ORIGINAL ARTICLE

Psychological impacts from expectation of worsening conditions and obstacles to life planning are affected by glycemic control, self-reported symptoms, and drug therapy in patients with type 2 diabetes mellitus

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ABSTRACT

Introduction/Aims: It is important to reduce psychological stresses for glycemic control in diabetes. We investigated the factors affecting psychological impact, which was involved in the disease conditions in 378 patients with type 2 diabetes mellitus.

Materials and Methods: Patients' self-assessed symptoms and four subscales of psychological impacts on diabetes – impact from diabetes (S1), anxiety from having a chronic disease (S2), expectation of worsening conditions (S3) and obstacles to life planning (S4) – were analyzed.

Results: Significant odds ratios (ORs) were found for sex and age in S1, age and glycemic control in S2, glycemic control in S3, disease duration and glycemic control in S4, and number of symptoms in S1–S4. Scores of S1 and S2 in women were lower than those in men, and decreased age-dependently. Significant ORs for the number of symptoms in S3 and S4 were greater than in S1 and S2. ORs increased markedly for patients under oral hypoglycemic agent therapy in S4 and insulin therapy in S1–S4 when compared with ORs for lifestyle therapy alone.

Conclusions: The psychological impact of type 2 diabetes involved *a priori* factors dependent on sex and aging in the subscales of current anxieties and impact, and *a posteriori* factors, such as disease duration, glycemic control and treatment methods, in the subscales of expectation of worsening conditions and obstacles to life planning.

INTRODUCTION

The number of people with diabetes is on the rise worldwide as a result of changing diet and aging[1]. The number of patients surpassed 9.5 million in Japan in 2012[2]. Because more than 40% of dialysis patients suffer from diabetic nephropathy[3], the prevention of diabetic complications, even more than primary and secondary prevention, is a medical and economic problem that must be dealt with immediately.

In contrast to other chronic diseases, diabetes demands dietary and behavioral changes, and constant self-management of blood glucose levels with medication and by other means,

because the disease can result in serious complications, such as retinopathy, nephropathy and neuropathy. This often leads to lowering of patients' quality of life; therefore, in terms of treatment, it is particularly important for patients to maintain good glycemic control by reducing psychological stresses[4]. Although lifestyle therapy through diet, exercise and drug therapy can control a patient's blood glucose levels, it has been the responsibility of healthcare professionals, such as doctors, nurses and dieticians, to provide guidance to patients toward meeting glycemic control targets. A recently proposed concept called patient empowerment[5,6] presents the idea that having patients with type 2 diabetes set their own glycemic control targets and take responsibility for their own behavior would lead to effec-

tive glycemic control. This concept is currently being introduced in Japan.

We developed a simple self-completed questionnaire on empowerment for Japanese type 2 diabetes patients that consisted of scales to measure self-control of diet and exercise, psychological impact of the disease, and family relations, and we investigated its reliability and validity, and analyzed the factors affecting the questionnaire's component scales[7]. The questionnaire's psychological impact of diabetes scale was found to involve the age of the patient, glycated hemoglobin (HbA1c) levels, treatment method and the number of self-reported symptoms. There is a strong possibility that behavioral change and appropriate treatment could alleviate the effect of the three factors other than age. Accordingly, we investigated factors affecting the four subscales of the psychological impact scale (impact from diabetes [S1], anxiety from having a chronic disease [S2], expectation of worsening conditions [S3] and effects on future life planning [S4]) using multivariate analysis.

MATERIALS AND METHODS

Participants

Participants were selected from patients who had been diagnosed with type 2 diabetes more than 6 months before the study and were continuing treatment with oral hypoglycemic agent (OHA) or insulin (or a combination of both) or lifestyle therapy (diet or exercise) while living with a family member not related by blood. Persons with cognitive dysfunction or drug-induced or secondary diabetes were excluded. The study was carried out at six facilities, including a university, key hospitals, medical examination centers, and clinics in Fukuoka and Kumamoto prefectures over a period from 2007 to 2011. A total of 384 questionnaires were collected. After six incomplete questionnaires were excluded, 378 questionnaires were selected for analysis (valid response rate: 98.4%). Table 1 is a summary of the characteristics of the participants: 185 male and 193 female participants. There were no significant sex differences in age, disease duration and HbA1c levels. Approximately 90% of male and 70% of female participants lived with their spouses. With respect to treatment method, approximately 10% were being treated with lifestyle therapy, such as diet and exercise, 50% with OHA only, 30% with insulin only, and 10% with a combination of insulin and OHA, with no significant sex differences.

Self-assessment questionnaire

The self-assessment questionnaire contained questions regarding age, sex, presence of diabetes-related symptoms (numbness, swelling, cold sweat, malaise, reduced visual acuity, decreased appetite, fatigue, dyspnea, insomnia and agitation), HbA1c level, disease duration, treatment method and psychological impact scale consisting of four categories.

The Japanese version of the four-category psychological impact scale was prepared based on the Appraisal of Diabetes Scale developed by Carey et al.[8] with their permission. We had previously tested the reliability and validity of the Appraisal of Diabetes Scale, and reported that the Japanese version of the Appraisal of Diabetes Scale could be divided into three scales of 'sense of self-control,' 'efforts for symptom management' and 'psychological impact of diabetes'[9]. Participants took less than 10 min to complete the questionnaire.

Table 1 | Characteristics of participants

		Overall		Male		Female		P-value
		n	%	n	%	n	%	
Sex		378	100	185	48.9	193	51.1	
Age (years)	Mean ± SD (range)	63.7 ± 10.8 (28–94)		64.3 ± 10.5 (39–94)		63.1 ± 11.0 (28–86)		NS
Age group (years)	<40	10	2.6	2	1.1	8	4.1	NS
	40–49	26	6.9	14	7.6	12	6.2	
	50–59	87	23.0	44	23.8	43	22.3	
	60–69	143	37.8	68	36.8	75	38.9	
	70–79	91	24.1	45	24.3	46	23.8	
	≥80	21	5.6	12	6.5	9	4.7	
Disease duration (years)	Mean ± SD (range)	12.5 ± 9.8 (0.2–53.0)		12.9 ± 9.7 (0.2–44.0)		12.1 ± 9.9 (0.8–53.0)		NS
HbA1c (%, NGSP)	Mean ± SD (range)	7.4 ± 1.2 (4.7–13.0)		7.3 ± 1.1 (5.4–13.0)		7.5 ± 1.2 (4.7–12.6)		NS
	≥7.0%	230	60.8	112	60.5	118	61.1	NS
	<7.0%	148	39.2	73	39.5	75	38.9	
Treatment	Lifestyle therapy	36	9.5	18	9.7	18	9.3	NS
	OHA	188	49.7	99	53.5	89	46.1	
	Insulin	117	31.0	56	30.3	61	31.6	
	OHA plus insulin	37	9.8	12	6.5	25	13.0	

Continuous data (age, disease duration, glycated hemoglobin [HbA1c]) were analyzed by Student's t-test. Categorical data (age group, glycemic control (HbA1c ≥7.0% or <7.0%), treatment) were analyzed by χ^2-test. P < 0.05 was considered significant (female vs male). NGSP, National Glycohemoglobin Standardization Program; NS, not significant; OHA, oral hypoglycemic agent.

Handling of data and analysis method

All of the collected questionnaires were identified by ID numbers, and the data contained in them were stored in magnetic media. Only the questionnaires in which all questions were answered were used for the analyses. For the logistic regression analysis, sex was coded as 0 for female and 1 for male. For self-reported symptoms, code 0 was given to No and code 1 to Yes. The HbA1c levels were grouped by either good glycemic control with less than 7.0% (code 0) or poor glycemic control with 7.0% or higher (code 1). Disease duration was coded 0 for less than 10 years and 1 for 10 or more years. Treatment method was divided into four categorical variables (lifestyle [diet and/or exercise], OHA, insulin, OHA plus insulin therapy). The scale for psychological impact of diabetes was divided into four subscales: impact from having diabetes (S1: How upsetting is having diabetes for you?); anxiety caused by chronic disease (S2: How much anxiety do you currently experience in your life as a result of being diabetic?); expectation of worsening conditions (S3: How likely is your diabetes to worsen over the next several years?); and effects on life planning (S4: To what degree does your diabetes get in the way of developing life goals?). The questionnaire required five-level responses, from no impact (score: 1) to very high impact (score: 5). The scores of psychological impact of diabetes and its subscales as dependent variables were dichotomized (0 for ≤50 percentiles of the scores [less affected]; 1 for >50 percentiles [more affected]). Multiple logistic regression analyses were carried out with forced entry option. Odds ratios (ORs) were adjusted by sex, age, disease duration, glycemic control and number of self-reported symptoms or each specific symptom. The omnibus tests of model coefficient (χ^2) were significant ($P < 0.01$) for all models. Correlation coefficients (r) among predictive values were tested, and all the r-values <0.26, showing there was no multicollinearity. Goodness-of-fit was analyzed by Hosmer–Lemeshow statistic, and the P-values were well above 0.05 for all models. Statistical analyses including Student's t-test for the analyses of continuous variables of two groups, χ^2-test for the analyses of categorical data, one-way ANOVA for the analyses of continuous variables of more than three groups, correlation analysis and multiple logistic-regression analysis were carried out on statistical software packages JMP version 10 (SAS Institute Inc., Cary, NC, USA) and SPSS version 21.0 (IBM Corporation, Armonk, NY, USA). Significance was set at $P < 0.05$.

Ethical considerations

The present study was approved by the Clinical Ethical Review Board of Kurume University School of Medicine. Before investigation, the participants were provided with explanations in person as to the purpose and method of the study, as well as information regarding the handling of the results. The study was carried out on receiving their written consent.

RESULTS

Factors affecting the subscales of the psychological impact of diabetes

Multiple logistic regression analysis was carried out using the four subscales of the psychological impact of diabetes scale as dependent variables, and sex, age, disease duration, glycemic control and the number of self-reported symptoms as predictive variables. The results are summarized in Figure 1a. The ORs were significant for sex and age in S1, age and glycemic control in S2, glycemic control in S3, disease duration and glycemic control in S4, and the number of self-reported symptoms in all subscales. In S1, impact decreased significantly among men compared with women, and in S1 and S2, impact and anxiety both decreased significantly for each year increase in age. As the number of self-reported symptoms increased by one in S1 and S2, impact and anxiety increased significantly by 1.23- and 1.32-fold, respectively. In S3 as well as S2, poor glycemic control increased expectation of worsening conditions by 2.53-fold compared with good glycemic control, and as the number of self-reported symptoms increased by one, the expectation of worsening conditions increased by 1.37-fold. In S4, obstacles to life planning increased by 1.93-fold in patients with a disease duration of 10 years or more compared with those with a disease duration of less than 10 years, by 1.57-fold among those having poor glycemic control compared with those with good control, and by 1.31-fold as the number of self-reported symptoms increased by one. Crude ORs that were significant for sex, age, disease duration, glycemic control and number of symptoms all maintained significance after ORs were adjusted, except those for sex in S1 and glycemic control in S2 and S4.

Effects of sex and age on the subscales of psychological impacts of diabetes

In order to investigate the effects of sex and age that showed significantly low ORs in S1 and S2, the participants were stratified by age for each sex. The results are summarized in Table 2. There were three age groups: younger than 60 years, 60–69 years and 70 years or older. Among men and women together (the 'overall' category), scores in S1, S2 and S3 decreased with aging, and showed significant differences in the F-values of ANOVA. There was no significant variation in S4. A comparison by sex shows scores for the age group younger than 60 years being higher among women than men in all subscales. Scores among women in S1, S2 and S3 decreased as their age increased, with considerable decrease after the age of 70 years. Among men, there was no significant age-related change in scores in any of the subscales.

Effects of diabetes-related symptoms on the subscales of psychological impacts of diabetes

Next, the relationship between subscales and the presence or absence of 10 diabetes-related symptoms among the number of self-reported symptoms was analyzed using the multiple logistic
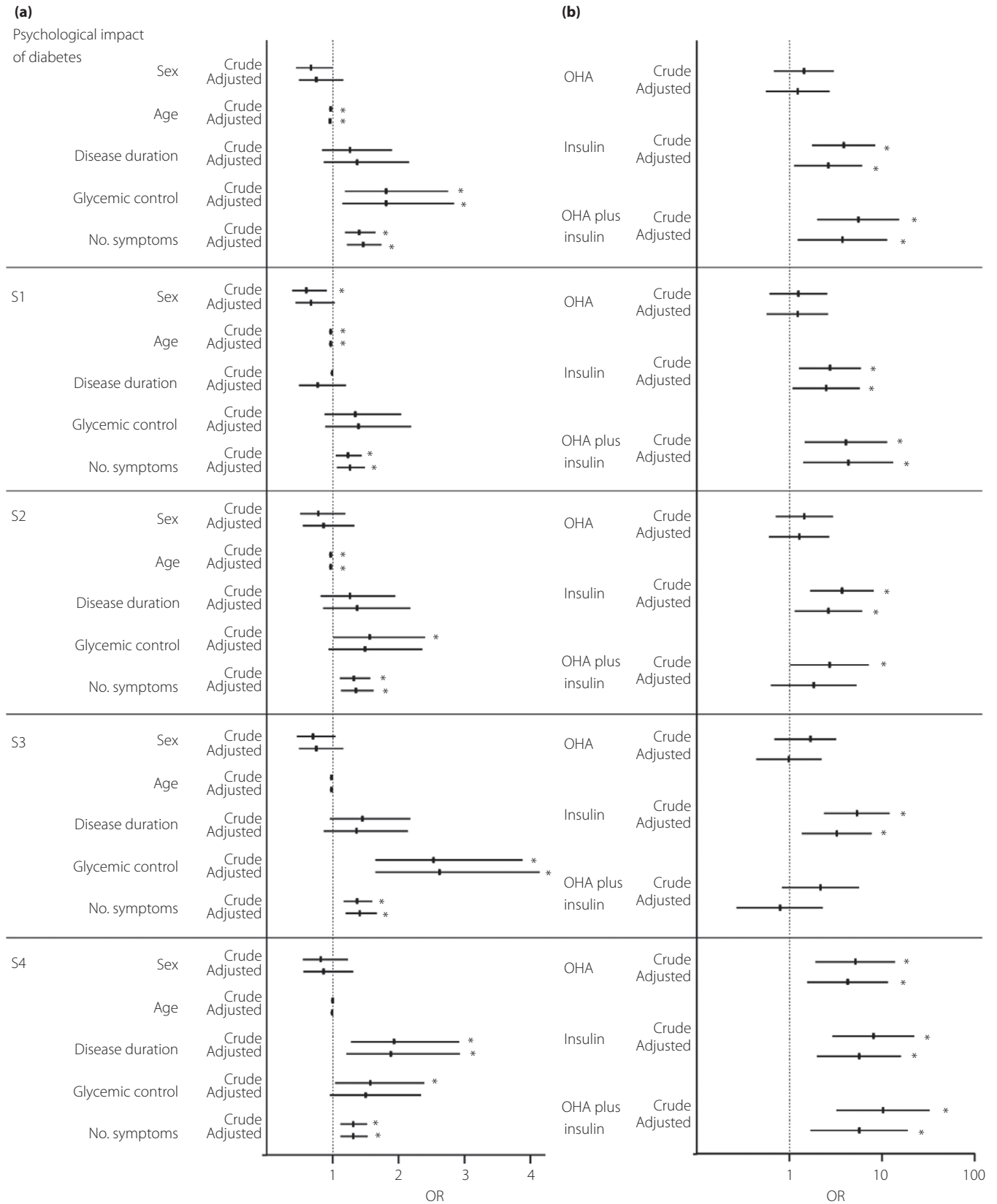
(a)

Psychological impact
of diabetes

(b)

Figure 1 | Logistic regression analysis of (a) factors including sex, age, disease duration, glycemic control and number of self-reported symptoms, or (b) treatment method affecting the psychological impact of diabetes scale and its subscales. (a, b) All adjusted odds ratios (OR) were adjusted by sex, age, disease duration, glycemic control and number of self-reported symptoms. (b) Treatment method was divided into four categorical variables. Subscale 1 (S1), impact from diabetes; subscale 2 (S2), anxiety from having a chronic disease; subscale 3 (S3), expectation of worsening conditions; and subscale 4 (S4), obstacles to life planning. The vertical short line represents ORs; the horizontal line represents 95% confidence interval; the asterisk (*) represents significant OR ($P < 0.05$). ORs in (a) are shown in linear scale; ORs with respect to lifestyle therapy (reference) in (b) are shown in logarithmic scale.

Table 2 | Scores of the psychological impact of diabetes scale and its subscales by age group

	Age group (years)	n	Psychological impact of diabetes	Subscale 1	Subscale 2	Subscale 3	Subscale 4
Overall	<60	123	11.24 ± 3.10	3.04 ± 1.03	3.03 ± 0.95	2.67 ± 1.00	2.49 ± 1.08
	60–69	143	10.71 ± 3.34	2.76 ± 1.05	2.90 ± 1.04	2.58 ± 1.06	2.48 ± 1.11
	≥70	112	9.73 ± 3.13**#	2.46 ± 1.11***	2.61 ± 1.06**	2.33 ± 0.87*	2.34 ± 1.08
	One-way ANOVA		$P < 0.01$	$P < 0.001$	$P < 0.01$	$P < 0.05$	NS
Male	<60	60	10.28 ± 3.04	2.75 ± 0.97	2.73 ± 0.92	2.42 ± 0.89	2.38 ± 1.08
	60–69	68	10.21 ± 3.20	2.54 ± 1.03	2.76 ± 0.96	2.51 ± 1.01	2.38 ± 1.04
	≥70	57	9.60 ± 0.42	2.42 ± 1.03	2.63 ± 1.03	2.25 ± 0.87	2.30 ± 1.13
	One-way ANOVA		NS	NS	NS	NS	NS
Female	<60	63	12.14 ± 2.91	3.32 ± 1.01	3.32 ± 0.89	2.92 ± 1.04	2.59 ± 1.09
	60–69	75	11.17 ± 3.42	2.95 ± 1.15	3.03 ± 1.10	2.64 ± 1.11	2.56 ± 1.17
	≥70	55	9.87 ± 3.05***	2.50 ± 1.07***#	2.58 ± 1.10***#	2.42 ± 0.88*	2.38 ± 1.03
	One-way ANOVA		$P < 0.001$	$P < 0.001$	$P < 0.001$	$P < 0.05$	NS

*$P < 0.05$ vs '<60' group; **$P < 0.01$ vs '<60' group; ***$P < 0.001$ vs '<60' group; #$P < 0.05$ vs '60–69' group. Data were analyzed using one-way analysis of variance (ANOVA) followed by Tukey–Kramer honestly significant difference test as a *post-hoc* test. $P < 0.05$ was considered statistically significant. Subscale 1, impact from diabetes; subscale 2, anxiety from having a chronic disease; subscale 3, expectation of worsening conditions; subscale 4, obstacles to life planning. NS, not significant.

regression method. The results are summarized in Table 3. The ORs were significantly high compared with symptomless patients in S1 for reduced visual acuity and fatigue with ORs of 1.70 and 1.81 respectively; in S2 for malaise, reduced visual acuity, and fatigue with ORs of 3.22, 1.90 and 1.70, respectively; in S3 for swelling, cold sweat, malaise, reduced visual acuity, fatigue, and agitation with respective ORs of 2.39, 4.17, 3.22, 1.93, 1.85 and 2.47; and in S4 for swelling, cold sweat, malaise, and agitation with respective ORs of 2.07, 3.29, 3.45, and 2.32. However, ORs adjusted for sex, age, disease duration, and glycemic control showed significance only for reduced visual acuity in S1, S2 and S3, and swelling in S3.

Effects of treatment methods on the subscales of the psychological impact of diabetes

As all study participants were undergoing treatment, treatment methods were coded according to average score on the psychological impact of diabetes scale, and analyzed using multiple logistic regression analysis in order to investigate the relationship with drug therapy. The results are summarized in Figure 1b. ORs with respect to lifestyle therapy with exercise and diet were significant in S1 for insulin therapy and OHA plus insulin therapy with ORs of 2.73 and 4.05, respectively; in S2 for insulin therapy and OHA plus insulin therapy with ORs of 3.68 and 2.70 respectively; in S3 for insulin therapy alone with OR of 5.33; and in S4 for and OHA, insulin, and OHA plus

insulin therapies with respective ORs of 5.12, 8.02 and 10.19. Factors such as sex, age, disease duration, glycemic control and number of self-reported symptoms, which showed significant crude ORs, also showed high ORs in a range of 2.48–5.64 after adjustment. In S4 in particular, ORs for drug therapy were still four to fivefold higher than for lifestyle therapy even after adjustment, and ORs for insulin therapy and OHA plus insulin therapy were higher than for OHA therapy.

Relationships between treatment method stratified by glycemic control and the scores of subscales, symptoms and other factors

Table 4 is a summary of the results of analyses carried out for each treatment method, with the scores in subscales S1 to S4, disease duration (years), number of self-reported symptoms, type of self-reported symptoms, sex, age and body mass index each grouped according to HbA1c level of 7.0% or higher (poor glycemic control) or less than 7.0% (good glycemic control). Scores in S1 and S2 were not significantly different between patients with good or poor glycemic control with any of the treatment methods, but for patients with poor glycemic control, scores in S3 were significantly higher in patients on OHA and insulin therapies, and scores in S4 were significantly higher for patients on insulin therapy, showing the relevance between the psychological impact of diabetes and the effectiveness of drug therapy. For the patients on insulin therapy, however, disease

Table 3 | Logistic regression analyses of symptoms affecting the psychological impact of diabetes scale and its subscales

Symptom	Psychological impact		Subscale 1		Subscale 2		Subscale 3		Subscale 4	
	Crude OR (95% CI)	Adjusted OR (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)
Numbness	1.13 (0.68–1.87)	0.99 (0.55–1.79)	0.88 (0.53–1.47)	0.84 (0.48–1.48)	0.94 (0.56–1.59)	0.78 (0.43–1.40)	1.13 (0.68–1.86)	0.88 (0.49–1.60)	1.39 (0.84–2.31)	1.10 (0.63–1.93)
Swelling	1.68 (0.88–3.20)	1.35 (0.64–2.84)	1.14 (0.60–2.16)	0.91 (0.45–1.86)	1.56 (0.78–3.13)	1.37 (0.64–2.95)	2.39 (1.24–4.59)	2.24 (1.07–4.71)	2.07 (1.10–3.91)	1.67 (0.83–3.36)
Cold sweat	7.73 (1.76–33.95)	6.60 (1.41–30.97)	2.57 (0.84–7.90)	2.23 (0.68–7.34)	2.92 (0.84–10.21)	2.16 (0.58–8.00)	4.17 (1.36–12.81)	3.07 (0.91–10.40)	3.29 (1.16–9.33)	2.28 (0.75–6.99)
Malaise	3.18 (1.25–8.06)	1.99 (0.71–5.55)	2.44 (0.96–6.18)	1.83 (0.65–5.11)	3.22 (1.09–9.52)	2.13 (0.67–6.79)	3.22 (1.33–7.81)	2.51 (0.93–6.73)	3.45 (1.42–8.37)	2.60 (0.98–6.89)
Reduced visual acuity	2.21 (1.35–3.62)	2.27 (1.33–3.87)	1.70 (1.04–2.79)	1.72 (1.01–2.92)	1.90 (1.12–3.23)	1.78 (1.02–3.10)	1.93 (1.20–3.09)	1.87 (1.11–3.16)	1.49 (0.93–2.37)	1.27 (0.77–2.11)
Decreased appetite	1.19 (0.37–3.81)	0.94 (0.25–3.49)	2.01 (0.54–7.56)	1.92 (0.46–8.00)	1.59 (0.42–5.99)	1.31 (0.31–5.50)	1.05 (0.33–3.30)	0.78 (0.21–2.84)	1.12 (0.35–3.52)	0.84 (0.23–3.02)
Fatigue	1.80 (1.14–2.86)	1.48 (0.88–2.50)	1.81 (1.12–2.92)	1.51 (0.89–2.55)	1.70 (1.04–2.80)	1.42 (0.82–2.44)	1.85 (1.17–2.91)	1.46 (0.87–2.45)	1.47 (0.94–2.30)	1.16 (0.71–1.92)
Dyspnea	1.59 (0.74–3.42)	1.08 (0.45–2.59)	1.22 (0.57–2.62)	0.88 (0.38–2.07)	1.88 (0.79–4.50)	1.43 (0.56–3.68)	1.29 (0.62–2.71)	0.81 (0.34–1.91)	1.39 (0.66–2.90)	0.92 (0.40–2.13)
Insomnia	1.82 (0.96–3.44)	1.09 (0.52–2.30)	1.52 (0.80–2.91)	0.97 (0.46–2.03)	1.90 (0.93–3.86)	1.38 (0.62–3.04)	1.70 (0.92–3.16)	1.18 (0.56–2.48)	1.66 (0.90–3.07)	1.13 (0.55–2.32)
Agitation	2.58 (1.22–5.47)	1.79 (0.76–4.18)	1.96 (0.92–4.16)	1.46 (0.63–3.36)	1.78 (0.82–3.88)	1.13 (0.48–2.69)	2.47 (1.21–5.05)	1.60 (0.71–3.62)	2.32 (1.15–4.69)	1.66 (0.76–3.62)

Adjusted odds ratios (OR) were adjusted by sex, age, disease duration and glycemic control. Subscale 1, impact from diabetes; subscale 2, anxiety from having a chronic disease; subscale 3, expectation of worsening conditions; subscale 4, obstacles to life planning. CI, confidence interval.

duration was longer than for those on OHA therapy, and in insulin-treated patients with good glycemic control, the number of self-reported symptoms was significantly higher than in patients with poor control, and a significantly higher percentage of these patients with good glycemic control reported diabetes-related numbness and insomnia. For the patients on OHA plus insulin therapy, there were no notable differences in scores in S1 to S4 between patients with good glycemic control and those with poor glycemic control, although it is difficult to make a meaningful comparison because of the insufficient number of patients with good glycemic control.

DISCUSSION

Our studies of patients with type 2 diabetes mellitus in the past confirm that the psychological impact of diabetes scale correlates well with HbA1c levels and treatment methods, reflecting anxieties routinely felt by patients[9,10]. Some questions remain, however, as to what aspects of the patients' everyday anxieties are affected by HbA1c levels and treatment methods, or whether patient empowerment education is sufficient to alleviate the psychological impacts felt by the patients. In the present study, factors affecting the four subscales that make up the impact scale were analyzed by using male and female type 2 diabetes patients and multivariate analysis.

Although sex and/or age were identified as factors affecting subscales S1 and S2 (Figure 1a), women were found to be more strongly affected than men, but the effect decreased as the women aged (Table 2). With respect to impact from diabetes (S1), for which a sex difference was particularly noticeable, it was suggested that women were particularly sensitive to the psychological impact caused by diabetes, because significance disappeared after adjustments by sex, disease duration, glycemic control and number of (Figure 1a), and stratification by age showed significance only in women (Table 2). In an earlier study that we carried out into perceived stress and coping behaviors in 140 type 2 diabetes patients aged 40 years or older[10], factor analysis identified clear sex differences in perceived stress and coping among these patients: relative to men, women were always aware of the psychological stress of having diabetes, but their coping was passive, with the 50–69 years age group showing the lowest level of self-awareness, sense of responsibility or self-empowerment relating to diabetes. The sex difference in perceived stress and coping was assumed to be a result of social, innate and situational factors[11,12]. With respect to the sex differences relating to functional limitations in adult type 2 diabetes patients, Chiu and Wray[13] suggested that women were excellent in self-management of diet and blood glucose, but compared unfavorably with men in terms of exer-

Table 4 | Effect of treatment method on the scores of psychological impact of diabetes scale and its subscales, and self-reported symptoms

Treatment		n	Psychological impact of diabetes	Subscale 1	Subscale 2	Subscale 3	Subscale 4	Disease duration (years)	No. symptoms	Sex (male/ female)	Age (years)	BMI (kg/m^2)
Lifestyle therapy												
HbA1c	≥7.0%	13	8.85 ± 2.89	2.62 ± 1.04	2.38 ± 0.96	2.08 ± 0.76	1.77 ± 0.73	13.19 ± 10.65	0.62 ± 0.77	9/4	63.77 ± 9.63	22.30 ± 3.17
	<7.0%	23	9.09 ± 2.89	2.65 ± 1.15	2.74 ± 1.18	2.09 ± 0.85	1.61 ± 0.84	5.65 ± 4.57	0.78 ± 1.04	9/14	66.52 ± 10.45	23.11 ± 3.02
	t-test		NS	NS	NS	NS	NS	*P* < 0.01	NS	NS*	NS	NS
OHA												
HbA1c	≥7.0%	108	10.17 ± 3.52	2.57 ± 1.15	2.75 ± 1.09	2.53 ± 1.06	2.31 ± 1.12	11.99 ± 9.13	1.08 ± 1.31	59/49	63.51 ± 10.94	24.13 ± 3.93
	<7.0%	80	9.70 ± 3.17	2.59 ± 1.11	2.65 ± 0.99	2.14 ± 0.90	2.33 ± 0.99	9.99 ± 8.60	1.43 ± 1.60	40/40	66.96 ± 8.73	23.99 ± 3.33
	t-test		NS	NS	NS	*P* < 0.01	NS	NS	NS	NS*	*P* < 0.05	NS
Insulin												
HbA1c	≥7.0%	76	12.36 ± 2.64	3.08 ± 1.02	3.24 ± 0.85	3.16 ± 0.78	2.88 ± 1.01	14.21 ± 9.69	1.28 ± 1.24	35/41	60.14 ± 10.67	24.55 ± 0.54
	<7.0%	41	10.90 ± 3.28	2.88 ± 1.00	2.98 ± 1.08	2.59 ± 1.05	2.46 ± 1.00	14.60 ± 12.72	1.93 ± 2.24	21/20	60.90 ± 11.70	23.48 ± 4.29
	t-test		*P* < 0.05	NS	NS	*P* < 0.01	*P* < 0.05	NS	*P* < 0.05	NS*	NS	NS
OHA plus insulin												
HbA1c	≥7.0%	33	11.27 ± 2.48	3.00 ± 0.90	3.00 ± 0.97	2.52 ± 0.83	2.76 ± 1.15	17.03 ± 9.77	1.79 ± 1.65	9/24	65.12 ± 11.86	24.21 ± 4.41
	<7.0%	4	12.00 ± 3.46	3.00 ± 1.15	2.50 ± 0.58	2.75 ± 1.26	3.75 ± 1.26	22.25 ± 5.85	1.75 ± 2.36	3/1	71.50 ± 9.68	21.76 ± 5.71
	t-test		NS	NS	NS	NS	NS	NS	NS	NS*	NS	NS
	Effect size		*d* = 0.29	*d* = 0.00	*d* = 0.55	*d* = 0.27	*d* = 0.88	*d* = 0.57	*d* = 0.02	φ** = 0.29	*d* = 0.56	*d* = 0.55

Treatment		n	Symptom									
			Numbness	Swelling	Cold sweat	Malaise	Reduced visual acuity	Decreased appetite	Fatigue	Dyspnea	Insomnia	Agitation
Lifestyle therapy			Yes/all									
HbA1c	≥7.0%	13	0/13	0/13	0/13	1/13	2/13	1/13	2/13	0/13	2/13	0/13
	<7.0%	23	2/23	1/23	0/23	2/23	3/23	0/23	6/23	0/23	2/23	2/23
	χ^2-test		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
OHA												
HbA1c	≥7.0%	108	24/108	10/108	5/108	2/108	21/108	2/108	26/108	9/108	9/108	9/108
	<7.0%	80	17/80	14/80	2/80	9/80	23/80	3/80	21/80	8/80	12/80	5/80
	χ^2-test		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Insulin												
HbA1c	≥7.0%	76	12/76	8/76	4/76	5/76	20/76	2/76	26/76	5/76	7/76	8/76
	<7.0%	41	13/41	8/41	4/41	5/41	13/41	3/41	10/41	6/41	11/41	6/41
	χ^2-test		*P* < 0.05	NS	NS	NS	NS	NS	NS	NS	*P* < 0.05	NS
OHA plus insulin												
HbA1c	≥7.0%	33	8/33	4/33	3/33	1/33	12/33	1/33	15/33	3/33	5/33	7/33
	<7.0%	4	0/4	1/4	1/4	2/4	1/4	0/4	1/4	0/4	0/4	1/4
	χ^2-test		NS	NS	NS	*P* < 0.05	NS	NS	NS	NS	NS	NS
	Effect size		φ = 0.18	φ = 0.12	φ = 0.16	φ = 0.54	φ = 0.07	φ = 0.06	φ = 0.13	φ = 0.10	φ = 0.14	φ = 0.03

Continuous variables (psychological impact of diabetes scale and its subscales, disease duration, number of self-reported symptoms, age, body mass index [BMI]) were analyzed by Student's *t*-test. Categorical variables (sex, symptoms) were analyzed by χ^2-test. *P* < 0.05 was considered statistically significant. Subscale 1, impact from diabetes; subscale 2, anxiety from having a chronic disease; subscale 3, expectation of worsening conditions; subscale 4, obstacles to life planning. HbA1c, glycated hemoglobin; NS, not significant; OHA, oral hypoglycemic agent. *χ^2-test. **Cramer's *V*.

cise behavior, understanding of the importance of glycemic control, self-efficacy, coping, depressive symptoms and family support, to which biological and behavioral factors unique to women were acting directly on these functional constraints.

Generally, insulin resistance in diabetes patients increases as they age. An elevated blood glucose level in elderly patients often does not produce symptoms, such as increased urine production, thirst or increased water intake[14]. Consequently, it appears that anxieties and impact of diabetes declined, possibly because of a reduced level of self-recognition of diabetes-related symptoms as a result of aging. However, there were no significant differences in the number of symptoms between men and women (data not shown; χ^2-test, *P* = 0.4310), nor any differences between ORs and their adjusted ORs for age and number of symptoms. With respect to the relationships between anxiety and sex, women had a higher prevalence of anxiety disorder than men[15]. There are many reports regarding the effect of age on anxiety; however, the results were not consistent among the reports[16–19]. We could not find any detailed research on the relationship between anxiety or distress level and age/sex

among patients with type 2 diabetes mellitus. Accordingly, it is quite possible that the effects of aging and the number of symptoms on women's anxieties, and the impact caused by diabetes arose from the aforementioned biological and behavioral factors unique to women. This point, however, will require further investigation.

The number of symptoms and state of glycemic control were identified as affecting factors in S3, and disease duration, state of glycemic control and the numbers of self-reported symptoms were affecting factors in S4 (Figure 1a). In S3 and S4, ORs for the number of symptoms were lower than those for glycemic control in S3 and disease duration in S4. As these affecting factors remain significantly high for adjusted ORs, acquired factors relating to diabetes were thought to be strongly involved in the psychological impact in terms of future expectation of worsening conditions (S3) and obstacles to life planning (S4).

We examined 10 diabetes-related symptoms, and found six symptoms with significant ORs in S3 and four in S4, relatively more in number than in S1 and S2, with swelling, cold sweat, malaise, and agitation in S3 and S4 showing significantly high ORs (Table 3). Adjusted ORs, however, lost significance after adjustments, except for reduced visual acuity and swelling in S3, suggesting the possibility that psychological impact of diabetes as a result of acquired factors can be alleviated with good glycemic management, alleviation of symptoms, or the prevention or delaying of complications with effective treatment.

With the suggestion of the possibility of alleviating psychological impact of 'expectation of worsening conditions (S3)' and 'obstacles to life planning (S4)' by self-management of blood glucose levels and treatment, we analyzed relationships among four types of treatment methods and the four subscales. The results showed that three types of drug therapy had high OR values as compared with lifestyle therapy in S4 'obstacles to life planning.' Adjusted ORs were also significantly high in S4 (Figure 1b). We compared the scores from patients with poor glycemic control (HbA1c levels of 7.0% or higher) with scores from patients with good glycemic control (HbA1c levels below 7.0%) within each type of therapy, and found significant differences in S3 for OHA therapy, and in S3 and S4 for insulin therapy (Table 4). The patients undergoing OHA or insulin therapies showed significantly lower scores than patients with good glycemic control in S3 and S4, except for S4 of the OHA group, compared with those with poor control, indicating a low impact. However, among patients on insulin therapy, the number of self-reported symptoms had significantly high scores in patients with good glycemic control compared with those with poor control, with a high percentage of participants reporting numbness or insomnia. More patients with long disease duration are receiving insulin therapy. Accordingly, we believe it is possible that the high rate of symptoms, such as numbness or insomnia, was affected by neuropathy, which was already present during a period in which self-management of blood glucose level was inadequate before starting or at an early stage of insulin therapy. This point requires further investigation.

It is well known that self-reported symptoms and treatment methods are deeply involved in the QOL of patients with diabetes[4]. There are, however, very few reports of investigations into stress caused to patients by the disease from the point of view of psychological impact. Furthermore, with the exception of drug trials, there are just a few reports of psychological aspects using male and female diabetes patients, such as the present study. Our study made it clear that the psychological impact of type 2 diabetes involves several factors: inherent factors dependent on sex and aging in the psychological impact arising from current anxieties and impact of diabetes; acquired factors, such as disease duration, glycemic control and treatment methods, in psychological impact arising from expectation of worsening conditions and construction of life planning; and, in all subscales, the number of self-reported symptoms. The acquired factors had strong relevance to self-management of blood glucose level and treatment methods. Consequently, the present study suggested that it was possible to alleviate psychological impact by enhancing glycemic self-management through patient empowerment education, improvements in symptoms through appropriate treatment and continuing maintenance of appropriate blood glucose levels. It is difficult, however, for patients with type 2 diabetes, which is a chronic disease, to sustain proper self-management by the self-effort of patients alone for a long time. It is important to have support from family members close to patients and medical professionals[20–22]. We previously used the Japanese version of the Diabetes Family Behavior Checklist to carry out a survey of type 2 diabetes patients and their families, and found that there was a large gap between a patient's self-management behavior and the perception of the patient by the patient's family[23]. Furthermore, with reduced visual acuity and swelling, as well as the number of symptoms found to be strongly affecting the expectation of worsening conditions (S3) in the present study, it is possible that these symptoms might heighten anxiety relating to complications.

It has been reported that glycemic control and poor treatment adherence in patients with type 2 diabetes mellitus were associated with depression[24]. With respect to alleviating a patient's anxiety towards worsening conditions, although support by a patient's family is important, it might also be useful for medical professionals to provide accurate medical information on the prevention of complications and symptomatic treatments. Limitations of the present study included its cross-sectional design, reliance on self-report information only and the use of a brief scale to examine psychological impact.

In conclusion, the psychological impact of type 2 diabetes involved *a priori* factors dependent on sex and aging in the subscales of current impact (S1) and anxiety (S2); and *a posteriori* factors, such as disease duration, glycemic control and treatment methods, in the subscales of expectation of worsening conditions (S3) and obstacles to life planning (S4). The number of self-reported symptoms was an affecting factor in all subscales of the psychological impact scale. The present study suggested that, in addition to patient empowerment education, the

understanding of symptoms and complications, and proper treatment as well as a better socially supportive environment were important for the alleviation of psychological impacts.

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DISCLOSURE
The authors declare no conflict of interest.

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