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Original article

Evaluation of physical activity with the International Physical Activity Questionnaire among outpatients with type 2 diabetes mellitus in Japan

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Abstract

Objective: This study aimed to investigate the amount of physical activity, including daily movement, and the factors related to the amount of physical activity undertaken by patients with type 2 diabetes mellitus at an outpatient clinic.

Patients and Methods: A self-administered questionnaire was distributed to 111 patients, aged 20 years or older, with type 2 diabetes mellitus, who visited a diabetes outpatient clinic. The amount of physical activity was investigated using the International Physical Activity Questionnaire-Long Version. Influencing factors were divided into individual attributes (age, sex, and employment status), disease-related factors (body mass index, treatment period, medication usage, insulin usage, symptoms of fatigue, and lethargy), and emotion-related factors (depression and optimism). These were tested using stepwise regression analysis.

Results: Daily physical activity was 288 metabolic equivalents of task/minute. The sub-scores by the time of day showed "physical activity within the household" and "physical activity during leisure time" as the highest, with 51 metabolic equivalent of tasks/minute. Employment status, medication usage, and depression status were found to have a significant influence and explained 17.9% of the distribution of the entire model.

Conclusion: The results suggest that the amount of daily physical activity among non-working patients should increase. Moreover, we highlight the need to provide diabetes education from the early treatment stages and the importance of early detection and care of patients' psychological needs.

Key words: depression, International Physical Activity Questionnaire, physical activity, Self-rating Depression Scale, type 2 diabetes mellitus

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Introduction

According to the 2016 Japan National Health and Nutrition Survey, approximately 20 million people are suspected to have diabetes[1]. Chronic hyperglycemia is a risk factor for stroke and ischemic heart disease, which are common causes of death in Japan. Because complications related to diabetes cause a marked decrease in quality of life[2], it is desirable to start treatment early and continue it as prescribed. In treating type 2 diabetes mellitus, specific glycemic targets and treatment methods, such as diet, exercise, and drug therapy, are set for each patient. These are selected to improve metabolic abnormalities and prevent complications. Particularly, exercise therapy has been found to improve blood glucose control, lipid metabolism, and insulin resistance and reduce cardiovascular disease risk owing to improved cardiopulmonary function. Exercise therapy also

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improves physical fitness and psychological aspects, such as an increased sense of fulfillment and happiness[3, 4]. For patients with type 2 diabetes mellitus, exercise therapy helps achieve blood glucose control goals and improve the disease condition and can also enhance the quality of life by helping to attain peace of mind. These aspects support research focusing on the importance of exercise.

Most studies on exercise and physical activity in patients with diabetes have considered factors related to glycemic control and depression. Aerobic exercise, which enhances cardiopulmonary function, and resistance exercise, which adds resistance to the skeletal muscles and increases muscle function, have been shown to be effective in achieving glycemic control[5–7]. Moreover, combining both types of exercise effectively reduces glycated hemoglobin (A1C)[8–11]. In a meta-analysis that included exercise therapy for 8 weeks or more, A1C was found to have significantly improved, even without significant weight loss[12, 13]. Despite findings showing the effectiveness of exercise therapy in improving blood glucose control, time constraints and lethargy often hinder action[14, 15]. This leads to exercise therapy showing unfavorable results when compared with drug therapy and self-measurement of blood glucose[16]. Consequently, in recent years, daily non-exercise movements, such as housework activities and locomotion (non-exercise activity thermogenesis[17]), have been found to be effective in improving blood glucose control[18–20]. However, there is a knowledge gap concerning the factors that promote physical activity, including daily movement. Thus, research on exercise habits, including daily physical movement, is necessary.

In addition, studies on depression and physical activity have found that regular exercise has the same effect on depression as psychotherapy[21]. Regular exercise can alleviate mild depression among emotionally healthy people[22], suggesting that physical activity has antidepressant effects[23]. However, there is insufficient research on the positive emotional aspects of physical activity in patients with diabetes. Moreover, although studies on physical activity exist, evidence regarding the effect of physical activity, including daily activities and aerobic and resistance exercise, is lacking.

This study investigated the amount of physical activity, including daily movement, and the factors affecting the amount of physical activity in outpatients with type 2 diabetes mellitus.

Patients and Methods

Participants and survey method

Data were collected from patients at an outpatient clinic between April and June 2018. All participants were over 20 years old and diagnosed with type 2 diabetes mellitus. To measure the amount of physical activity and assess the state of depression, patients who satisfied the following criteria were selected:

1. Patients diagnosed with type 2 diabetes mellitus who were patients at a diabetes outpatient clinic.
2. Patients who could walk without assistance.
3. Patients who had not been instructed by a doctor to restrict exercise as a treatment.
4. Patients not diagnosed with or being treated for mental illness.

The researchers explained the study to 111 patients. Each patient provided informed consent to participate in a medical interview with an outpatient nurse. The survey was conducted using self-administered questionnaires, which patients completed during the hospital waiting time. The researchers assisted those who encountered difficulties in completing the questionnaire by transcribing the answers spoken by the patient. Patients returned the questionnaires by posting them in a dedicated collection box or mailing them directly to the researchers. The researchers were able to collect completed questionnaires from 110 patients.

Questionnaire items

Basic attributes

The basic attribute questionnaire items included age, sex, family structure, and employment status.

Disease-related items

Disease-related questionnaire items were disease duration, treatment duration, diabetes medication use, presence or absence of subjective symptoms, presence or absence of comorbidities and their treatment, A1C, and body mass index (BMI).

Physical activity items

The International Physical Activity Questionnaire (IPAQ) Long Version (Japanese version) created by Murase *et al.*[24] was adopted with the consent of the authors. The IPAQ consists of 31 items on physical activity in four daily situations: work (8 items), locomotion (8 items), home (6 items), leisure (7 items), and inactive time (2 items). The number of hours/days spent on high-intensity physical activity, moderate physical activity, and walking in different daily situations were investigated over 1 week and used to calculate the total amount of physical activity (metabolic equivalent of tasks [METs]/minute) per day.

Emotional aspect items

Depression status: Zung's Self-rating Depression Scale (SDS) was used to investigate depression status. The SDS consists of 20 items divided into three sub-items: main emotions (2 items), physiological symptoms (8 items), and psychological symptoms (10 items). The responses were scored on a 4-point scale. The scores ranged from 20–80, with

higher scores indicating higher depressive tendencies. We purchased the required copies of the Japanese version of the SDS (Sankyobo) and incorporated it into the contents of the questionnaire.

Optimism: Items were selected to evaluate positive emotional elements using the Optimism and Pessimism Scale[25]. The questions consisted of 20 items related to two factors—optimism and pessimism—scored on a 4-point scale. The total scores ranged from 10–40 each for optimism and pessimism, with higher total scores indicating stronger tendencies toward each factor. The researchers obtained consent from the authors to use this scale.

Analysis method

Nine of the 110 questionnaires returned were excluded because of incomplete data (effective response rate: 92.7%), leaving 101 for analysis using simple tabulation and descriptive statistics. Furthermore, Cronbach's alpha was calculated for the SDS and the Optimism and Pessimism Scale to test for data reliability, and a normality test was conducted for each variable.

The amount of daily physical activity was the dependent variable. Factors influencing this variable were categorized into basic attribute-related (age, sex, and employment status), disease-related (BMI, treatment period, medication usage, insulin usage, presence or absence of fatigue symptoms, and presence or absence of lethargy), and emotion-related factors (total SDS score and total optimism score), which were considered independent variables.

After examining the relationship between the independent variables and the amount of physical activity using Spearman's rank correlation coefficient or the Mann–Whitney U test, a stepwise regression analysis (step-down method) was performed to test for factors that affected physical activity. This was done to find a more powerful analysis model. The statistical software SPSS Statistics 22.0 (IBM Corp., Armonk, NY, USA) was used, and the significance level was set at 5%.

Ethical considerations

Participants received verbal and written explanations of the research aims and methods. They were informed that participation was voluntary and that declining to participate or not completing the questionnaire would not affect their treatment. Potential participants were told that the data collected would not be used in any form other than for this research and that their privacy would be protected. Consent to participate was assumed when the participant placed the completed questionnaire in the collection box provided by the researcher or when it was mailed directly to the researcher. This study was approved by the Ethics Committee of the Nagasaki University Graduate School of Biomedical Sciences (Approval No.18030816) and the Ethics Review Committee of the survey execution facility (Approval No. 2018-02).

Results

Overall attributes of the participants

Table 1 shows the overall attributes of the participants: 51 were men, 50 were women, and the average age was 64.7 ± 10.8 years (mean ± SD). Regarding family structure, 42 (41.6%) lived in a two-generation household, the most common among the participants, followed by 38 (37.6%) who lived in a married couple with no children household. Fifty-one participants (50.5%) were employed.

Regarding illness, the average disease duration was 10.6 ± 9.0 years, and the average treatment period was 9.0 ± 8.6 years. As for participant symptoms, 27 (26.7%) answered "yes" to whether they felt fatigue, making fatigue the most common symptom. Thirty-nine participants (38.6%) answered "yes" to having comorbidities, the most common being hypertension (14 participants). The average A1C was 7.0 ± 1.0%, and the average BMI, which shows the degree of obesity, was 25.0 ± 4.1.

The daily amount of physical activity was 288 METs/minute. The sub-scores by the time of day showed "physical activity within the household" and "physical activity during leisure time" to be the highest, with 51 METs/minute. The physical activity type sub-scores showed that "moderate physical activity" was the highest, with 111 METs/minute (Table 2).

Regarding emotional aspects, Cronbach's alphas for the SDS and optimism in this study were 0.77 and 0.90, respectively. The average total SDS score was 38.7 ± 8.0, and the average total optimism score was 25.6 ± 6.0. The results for Zung's level of depression showed that 59 (58.4%) participants were normal (not depressed), 27 (26.7%) were mildly depressed, 14 (13.9%) were moderately depressed, and 1 (1.0%) was severely depressed. According to the Japanese version of the SDS User's Guide[26], setting a cutoff value of 48 for people over 65 is recommended. This classification showed that 74 (73.3%) patients had no depression tendencies, and 27 (26.7%) had depression tendencies.

Relationship between dependent and independent variables

No significant differences in the amount of daily physical activity were observed according to sex, employment status, medication usage, insulin usage, presence or absence of fatigue, and presence or absence of lethargy.

Table 3 presents the correlations between the dependent and independent variables. A significant negative correlation ($P<0.01$) was observed between the amount of daily physical activity and total SDS score, and there was a positive correlation ($P<0.05$) between daily physical activity

Table 1 Basic patient attributes (n=101)

			Number	Proportion (%)	Average	Standard deviation
Sex	Men		51	50.5		
	Women		50	49.5		
Age					64.7	10.8
Family structure	Single household		9	8.9		
	Married couple with no children		38	37.6		
	Two-generation household		42	41.6		
	Three-generation household		9	8.9		
	Other		3	3.0		
Age distribution by employment status	With work	Under 65 years old	33	64.7	59.6	9.9
		Over 65 years old	18	35.3		
	Unemployed	Under 65 years old	10	20.0	69.8	9.3
		Over 65 years old	40	80.0		
Sex distribution by employment status	With work	Men	29	56.9		
		Women	22	43.1		
	Out of work	Men	22	44.0		
		Women	28	56.0		
Diabetes duration					10.6	9.0
Treatment duration					9.0	8.6
HbA1c level	Normal (Less than 5.8%)		6	5.9	7.0	1.0
	Good (5.8–6.5%)		22	21.8		
	At risk (6.5–7.0%)		26	25.7		
	Slightly dangerous (7.0–8.0%)		31	30.7		
	Dangerous (Above 8.0%)		16	15.8		
BMI	Underweight (Under 18.5)		5	5.0	25.0	4.1
	Normal (18.5–25)		55	54.5		
	Overweight (Above 25)		41	40.6		
Physical symptoms	Dry mouth		20	19.8		
	Polyposia		21	20.8		
	Polyuria/pollakiuria		23	22.8		
	Fatigue		27	26.7		
	Lethargy		8	7.9		
	Others		10	9.9		
Disease other than diabetes	Hypertension		14	13.9		
	Hyperlipidemia		10	9.9		
	Cardiovascular disease		8	7.9		
	Locomotive syndrome		5	5.0		
	Others		14	13.9		

BMI: body mass index.

and total optimism score. No significant correlations were seen with the other variables.

Factor analysis affecting physical activity: multiple regression analysis

The attribution-related factor of employment status, the disease-related factor of medication usage, and the emotion-related factor of total SDS score were adopted as variables that have significant influence; these variables explained 17.9% of the variance of the entire model (Table 4). Being employed, using medication, and having low depressive tendencies significantly affected the amount of physical activity.

Discussion

Amount of physical activity in patients with type 2 diabetes mellitus

The daily amount of physical activity was 288 METs/minute. Calorie consumption calculated from physical ac-

Table 2 Amount of physical activity per day (METs/min)

Item		Median	Interquartile range	Score range
Total amount of physical activity		288	868	0–4,015
Time of day	During work	0	418	0–3,376
	Transportation	0	57	0–396
	At home	51	180	0–1,243
	Leisure time	51	139	0–1,057
Type of physical activity	Walking-related activity	85	173	0–1,754
	Moderate physical activity	111	414	0–1,551
	Hard physical activity	0	171	0–3,291

MET: metabolic equivalent of tasks.

Table 3 Correlation of dependent and independent variables

	Amount of physical activity/day	
	ρ	*P*
Basic attribute-related factors		
Age	−0.00	0.98
Disease-related factors		
BMI	−0.13	0.19
Treatment period	−0.11	0.26
Emotion-related factors		
Total SDS score	−0.27	0.01**
Total optimism score	0.23	0.02*

Spearman's rank-correlation coefficient (*P<0.05, **P<0.01).

BMI: body mass index; SDS: self-rating depression Scale.

Table 4 Multiple regression analysis with physical activity as a dependent variable

Independent variable	Partial regression coefficient (B)	Standard error	*P*
Basic attribute-related factors			
Age			
Sex			
Employment status	362.881	145.136	0.014*
Disease-related factors			
BMI			
Treatment period			
Medication usage	499.485	205.553	0.017*
Insulin treatment usage			
Presence/absence of fatigue	−384.174	199.575	0.057
Presence/absence of lethargy	529.289	307.858	0.089
Emotion-related factors			
Total SDS score	−22.726	10.396	0.031*
Total optimism score			
Determination coefficient (R^2)	0.179		

Stepwise regression analysis (step-down method) (*P<0.05, **P<0.01).

BMI: body mass index; SDS: self-rating depression Scale.

tivity was 367 kcal/day, which was higher than the 157 kcal/day calorie consumption reported by Shirai *et al.*[27] in men with type 2 diabetes mellitus. Furthermore, according to a study targeting healthy middle-aged and older workers, the weekly amount of physical activity was 558 METs/minute in men and 375 METs/minute in women[28]. In our study, it was 2,019 METs/minute, which was much higher than that of healthy workers.

The amount of physical activity tends to be affected by the season. As previous studies were conducted during different seasons, the season in which the investigation was conducted might have led to the difference between our results and those of previous studies. Nevertheless, it is inferred that the participants in our investigation were trying to be active because of the need to manage their disease or condition.

Factors affecting the amount of physical activity in patients with type 2 diabetes mellitus

Being employed, using medication, and having low depressive tendencies significantly affected the amount of physical activity. Age, sex, treatment period, subjective symptoms, and optimism were found to be insignificant variables.

In this study, BMI was taken as the independent variable that influences the amount of physical activity, assuming that the higher the obesity level, the lower the amount of physical activity. However, BMI is merely an index calculated from height and weight and cannot directly reflect body composition such as body fat percentage or muscle mass. Therefore, BMI was not considered a variable influencing the amount of physical activity.

As mentioned above, the amount of physical activity in the sample population in this study was higher than that reported in previous studies of patients with chronic diseases and healthy adults. It is possible that the study participants, as a whole, were consciously engaging in physical activity to control their disease, regardless of their BMI.

Because being employed was found to be a factor affecting the amount of physical activity, it is surmised that employed individuals maintain a certain amount of physical activity from daily labor and commuting. Furthermore, there was a significant difference between the ages of those employed and those who were not. The average age of employed individuals was 59.6 ± 9.9 years, and 69.8 ± 9.3 years for those who were unemployed. Being younger affects the amount of engagement in walking and energetic activities in people with type 2 diabetes[29]; therefore, it is possible that physical activity may be reduced in older people owing to age-related decline in physical function and motivation. Therefore, the significant relationship between working status and age distribution could have been one reason why employment status was found to be a factor affecting physical activity. In addition, 33 (64.7%) employed individuals were under 65 years old, whereas 40 (80%) unemployed individuals were over 65 years old, suggesting that many retired people might have been included. A previous study reported that the frequency of exercise in those over 65 years old decreased after retirement[30], and the scope of outdoor activity is likely to decrease in older men after retirement[31]. Therefore, it can be assumed that the difference in the distribution of older people between the employed and unemployed participant groups may explain why employment status affects the amount of physical activity.

Few subjective symptoms of glucose metabolism disorder exist in the early stages of type 2 diabetes mellitus, making it difficult to establish self-management behaviors. Activities such as taking daily medications and having regular medical examinations enhance patients' self-cognition of having diabetes mellitus, which is thought to be linked to self-management behavior, such as increasing physical activity. Moreover, if medication is insufficient to achieve glycemic control, it is necessary to consider introducing insulin therapy. Patients feel resistant to insulin therapy because of the pain and burden of injections, increased economic burden, life and work restrictions, and fear of hypoglycemia, among other reasons[32]. Therefore, it is possible that the desire to control glucose through orally ingested medication alone, without introducing insulin therapy, can be a motivating factor for self-management behaviors. Additionally, subjective symptoms may become more pronounced compared with the early stages of treatment, and a sense of crisis regarding further deterioration and associated complications may occur. The association between risk perception and health behaviors in chronically ill patients[33] is reported as an important step in integrating health behaviors into daily life[34, 35]. Thus, risk perception may influence physical activity.

Low depressive tendencies were associated with an increased amount of physical activity. This result supports reports that depression decreases the amount of physical activity[36] and increases the tendency toward physical inactivity[37]. In a state of severe depression, symptoms such as reduced activity motivation, fatigue, and lethargy appear, and it is speculated that a decrease in overall activity may affect the amount of physical activity.

Conclusion

This study analyzed the amount of physical activity calculated using the IPAQ and its influencing factors in 101 patients with type 2 diabetes mellitus at a diabetes outpatient clinic. The analysis showed that among the independent variables investigated, being employed, using medication, and having low depression tendencies had a significant influence on physical activity, which explained 17.9% of the

variance in the entire model. These results suggest the need for increased physical activity in the daily lives of people who are out of work. They also emphasize the importance of providing diabetes education from the early stages of treatment and the need for early detection and appropriate care of patients' psychological needs.

This study defines physical activities as those related to daily housework, locomotion, and activities derived from planned and consistent physical exercise to maintain and improve physical fitness. This study aimed to understand how and where patients with type 2 diabetes engaged in physical activity and the factors influencing the amount of physical activity to help promote it.

This investigation indicates the importance of employment status, medication usage, and depression tendencies as key factors in promoting physical activity. These findings suggest a need for support that incorporates these key factors. An approach for patients with type 2 diabetes mellitus that increases the amount of physical activity by focusing on daily activities, such as housework, locomotion, and leisure activities, especially for people who are out of work, is necessary. Furthermore, applying these findings to diabetes education, such as providing information on the emergence of subjective symptoms and complications associated with changes in medical conditions and strengthening treatment, may also facilitate increased motivation for self-management behavior. Encouraging participation in support groups in the early stages of treatment may also increase self-management behavior. In addition, reports have shown that patients with diabetes are three times more likely to experience depression than the general population. Depression is expected to become more severe and prolonged in this group than in those without diabetes[38]. Accordingly, we believe that early detection and care of psychological disorders through regular depression screenings may help prevent a decrease in patients' amount of physical activity.

Conflict of interest: The authors declare that there are no conflicts of interest.

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Ethics approval: This study was approved by the Ethics Committee of the Nagasaki University Graduate School of Biomedical Sciences (Approval No.18030816) and the Ethics Review Committee of the survey execution facility (Approval No. 2018-02). The study was conducted in accordance with the principles of the Declaration of Helsinki and its later amendments.

Consent to participate: Each patient provided their consent during a medical interview with an outpatient nurse.

Consent for publication: All authors approved the manuscript for publication in the Journal of Rural Medicine.

Data availability statement: The datasets generated and analyzed during the current study are not publicly available owing to the nature of this research. The study participants did not consent to their data being shared publicly.

Author contributions: Miki Yokoyama: Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Visualization; Writing-original draft. Yoko Kusuba: Conceptualization; Formal analysis; Methodology; Project administration; Supervision; Writing-review & editing. Kaori Hashizume: Methodology; Writing-review & editing. Emi Matsuura: Conceptualization; Data curation; Methodology; Writing-review & editing.

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