personnel to introduce self-management behaviors to encourage patients to maintain their level of physical activity. Cognitive-behavioral techniques such as "self-monitoring," "self-reinforcement," and "goal setting" have been used to promote adherence to physical activity (22), whereas "Self-monitoring of physical activity," "Exercising to stimulate the enjoyment of eating," and "Creating situations to enhance active behavior" are ways for patients to maintain their level of physical

Table 5—*Internal consistency and reproducibility of the scale*

Subscale	Number of items	Mean ± SD	α*	ICC
Self-management behavior to enhance physical activity in daily life				
Factor 1: Increasing the number of steps through shopping activities	4	5.4 ± 4.6	0.89	0.63
Factor 2: Increasing the frequency of household activities	4	5.6 ± 3.4	0.74	0.84
Factor 3: Deliberately increasing the amount of exertion required in daily activities	4	6.8 ± 3.8	0.73	0.83
Factor 4: Increasing the number of steps through commuting activities	4	7.6 ± 3.9	0.77	0.72
Self-management behavior to maintain the level of physical activity				
Factor 1: Selecting a suitable place or time for physical activities	5	9.1 ± 5.5	0.83	0.75
Factor 2: Self-monitoring of physical activities	3	3.8 ± 3.9	0.80	0.88
Factor 3: Making active behavior a habit	3	6.0 ± 3.8	0.74	0.72
Factor 4: Exercising to stimulate the enjoyment of eating	2	1.7 ± 1.9	0.90	0.60
Factor 5: Creating situations to enhance active behavior	3	2.7 ± 2.7	0.56	0.66

*Cronbach's α. ICC, intraclass correlation coefficient.

activity by using these skills. "Exercising to stimulate the enjoyment of eating," may enable patients to eat greater quantities of food or snacks after adequate exercising, which is likely to encourage patients who experience a loss of freedom with regard to eating (24). Patients who exercise adequately can expect to be able to eat greater quantities of food or snacks. Because individuals generally expect psychological benefits, enhancement of body image, and health benefits from adequate exercising (25,26), exercising sufficiently in the hope of allowing oneself to eat more than usual may be specific to patients with type 2 diabetes. They feel distressed not only when they follow instructions for their dietary regimen but also when they fail to do so (27). On the other hand, when they exercise to stimulate the enjoyment of eating, patients with type 2 diabetes can eat what they want and in greater quantities without feeling guilty about eating too much. However, even if patients exercise enough, they should not eat excessively (28); therefore, further research is needed to determine whether "Exercising to stimulate the enjoyment of eating" constitutes unqualified good behavior. In connection with "Selecting a suitable place or time for physical activity," it has been reported that vigorous, moderate, or recommended activity peaks in the summer, whereas inactivity peaks in the winter (29). Because patients need to try to avoid seasonal fluctuations in their level of physical activity, the aim of "Making active behavior a habit" is to suggest to patients that they try to perform physical activity consistently at the recommended level.

The IPAQ was used to assess the concurrent validity of part 1 only, since there is no appropriate scale to evaluate the concurrent validity of part 2. The results were almost the same as expected (Table 4). Factor 3, "Deliberately increasing the amount of exertion required in daily activities," was a concept that was not included in the IPAQ, as it did not show a significant correlation with any of the IPAQ subscales. There were no other items particularly difficult to interpret, which suggests that the concurrent validity is satisfactory.

Cronbach's α coefficient was 0.56 for factor 5 in part 2 (Table 3). However, because this factor includes important items such as "stimulus control," "helping relationships," and "goal setting" (22,30,31), we decided to include it as a subscale in the ES-SMBPA-2D. Cronbach's α coefficient of $\geq$0.73 for the other subscales confirmed a strong internal consistency. Moreover, the intraclass correlation coefficient of $\geq$0.60 indicates good reproducibility.

Further studies are now required to determine the applicability of the scale to ethnic populations other than Japanese. The ES-SMBPA-2D was found to be reasonably reliable and valid and is expected to prove to be a useful scale for the assessment of patients' self-management behavior and individualized instruction.

Acknowledgments— This work was supported by a grant from the 21st Century Center of Excellence Program, "Center of Excellence for Signal Transduction Disease: Diabetes Mellitus as a Model," from the Ministry of Education, Culture, Sports, Science and Technology of Japan.

We are grateful to the patients who participated in the study and to the staff members of the outpatient clinic of Kobe University Hospital.

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