

A study on diabetes distress and how people living with type 2 diabetes mellitus cope with it

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Abstract: Diabetes distress is common and sometimes has serious impacts on people living with diabetes mellitus. We developed a Feelings about Diabetes Distress Scale (FDDS), an Awareness of Diabetes Distress Scale (ADDS), and a Coping with Diabetes Distress Scale (CDDS). The objective of this study was to analyze the reliability and validity of these scales. Japanese adults living with type 2 diabetes mellitus completed a self-reported questionnaire ($N = 290$). FDDS consisted of one factor, ADDS consisted of eight sub-factors, and CDDS consisted of five sub-factors through factor analyses. The internal consistency for each factor was adequate. Some scores for FDDS, ADDS, and CDDS showed correlations with some scores for the scales concerning mood status, self-efficacy, and sense of health. Participants with diabetes complications (retinopathy and/or symptomatic neuropathy) showed statistically significant higher scores on FDDS and some of the ADDS subscales and their totals than those without the complication. This suggests that FDDS, ADDS, and CDDS are reliable and validated assessment instruments for dealing with diabetes distress and coping.

Keywords: diabetes distress, awareness of diabetes distress, coping with diabetes distress, people living with type 2 diabetes mellitus, diabetes distress and coping assessment scale

Background

Type 2 diabetes mellitus is one of the most serious health problems worldwide due to its rapidly growing prevalence. It is a major cause of blindness, renal failure, cardiovascular disease, and limb amputation. Complex and demanding daily self-management, the threat of complications, and changes in therapy may become an emotional burden for people living with diabetes mellitus. Diabetes distress refers to negative emotional or affective experiences in response to living

with diabetes mellitus. Its prevalence is reported to be 18-45%. Diabetes distress is distinct from psychological disorders such as depression and is associated with lower levels of diabetes mellitus self-care (Young-Hyman et al., 2016).

Diabetes distress negatively influences self-efficacy, adherence to pharmacological therapy, and diet and exercise therapies. A higher level of diabetes distress is associated with higher HbA1c. It is important to provide adequate care for people with diabetes distress, especially during periods of diagnosis or when

treatment targets are unmet, progression of complications related to medical, physical and/or psychosocial factors are present, and when transitions in life and changes in care occur (American Diabetes Association Professional Practice Committee, 2022; Young-Hyman et al., 2016). Counselling may be beneficial for people living with diabetes distress (Young-Hyman et al., 2016). Studies on psychological support for people living with diabetes mellitus have been developed around the world as well as in Japan (Chiba, 2021).

For assessment of diabetes distress, questionnaires such as the Problem Areas in Diabetes (PAID) (Polonsky et al., 1995) and the Diabetes Distress Scale (DDS) (Polonsky et al., 2005) are used (Hessler, 2021). However, using PAID and DDS to assess diabetes distress in adults includes a number of issues and concerns about psychometric validity, such as suboptimal precision, targeting, and item misfit (Fenwick et al., 2018).

Diabetes management guidelines in many countries recommend screening for diabetes distress in people with diabetes. PAID (Polonsky et al., 1995) and DDS (Polonsky et al., 2005) are recommended as validated measures to monitor diabetes distress (Young-Hyman et al., 2016). The adult version of PAID comprises 20 items and the adult version of DDS comprises 17 items that include combinations of the feelings and the situations concerning diabetes distress. These assessments are used as screening tools for diabetes distress in important areas of treatment of diabetes mellitus. However, there is no comprehensive scale that covers the details of all areas of diabetes distress related to complex and diverse treatment, self-management, and diabetes complications. Comprehensive assessment tools that

yield actionable information to assess diabetes distress are therefore required. Assessment of diabetes distress needs to focus on the negative emotions combined with specific sources and contributors (e.g., psychological burden of each therapy, fear of hypoglycemia, and so on). Understanding the coping behaviors and attitudes of each person with diabetes mellitus will be useful for both the therapist and the person with diabetes mellitus, enabling them to cope with diabetes distress together.

We attempted to develop new questionnaires to assess the detailed contents of diabetes distress and its coping behaviors and attitudes using detailed diabetes distress surveying which includes feelings about diabetes distress and awareness of diabetes distress as well as beneficial coping against diabetes distress among adults living with diabetes distress. Qualitative analysis was performed using a self-reported questionnaire and interview about feelings and the detailed situation concerning diabetes distress as well as coping behaviors and attitudes among 295 people living with diabetes mellitus. The questionnaire included an open question concerning the details of the contents or situation that contribute to feeling of distress, irritation or discomfort in daily self-management of diabetes mellitus including continuing treatment, pharmacological treatment, diet therapy, exercise therapy and daily life. The questionnaire also included a question about the methods or strategies to overcome or get along with the details of the contents or situation. Based on the qualitative study, we attempted to develop a Feelings about Diabetes Distress Scale (FDDS), an Awareness of Diabetes Distress Scale (ADDSD), and a Coping with Diabetes Distress Scale (CDDSD) to assess diabetes distress and to understand coping

behaviors and attitudes as well as the detailed situation contributing to diabetes distress to obtain actionable information.

The aim of this study is to develop a psychological tool to improve diabetes treatment and care in collaborative work between people living with diabetes mellitus and health care workers. Based on this aim, self-reported questionnaires including feelings about diabetes distress, specific and detailed situations related to diabetes distress, and coping behaviors and attitudes of each person living with diabetes mellitus were developed. The objective of this study is to develop the FDDS, ADDS, and CDDS and to analyze their reliability and validity among Japanese adults living with type 2 diabetes mellitus. Mood status was reported to be associated with diabetes distress (Kato et al., 2010). People with diabetes distress were reported to have a lower sense of health than people without diabetes distress (Ando et al., 2020). Diabetes distress negatively influences self-efficacy regarding self-management of diabetes mellitus (Young-Hyman et al., 2016). Self-efficacy regarding self-management of diabetes mellitus and sense of health showed positive changes among Japanese adults living with diabetes mellitus in our psychological intervention study. We presumed that the FDDS, ADDS, and CDDS were related to items of mood status, self-efficacy regarding self-management of diabetes mellitus, and sense of health.

Methods

Participants

A questionnaire survey was administered to Japanese adults living with type 2 diabetes mellitus in two hospitals in Japan between October 2019 and April 2020. A

total of 290 participants from 19 to 91 years of age ($M \pm SD = 64.2 \pm 12.6$) (181 male and 109 female) completed the survey.

Thirty-four participants (11.7%) were treated with diet and exercise only. One hundred fifty-four participants (53.1%) were treated with oral hypoglycemic agents. Forty-one participants (14.1%) were treated with glucagon-like peptide-1 receptor agonists in combination with oral hypoglycemic agents. Sixty-one participants (21.0%) were treated with insulin.

Procedure

Consent was obtained from each participant. People living with diabetes mellitus were recruited and received an explanation about the study as well as the questionnaire sheet from medical clerks while waiting for a medical examination. The recruited people participated in the survey after giving their consent. The participants then submitted the completed questionnaire sheet to their attending physician during treatment. The attending physician confirmed whether the survey was completed as well as answering any questions concerning the survey from the participants.

The study was reviewed and approved by the ethical committee in each hospital (approval No. 1-99; approval No. 2-1). Written informed consent was obtained from each patient prior to any registration for the study.

The sample size was limited due to the methods of data collection. According to COSMIN Risk of Bias checklist for PROMs, the recommended sample size is more than seven times the number of items in the measures and ≥ 100 (Mokkink, 2018).

Measures

The study used a self-reported

questionnaire including diabetes distress and how it is coped with, self-efficacy, sense of health, and mood states, as follows.

Feelings about Diabetes Distress Scale (FDDS): Feelings about diabetes distress were assessed by firstly surveying distress, irritation, and feelings of discomfort related to daily diabetes treatment and self-care based on our previous diabetes distress study. Participants were asked about their feelings of irritation, sadness, fatigue, depression, excessive anxiety, and giving up on diabetes treatment and self-care in the last one month. The items were rated on a 5-point scale, ranging from 0 = “never,” 1 = “rarely,” 2 = “sometimes,” 3 = “often” to 4 = “almost always.”

Awareness of Diabetes Distress Scale (ADDS): Awareness of diabetes distress was assessed by surveying the specific and detailed situation concerning diabetes distress. The contents of the awareness of diabetes distress were originally developed by our previous diabetes distress study. Participants were asked about distress with regard to several situations in diabetes treatment and self-care in the last one month. Twenty-two items were rated on a 5-point scale, ranging from 0 = “do not feel distressed,” 1 = “mostly do not feel distressed,” 2 = “neither,” 3 = “feel somewhat distressed” to 4 = “feel very distressed.” A further fifteen items depending on diabetes treatment methods and complication status were rated on a 6-point scale, ranging from 0 = “do not feel distressed,” 1 = “mostly do not feel distressed,” 2 = “neither,” 3 = “feel somewhat distressed,” 4 = “feel very distressed” to 5 = “not applicable.” In the statistical analyses, the response 5 = “not applicable” was converted to 0.

Coping with Diabetes Distress Scale (CDDS): Coping with diabetes distress was

assessed by surveying coping behaviors and attitudes concerning diabetes distress. The contents were originally developed by our previous diabetes distress study. Participants were asked to respond regarding fifty-four coping behaviors and attitudes in the last one month. The items were rated on a 5-point scale, ranging from 0 = “useless,” 1 = “mostly useless,” 2 = “neither,” 3 = “a little useful” to 4 = “very useful.”

Self-management Efficacy for Diabetes Mellitus (SMED): Self-management efficacy for diabetes mellitus was assessed by items developed through a previous study and a referenced diabetes self-esteem scale (Schneider et al., 2009). Participants were asked about their confidence in diabetes care and treatment in the last one month. The items were rated on a 5-point scale, ranging from 0 = “do not think so,” 1 = “mostly do not think so,” 2 = “neither,” 3 = “think so a little” to 4 = “think so.”

Sense of Health (SH): Sense of health was assessed by one item. The participants were asked about their sense of health in the last one month. The item was rated on a 5-point scale, ranging from 0 = “not healthy,” 1 = “not very healthy,” 2 = “neither,” 3 = “somewhat healthy” to 4 = “very healthy.”

Profile of Mood States 2nd Edition (POMS2): Mood states were assessed using the Japanese validated short version of POMS2 (Heuchert et al., 2015). Thirty-five validated items were rated on a 5-point scale ranging from 0 (none) to 4 (extremely) which evaluated the participant responses across seven dimensions of mood; five of which represent negative mood statuses, namely anger-hostility (AH) (five items, $\alpha = 0.879$ in this study), confusion-bewilderment (CB) (five items, $\alpha = 0.830$ in this study), depression-dejection (DD) (five items, $\alpha = 0.811$ in this study),

fatigue-inertia (FI) (five items, $\alpha = 0.840$ in this study), and tension-anxiety (TA) (five items, $\alpha = 0.814$ in this study). The remaining two represent positive mood statuses, namely vigor-activity (VA) (five items, $\alpha = 0.903$ in this study), and friendliness (five items, $\alpha = 0.807$ in this study). Total Mood Disturbance (TMD) was scored by subtracting VA from the sum of the scores for AH, CB, DD, FI, and TA.

Statistical analyses

Each factor structure in each variable (FDDS, ADDS, CDDS, and SMED) was analyzed using exploratory factor analyses (maximum likelihood method, promax rotation, exclusion of items less than 0.4 in factor loading, and scree plot). Confirmatory factor analyses were then conducted when there were two or more sub-factors in the exploratory factor analyses (Rindskopf & Rose, 1988). Model fit was assessed with the root mean square error of approximation (RMSEA), the comparative fit index (CFI), and the Tucker-Lewis index (TLI), which are better than typical chi-square goodness-of-fit measures for large samples. The model is a better fit when CFI and TLI approximate 1.0 (Gerbing & Anderson, 1993). "A value of about 0.08 or less for the RMSEA would indicate a reasonable error of approximation and one would not want to employ a model with a RMSEA greater than 0.1" (Browne & Cudeck, 1993, p. 144). In this study, the interpretability of the model was judged based on these guides.

Reliability was analyzed to test whether internal consistency was accepted for each subscale by Cronbach's α .

Validity was analyzed to test whether scores for FDDS, ADDS and CDDS correlated with scores for POMS2, SMED, and SH by Spearman's rank correlations coefficients. The scores for FDDS and ADDS

were also analyzed to test whether there were any differences between participants with and without diabetes complications of retinopathy and symptomatic neuropathy by the Mann-Whitney U -test. As the data do not follow a normal distribution, the statistical tests were conducted by a non-parametric test.

Prevalence of feelings about diabetes distress was dichotomized into no distress or some degree of distress in FDDS.

Results were analyzed by means of JASP (Version 0.17.2) (Shimizu & Yamamoto, 2022), IBM SPSS Statistics 24, and model estimations were conducted with IBM SPSS Amos 24 for Windows. Sample sizes were analyzed by means of HAD on 18 (Shimizu, 2016).

The level of significance was set to $p < 0.05$.

Results

Each variable was analyzed using the sum of the scores for the items supported by the factor analyses.

We analyzed the sample size after collecting the data. With an effect size of medium (0.3), a significance level of 0.05, and a power of 0.8, it was estimated that a sample size of 82 would be needed to detect a correlation. With an effect size of medium (0.5), a significance level of 0.05, a power of 0.8, it was estimated that a sample size of 200 (160 and 40) for a sample ratio of 0.25 and 140 (90 and 50) for a sample ratio of 0.56 would be needed to detect differences between two conditions with no correspondence.

Factor analyses and internal consistency

FDDS showed one factor structure with six items ($\alpha = 0.927$).

Table 1. Factor analysis of the Awareness of Diabetes Distress Scale (ADDS)

	Factor							
	1	2	3	4	5	6	7	8
Distress related to dietary therapy ($\alpha = 0.862$)								
I cannot snack much	0.871	0.024	-0.086	-0.046	-0.013	-0.093	-0.078	0.029
I cannot eat at any time I like	0.780	0.090	-0.004	0.061	0.000	-0.018	-0.111	-0.080
I cannot eat as much fatty foods as I like	0.724	-0.002	0.016	-0.002	-0.078	0.008	-0.079	0.138
I cannot eat much of what I like	0.706	0.023	-0.014	-0.007	0.018	-0.008	0.032	0.015
I eat when I feel stressed	0.578	-0.065	-0.031	0.098	0.039	0.133	0.062	-0.112
I worry about calories	0.526	-0.051	0.071	0.004	-0.050	0.069	0.133	-0.063
I am cutting back on salt	0.518	-0.059	0.071	-0.107	0.014	0.016	0.062	0.052
I am not sure what to eat	0.504	-0.013	0.051	0.023	-0.006	0.006	0.201	-0.053
Distress related to continuing treatment ($\alpha = 0.854$)								
I am visiting the physician regularly	0.039	0.868	-0.008	-0.038	0.033	-0.062	-0.036	0.075
I am continuing my diabetes treatment	-0.040	0.826	-0.145	0.045	0.009	-0.013	0.047	-0.038
I am living a daily life with diabetes mellitus	-0.009	0.663	0.095	0.027	-0.019	0.081	0.190	-0.027
Distress related to leg and back problems ($\alpha = 0.800$)								
I have a sore foot	-0.081	-0.003	0.883	-0.044	-0.033	0.034	0.032	-0.055
I have numbness in my legs	0.074	-0.028	0.815	0.069	-0.029	-0.070	-0.023	0.036
I have a sore back pain	0.052	-0.088	0.608	-0.003	0.116	-0.008	-0.019	0.041
Distress related to injections ($\alpha = 0.769$)								
I use injections	0.053	-0.070	-0.114	0.811	0.104	0.006	-0.015	0.061
I inject insulin when I am out and about or in the presence of others	0.009	-0.018	0.015	0.714	-0.001	-0.068	-0.020	-0.023
I do blood glucose self-testing	-0.071	0.152	0.155	0.657	-0.115	0.042	-0.037	0.013
Distress related to taking medications ($\alpha = 0.807$)								
I take too many kinds of or excessive amounts of medicine	-0.035	-0.017	-0.008	0.007	1.011	0.065	-0.065	-0.018
I take my medication.	0.016	0.318	0.087	-0.064	0.631	0.003	-0.120	-0.024
I am worried about the side effects of medicine	-0.037	-0.128	-0.018	0.073	0.565	-0.101	0.350	0.047
Distress related to exercise therapy ($\alpha = 0.853$)								
I am spending more time on exercise	-0.028	0.015	-0.063	-0.019	-0.028	1.028	-0.014	0.018
Exercise such as stretching and walking	0.096	-0.050	0.050	-0.014	0.071	0.715	0.003	0.034
Distress related to overanxiety that diabetes may worsen ($\alpha = 0.706$)								
I worry about the progression of diabetic complications	-0.027	0.072	0.000	-0.019	-0.066	0.044	0.823	-0.006
I have difficulty in the treatment of diabetes	0.202	0.047	-0.050	0.050	0.046	-0.006	0.555	-0.035
I worry about hypoglycemia	0.113	0.035	0.034	-0.120	0.032	-0.082	0.450	0.117
Distress related to having complications ($\alpha = 0.680$)								
I have nephropathy	-0.045	-0.029	-0.075	-0.001	-0.046	-0.001	0.059	0.909
I have difficulty seeing	0.087	0.041	0.111	-0.046	0.078	0.066	-0.033	0.470
I have heart disease	-0.046	0.050	0.094	0.126	-0.002	0.033	-0.006	0.468

ADDS consisted of eight subfactors. Confirmatory factor analyses were performed based on the results (Table 1). The group-factor model fit the data, χ^2 ($df = 322, N = 201$) = 508.621, $p < 0.001$, CFI = 0.917, TLI = 0.903, RMSEA = 0.054 (0.045 - 0.063). The second-order factor model also fit the data, χ^2 ($df = 342, N = 201$) = 586.707, $p < 0.001$, CFI = 0.892, TLI = 0.880, RMSEA = 0.060 (0.052 - 0.068). We decided to use these factor structures in this study due to the reasonable models obtained.

Distress related to dietary therapy consisted of eight items ($\alpha = 0.862$). Distress related to continuing treatment consisted of three items ($\alpha = 0.854$). Distress related to leg and back problems consisted of three items ($\alpha = 0.800$). Distress related to injections consisted of three items ($\alpha = 0.769$). Distress related to taking medications consisted of three items ($\alpha = 0.807$). Distress related to exercise therapy consisted of three items ($\alpha = 0.853$). Distress related to overanxiety that diabetes may worsen consisted of

Table 2. Factor analysis of the Coping with Diabetes Distress Scale (CDDS)

	Factor				
	1	2	3	4	5
Stress management ($\alpha = 0.963$)					
Not allowing stress to build up	0.941	-0.035	-0.072	-0.009	-0.110
Not thinking too much about how hard diabetes care is	0.893	-0.006	0.012	-0.290	-0.005
Not worrying too much	0.880	-0.043	-0.080	-0.014	0.043
Doing things step by step at my own pace	0.855	0.035	0.016	-0.244	0.108
The importance of doing things at my own pace	0.834	0.082	-0.078	-0.050	0.011
Thinking of diabetes care as part of my life	0.708	0.041	0.150	-0.077	-0.001
Maintaining a healthy lifestyle	0.608	0.120	-0.007	0.271	-0.089
Recording blood glucose levels, body weight, and blood pressure	0.797	0.013	0.075	-0.031	-0.204
Having responsibility for my own body	0.792	-0.045	0.036	0.020	0.020
Taking care of myself	0.754	0.084	-0.042	-0.136	0.142
Never giving up	0.731	-0.060	0.075	0.181	-0.005
Taking care of myself and reflecting on myself	0.700	0.002	0.062	0.157	-0.038
Maintaining a strong sense of purpose	0.685	-0.019	0.008	0.163	0.068
I am looking forward to attaining my goals	0.631	-0.175	0.064	0.227	0.163
Being encouraged by improvements in my HbA1c and other parameters	0.639	0.136	-0.045	0.021	0.106
Obtaining cooperation from family members and others around me	0.635	0.027	0.106	-0.156	0.098
Collecting information about diabetes mellitus	0.583	0.051	-0.068	0.152	0.171
Setting goals and trying to achieve them	0.450	0.025	-0.108	0.348	0.100
Attitudes related to eating habits ($\alpha = 0.922$)					
Eating vegetables first	-0.115	0.865	-0.094	-0.038	0.136
Avoiding fatty foods	-0.022	0.860	-0.061	0.029	-0.015
Reducing my intake of salt	0.163	0.778	-0.011	-0.075	-0.109
Developing my own style of diet	0.033	0.744	0.072	0.070	-0.094
Refraining from snacking	0.161	0.738	-0.152	0.085	-0.156
Eating a lot of vegetables	-0.044	0.721	0.129	-0.078	0.155
Being careful about the amounts of food I eat	-0.031	0.711	0.031	0.087	0.078
Taking enough time to eat	-0.029	0.578	0.068	0.092	0.057
Consciousness regarding food quantity ($\alpha = 0.837$)					
Calculating calories to some extent	0.019	-0.086	0.868	0.064	-0.063
Checking calorie labels	0.028	0.015	0.811	-0.137	0.064
Making the menu a rewarding one from time to time.	-0.232	0.131	0.494	0.180	0.237
Eating small meals for a few days after a big meal	0.117	0.176	0.448	0.175	-0.132
Eating a constant amount of rice	0.226	0.276	0.429	-0.037	-0.083
Exercising ($\alpha = 0.807$)					
Walking	-0.246	0.105	0.057	0.793	0.021
Stretching and muscle training	-0.086	0.142	0.044	0.701	-0.033
Doing exercises that are suitable for me	0.289	-0.105	-0.095	0.698	0.024
Doing something enjoyable ($\alpha = 0.906$)					
Talking and laughing with others	0.250	-0.019	0.030	-0.006	0.768
Finding a hobby and enjoying it	0.252	-0.005	-0.034	0.076	0.653
Changing my mood	0.351	0.034	-0.001	-0.049	0.600

three items ($\alpha = 0.706$). Distress related to having complications consisted of three items ($\alpha = 0.680$). The total scores of the subfactors of ADDS (Total ADDS) were calculated and the Cronbach's α was shown as 0.885. Various factor correlations were seen between the scores for each scale of ADDS.

CDDS consisted of five sub-factors. Confirmatory factor analyses were performed based on the results (Table 2). The group-factor model indicated a mediocre fit, $\chi^2 (df = 619, N = 230) = 1600.034, p < 0.001, CFI = 0.855, TLI = 0.844, RMSEA = 0.083 (0.078 - 0.088)$. The second-order factor model also indicated

Table 3. Correlation coefficients between FDDS, ADDS subscales and their totals, CDDS subscales and their totals, POMS2 subscales, Self-management Efficacy for Diabetes Mellitus, and Sense of Health

	POMS2									
	AH	CB	DD	FI	TA	VA	F	TMD	SMED	SH
FDDS	0.522 ***	0.580 ***	0.556 ***	0.587 ***	0.554 ***	-0.055	0.041	0.596 ***	-0.234 ***	-0.332 ***
ADDS										
Distress related to dietary therapy	0.297 ***	0.300 ***	0.241 ***	0.278 ***	0.247 ***	-0.234 ***	-0.092	0.410 ***	-0.309 ***	-0.237 ***
Distress related to continuing treatment	0.287 ***	0.286 ***	0.234 ***	0.234 ***	0.232 ***	-0.203 **	-0.161 **	0.271 ***	-0.218 ***	-0.156 **
Distress related to leg and back problems	0.138 *	0.178 **	0.183 **	0.194 **	0.194 **	-0.099	-0.073	0.174 *	-0.048	-0.170 **
Distress related to injections	0.100	0.174 **	0.080	0.111	0.077	-0.107	-0.126 *	0.145 *	-0.125 *	-0.114
Distress related to taking medications	0.299 ***	0.324 ***	0.257 ***	0.232 ***	0.250 ***	-0.130 *	-0.068	0.335 ***	-0.146 *	-0.166 **
Distress related to exercise therapy	0.203 **	0.126 *	0.242 ***	0.253 ***	0.155 *	-0.242 ***	-0.106	0.258 ***	-0.197 **	-0.257 ***
Distress related to overanxiety that diabetes may worsen	0.219 ***	0.249 ***	0.212 ***	0.194 **	0.241 ***	-0.172 **	-0.045	0.338 ***	-0.215 ***	-0.208 ***
Distress related to having complications	0.176 **	0.117	0.138 *	0.138 *	0.090	-0.058	-0.029	0.139	-0.098	-0.228 ***
Total ADDS	0.380 ***	0.412 ***	0.320 ***	0.352 ***	0.318 ***	-0.273 ***	-0.158 *	0.461 ***	-0.339 ***	-0.392 ***
CDDS										
Stress management	-0.185 **	-0.174 **	-0.215 ***	-0.211 **	-0.049	0.413 ***	0.272 ***	-0.288 ***	0.507 ***	0.202 **
Attitudes related to eating habits	-0.044	-0.050	-0.126 *	-0.089	0.022	0.239 ***	0.207 ***	-0.157 *	0.225 ***	0.072
Consciousness regarding food quantity	-0.010	-0.012	-0.059	-0.033	0.010	0.225 ***	0.146 *	-0.101	0.266 ***	0.017
Exercising	-0.117	0.002	-0.125 *	-0.174 **	-0.026	0.421 ***	0.292 ***	-0.201 **	0.260 ***	0.234 ***
Doing something I enjoy	-0.051	-0.038	-0.092	-0.024	0.090	0.329 ***	0.249 ***	-0.106	0.309 ***	0.088
Total CDDS	-0.137 *	-0.110	-0.195 **	-0.194 **	-0.032	0.425 ***	0.288 ***	-0.281 ***	0.458 ***	0.165 *

Note. Missing values are excluded on a case-by-case basis. Significant at * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$ (two-tailed).

FDDS: Feelings about Diabetes Distress Scale; ADDS: Awareness of Diabetes Distress Scale; CDDS: Coping with Diabetes Distress Scale; POMS2: Profile of Mood States 2nd Edition; AH: Anger-Hostility (POMS2); CB: Confusion-Bewilderment (POMS2); DD: Depression-Dejection (POMS2); FI: Fatigue-Inertia (POMS2); TA: Tension-Anxiety (POMS2); VA: Vigor-Activity (POMS2); F: Friendliness (POMS2); TMD: Total Mood Disturbance; SMED: Self-management Efficacy for Diabetes Mellitus; SH: Sense of Health

a mediocre fit, χ^2 ($df = 624, N = 230$) = 1688.217, $p < 0.001$, CFI = 0.842, TLI = 0.832, RMSEA = 0.086 (0.081 - 0.091). We decided to use these factor structures in this study due to the reasonable models obtained.

Stress management consisted of 18 items ($\alpha = 0.963$). Attitudes related to eating habits consisted of eight items ($\alpha = 0.922$). Consciousness regarding food quantity consisted of five items ($\alpha = 0.837$). Exercising consisted of three items ($\alpha = 0.807$). Doing something enjoyable consisted of three items ($\alpha = 0.906$). The total scores of the subfactors of CDDS (Total CDDS) were calculated and the Cronbach's α was shown as 0.966. The factor correlations between the scores for each CDDS scale showed moderate to strong positive correlations.

SMED showed one factor structure with five items. Cronbach's $\alpha = 0.792$.

Prevalence of feelings about diabetes distress

83.5% of the participants showed some degree of feelings about diabetes distress.

Validity

The scores for FDDS showed strong positive correlations with the scores for POMS2 negative mood states such as AH ($\rho = 0.552, p < 0.001$), CB ($\rho = 0.580, p < 0.001$), DD ($\rho = 0.556, p < 0.001$), FI ($\rho = 0.587, p < 0.001$), TA ($\rho = 0.554, p < 0.001$), and TMD ($\rho = 0.596, p < 0.001$), and moderate negative correlations with the scores for SH ($\rho = -0.332, p < 0.001$) (Table 3).

The total ADDS scores showed moderate positive correlations with scores for POMS2 negative mood states such as AH ($\rho = 0.380, p < 0.001$), CB ($\rho = 0.412, p < 0.001$), DD ($\rho = 0.320, p < 0.001$), FI ($\rho = 0.352, p < 0.001$), TA ($\rho = 0.318, p < 0.001$), and TMD ($\rho = 0.461, p < 0.001$), and moderate negative correlations with the scores for SMED ($\rho = -0.339, p < 0.001$)

Table 4. Means, medians, and standard deviations in the comparisons between individuals with and without diabetes complications

	Diabetes retinopathy						Symptomatic diabetes neuropathy					
	Without (n=240)			With (n=50)			Without (n=182)			With (n=108)		
	Mean	Med	SD	Mean	Med	SD	Mean	Med	SD	Mean	Med	SD
FDDS	5.93	4.00	5.79	7.71	6.50	5.83 *	5.44	4.00	5.50	7.61	6.00	6.12 **
ADDS												
Distress related to dietary therapy	12.55	13.00	6.17	15.57	16.00	6.23 **	12.75	13.00	6.09	13.60	14.00	6.57
Distress related to continuing treatment	3.88	3.00	3.02	4.11	4.00	3.16	3.96	3.00	2.88	3.85	3.00	3.33
Distress related to leg and back problems	2.96	2.00	3.37	4.65	4.00	3.68 **	2.21	1.00	2.75	5.02	5.00	3.87 ***
Distress related to injections	1.49	0.00	2.52	2.50	0.00	3.26	1.23	0.00	2.25	2.39	0.00	3.18 **
Distress related to taking medications	3.27	3.00	3.02	4.04	4.00	3.25	3.03	3.00	2.95	4.03	4.00	3.16 *
Distress related to exercise therapy	3.03	3.00	2.17	3.96	4.00	2.19 **	3.10	3.00	2.15	3.35	3.50	2.27
Distress related to overanxiety that diabetes may worsen	5.63	6.00	2.77	6.42	6.00	2.45	5.81	6.00	2.69	5.71	6.00	2.79
Distress related to having complications	2.38	2.00	2.79	4.45	4.00	2.78 ***	2.24	2.00	2.65	3.65	3.00	3.12 ***
Total ADDS	35.72	35.00	15.50	45.09	49.00	17.82 **	34.80	34.00	14.79	42.17	45.50	17.91 **

Note. Missing values are excluded on a case-by-case basis. Significant at * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

and the scores for SH ($\rho = -0.392$, $p < 0.001$). The scores for distresses related to dietary therapy showed moderate positive correlation with the score for CB ($\rho = 0.300$, $p < 0.001$) and TMD ($\rho = 0.410$, $p < 0.001$). The scores for distresses related to taking medications also showed moderate positive correlation with the score for CB ($\rho = 0.324$, $p < 0.001$) and TMD ($\rho = 0.335$, $p < 0.001$). The scores for distresses related to overanxiety that diabetes may worsen showed moderate positive correlation with the score for TMD ($\rho = 0.338$, $p < 0.001$) (Table 3).

The total CDDS scores ($\rho = 0.425$, $p < 0.001$), stress management ($\rho = 0.413$, $p < 0.001$), exercising ($\rho = 0.421$, $p < 0.001$), and doing something enjoyable ($\rho = 0.329$, $p < 0.001$) showed moderate positive correlations with the scores for VA. The total CDDS scores showed moderate positive correlations with the score for SMED ($\rho = 0.458$, $p < 0.001$). The scores for stress management also showed strong positive correlations with SMED ($\rho = 0.507$, $p < 0.001$). The scores for doing something enjoyable showed moderate positive correlations with the score for SMED ($\rho = 0.309$, $p < 0.001$) (Table3).

The participants with diabetes retinopathy showed statistically significant higher scores

for FDDS ($U = 4377.500$, $p = 0.043$, $r = -0.186$), distress related to dietary therapy ($U = 3677.000$, $p = 0.004$, $r = -0.273$), distress related to leg and back problems ($U = 3547.500$, $p = 0.002$, $r = -0.279$), distress related to exercise therapy ($U = 4112.000$, $p = 0.005$, $r = -0.251$), distress related to having complications ($U = 2634.000$, $p < 0.001$, $r = -0.419$), and total ADDS ($U = 1996.500$, $p = 0.003$, $r = -0.325$) than those without diabetes retinopathy.

The participants with symptomatic diabetes neuropathy showed statistically significant higher scores for FDDS ($U = 6740.000$, $p = 0.002$, $r = -0.220$), distress related to leg and back problems ($U = 4559.000$, $p < 0.001$, $r = -0.423$), distress related to injections ($U = 7524.000$, $p = 0.002$, $r = -0.192$), distress related to taking medications ($U = 7245.500$, $p = 0.010$, $r = -0.182$), distress related to having complications ($U = 5252.000$, $p < 0.001$, $r = -0.267$), and total ADDS ($U = 3480.500$, $p = 0.003$, $r = -0.258$) than those without symptomatic diabetes neuropathy (Table 4).

Discussion

This study investigated the reliability and

validity of FDDS, ADDS, and CDDS as new scales for diabetes distress and coping with diabetes distress through cross-sectional association with diabetes distress in a regional sample of Japanese adults living with type 2 diabetes mellitus.

The prevalence of diabetes distress in this study was shown to be higher than in our previous study or in other reports (Young-Hyman et al., 2016).

It was suggested that the validity of FDDS, ADDS and CDDS was adequate. These new scales, developed as FDDS, ADDS and CDDS, were designed to support people living with diabetes mellitus through understanding how they feel about their daily diabetes treatments and complications, sharing this information with their health care providers, and working together to implement diabetes treatments that suit them.

Through the exploratory factor analyses and confirmatory factor analyses concerning ADDS and CDDS, it was suggested that the factor structures fit the data and both the group-factor model and the second-order factor model were accepted due to the reasonable models obtained. Based on these analyses, the scores of subscales and their totals were used. The structures of FDDS, ADDS, and CDDS were reasonable for understanding diabetes distress and its coping due to the fact that they related well with the main issues of diabetes treatments and self-care, and covered the aims of these new scales. The reliabilities of the scales for FDDS, ADDS, and CDDS were acceptable.

FDDS and ADDS appeared to screen diabetes distress depending on the severity of the diabetes mellitus, such as having the diabetes complications of retinopathy and symptomatic neuropathy. Especially, the scores for subscales of distress related to complication and leg and back problem for

ADDS showed strong differences between people living with and without diabetes complications.

FDDS appeared to have strong correlations with the negative feeling of POMS2 and the total ADDS score seemed to have moderate correlations with the negative feeling of POMS2. It was suggested that the distress, irritation, and uncomfortable feelings related to daily diabetes treatment and self-care (FDDS) were related to the general negative feelings in daily life (POMS2 negative feelings) from a moderate to a strong degree. For the screening of mood status regarding diabetes distress among people living with type 2 diabetes mellitus, it may be possible to use FDDS and ADDS rather than general mood status scales.

On the other hand, the general negative feeling in daily life (POMS2 negative feelings) seem to have only a weak correlation with diabetes distress associated with specific and detailed situations (ADDS). It was suggested that the subscales of ADDS may cover the details of original and personal issues of important areas of diabetes distress related to complex and diverse treatment, self-care, and diabetes complications. The scores for total ADDS and distress related to dietary therapy showed moderately negative correlations with the scores for SMED. These relationships were supported by previous studies showing that diabetes distress impacted self-efficacy negatively (American Diabetes Association Professional Practice Committee, 2022).

Concerning CDDS, the total CDDS scores and stress management showed relationships with the vigor-activity of POMS2, and confidence in diabetes care and treatment (SMED) to a moderate and strong degree. It may be helpful to use CDDS to understand how people living with

diabetes mellitus are coping with diabetes distress.

On the other hand, this positive feeling and confidence in daily life appears to be only weakly correlated with the detailed coping behaviors and attitudes concerning diabetes distress (CDDS). It was suggested that the subscales of CDDS may cover the details of original and personal areas of coping with diabetes distress related to complex and diverse treatment, self-care, and diabetes complications. Coping with diabetes distress seems to differ among individuals.

The necessity for intervention and the method of intervention should be considered based on the screening of diabetes distress.

Diabetes distress related to specific treatment methods and complications should be evaluated individually. It was suggested that ADDS and FDDS as well as CDDS can screen the individual issues to determine which issues influence the individual's distress. FDDS, ADDS, and CDDS are questionnaires that comprehensively cover distressing feelings, specific issues related to diabetes, and coping. It is necessary to identify modifiable factors associated with diabetes distress and awareness of diabetes distress situations that can be targeted and developed in intervention.

Conclusions

This study suggested that validity was adequate in FDDS, ADDS, and CDDS. These scales may be useful for performing multidimensional assessments of diabetes distress and its coping behaviors and attitudes.

It is important to acknowledge several limitations of the present study. All

information collected in the present study was gathered from self-reported questionnaires. It is possible that some respondents chose to provide socially desirable answers. Such underreporting presents a conservative bias serving mainly to reduce the magnitude of associations. The direction of relationships cannot be determined in cross-sectional research.

We did not implement a retest of scales to confirm their reliability and validity. Furthermore, our examination of the analyses was limited by the scales selected. In the future, it will be important to analyze the validity of each scale of FDDS, ADDS, and CDDS more carefully. For example, it may be useful to analyze the validity of FDDS and ADDS with scales such as PAID (Polonsky et al., 1995) and DDS (Polonsky et al., 2005). It may be useful to analyze the validity of CDDS with other scales about coping behaviors and attitudes.

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