WILEY | *I* INTERNATIONAL JOURNAL *of* NURSING PRACTICE

RESEARCH PAPER

Evaluation of factors related to glycaemic control among South Korean patients with type 2 diabetes

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Abstract

Aims: To examine specific self-care behaviours, depression, and diabetes-related stress among South Korean patients with type 2 diabetes and to evaluate whether these factors are related to glycaemic control.

Methods: This cross-sectional study included 171 patients with type 2 diabetes who visited an endocrinology clinic. A structured questionnaire and electronic medical records were used to collect data regarding self-care behaviours, depression, diabetes-related distress, and glycaemic control between May 2015 and July 2015.

Results: Compared with the group with good glycaemic control, the group with poor glycaemic control had significantly lower values for medication adherence and significantly greater values for regimen-related distress. Depression was not significantly associated with glycaemic control. In logistic regression analysis, only medication adherence was independently associated with glycaemic control.

Conclusions: Medication adherence should be continuously emphasized and monitored in clinical practice to effectively manage glycaemic control among patients with type 2 diabetes. Furthermore, consideration of diabetes-related distress may help improve glycaemic control among patients with type 2 diabetes.

KEYWORDS

diabetes mellitus, glycaemic index, medication adherence, nurses, self-care

SUMMARY STATEMENT

What is already known about this topic?

- To control glycaemic levels, patients with type 2 diabetes should practice self-care (medication, diet, exercise, and blood glucose monitoring). However, patients with type 2 diabetes complain that self-care is complicated and difficult to follow in daily life.

- Many people with type 2 diabetes experience high levels of depression and distress stemming from concerns associated with diabetes and its management.

- Diabetes-related distress, depression, and self-care behaviours have been thought to be related to glycaemic levels. However, data from cross-sectional studies on this relationship are not consistent. There are few studies on these variables in patients with type 2 diabetes in South Korea.

What this paper adds?

- Diabetes-related distress was only associated with glycaemic control, whereas depression and self-care behaviours were not significantly associated with glycaemic control among South Korean patients with type 2 diabetes.

- We subcategorized diabetes-related distress into emotional burden, physician-related distress, regimen-related distress, and diabetes-related interpersonal distress, but only regimen-related distress was significantly associated with glycaemic control. We subcategorized self-care behaviours into medication, diet, exercise, and blood glucose monitoring, but only medication was significantly associated with glycaemic control.

- Our findings suggest that among patients with type 2 diabetes, glycaemic control was only associated with medication adherence among the self-care behaviours that we evaluated.

The implications of this paper:

- In the clinical setting, health-care providers, including nurses, should assess and address regimen-related distress as this is a known barrier to accomplishment of optimal glycaemic control.

- Health-care providers, including nurses, should explain the need for medication adherence to patients so that they can manage type 2 diabetes, and they should continuously reassess adherence to medications.

- Future research in diabetes should include assessment of specific domains of diabetes-related distress and specific domains of self-care, along with measures of blood glucose control.

1 | INTRODUCTION

Diabetes mellitus is a chronic disease that is becoming increasingly prevalent (Danaei et al., 2011). In South Korea, diabetes prevalence among ≥ 30-year-old adults has rapidly increased from 8.8% in 2001 to 10.1% in 2010 and 11.9% in 2013 (Ministry of Health & Welfare & Korean Centers for Disease Control & Prevention, 2014). Furthermore, diabetes-related complications and hospitalizations have become more common, which undermines patients' quality of life and emphasizes the related socio-economic burden. Type 2 diabetes has a higher incidence than type 1 diabetes (8.3% among ≥ 30-year-old South Korean adults in 2013; 2.7 million persons); this increasing incidence highlights the importance of managing type 2 diabetes in South Korea (Korean Diabetes Association, 2015; Ministry of Health & Welfare & Korean Centers for Disease Control & Prevention, 2014).

The Diabetes Control and Complications Trial Research Group (1993) and UK Prospective Diabetes Study Group (1998a) suggest that aggressive glycaemic control is the most effective method for preventing or delaying the progression of diabetes-related complications. Several others also reported this recommendation (Stratton et al., 2000; The Diabetes Control and Complications Trial Research Group, 1995; UK Prospective Diabetes Study Group, 1998b). South Korea offers various programmes to promote glycaemic control among diabetes patients; these programmes incorporate medication, exercise, dieting, and blood glucose self-monitoring. However, the 2015 Korean Diabetes Fact Sheet indicates that most South Korean diabetes patients maintain poor glycaemic control, with only 43.4% achieving a target < 7% for glycated haemoglobin A_{1c} (HbA$_{1c}$) levels and 27.9% achieving a target < 6.5% (Korean Diabetes Association, 2015). Therefore, it would be useful to examine whether adherence to the South Korean guidelines' self-care behaviours affect glycaemic control;

the resulting information may help diabetes patients achieve appropriate glycaemic control.

Psychological variables have gained attention as factors that affect diabetes management and outcomes; several studies are currently exploring the associations of glycaemic control with depression and diabetes-related distress, which are observed in large proportions of type 2 diabetes patients (Aikens, 2012; Calhoun et al., 2010; Choi, 2007; Fisher, Glasgow, & Strycker, 2010; Fisher, Mullan, et al., 2010; Kang & Gu, 2012; Y. S. Park et al., 2005; Strandberg, Graue, Wentzel-Larsen, Peyrot, & Rokne, 2014). Studies have reported that a relatively high proportion of type 2 diabetes patients experience depressive symptoms (vs the general population); there is an association between depression and glycaemic control (Calhoun et al., 2010; Y. S. Park et al., 2005). Thus, depression alone may affect glucose and lipid metabolism in diabetes patients (Forrest, Becker, Kuller, Wolfson, & Orchard, 2000), and it may negatively affect glycaemic control by fostering the belief that the patient cannot adhere to their diabetes treatment, which may undermine their motivation and willpower (Calhoun et al., 2010; Y. S. Park et al., 2005). Others have argued that depression is not associated with glycaemic control among this patient population (Aikens, 2012; Parildar, Cigerli, & Demirag, 2015). Most type 2 diabetes patients also experience severe emotional diabetes-related distress because of their worries, diabetes management regimen, and/or diabetic complications (Fisher, Hessler, Polonsky, & Mullan, 2012). This diabetes-related distress may affect glycaemic control by indirectly impairing patients' abilities to effectively manage their diabetes and by directly stimulating the autonomic nervous system to induce neuroendocrine responses that lead to hyperglycaemia (Surwit, Schneider, & Feinglos, 1992). Although diabetes-related distress is significantly associated with glycaemic control (Aikens, 2012; Choi, 2007; Fisher, Glasgow, & Strycker, 2010; Fisher, Mullan, et al., 2010; Kang & Gu, 2012; Strandberg et al., 2014), heterogeneous results were observed in studies that analysed this association by classifying diabetes-related distress into emotional burden (EB), physician-related distress (PD), regimen-related distress (RD), and diabetes-related interpersonal distress (ID) (Choi, 2007; Kang & Gu, 2012; Strandberg et al., 2014). Therefore, it would be useful to examine whether diabetes-related distress subcategories are associated with glycaemic control, as this information may be used to promote glycaemic control and achieve better outcomes.

We aimed to evaluate the associations of glycaemic control with adherence to self-care behaviours, depression severity, and diabetes-related distress among South Korean type 2 diabetes patients. We also aimed to examine the associations of demographic and clinical factors with glycaemic control.

2 | METHODS

2.1 | Study design

This cross-sectional study was designed to examine the associations of glycaemic control with adherence to self-care behaviours (eg, medication adherence, exercising, dieting, and blood glucose self-monitoring), depression severity, and diabetes-related distress (EB, PD, RD, and ID) among South Korean type 2 diabetes patients.

2.2 | Participants

Convenience sampling was used to select participants from Gyeongsang University Hospital in South Korea between May 2015 and July 2015. We selected adult patients (≥ 19 y) who had been diagnosed with type 2 diabetes, had been undergoing treatment at the endocrinology clinic for ≥ 1 year, and had consented to participate. We excluded patients who had a medical condition (eg, malignant tumours, thyroid disease, stroke, myocardial infarction, heart failure, renal failure, dementia, and psychosis) or those who had undergone surgery during the previous 3 months. On the basis of these criteria, we identified 198 potential participants, although we excluded 27 participants for missing HbA_{1c} data or incomplete questionnaire responses. The final analyses included data from 171 participants.

A power analysis was performed for logistic regression using G*Power 3.1 (Faul, Erdfelder, Buchner, & Lang, 2009), with an odds ratio of 1.65, a Cronbach α value of 0.05, and power of 80%. Estimation of the odds ratio was based on previously reported medication adherence (Feldman et al., 2014), which was one of the main variables that could affect glycaemic control. We found that a sample size of 161 individuals would provide 80% power, and our sample was considered adequate for our analysis.

2.3 | Measures

2.3.1 | Self-care behaviours

Self-care behaviours were measured using a revised and updated version of the scale developed by Seo (2008). The original scale included 3 items for medication, 3 for diet, and 2 for exercise; we added 2 items for blood glucose self-monitoring after reviewing the literature and created a 10-item questionnaire. We also obtained consent from the tool developer to modify the scale. The self-administered questionnaire evaluated participants' adherence to the recommended self-care behaviours during the last 7 days. The items are answered using an 8-point scale, where 0 represents "I did not adhere to the guidelines at all" and 7 represents "I adhered to the guidelines every day." A higher score indicates higher adherence to the recommended self-care behaviours. The Cronbach α value for the original scale was 0.74 (Seo, 2008), and the value for our revised scale was 0.81. The self-care behaviour scale has good construct validity (Seo, 2008). The content validity of the revised questionnaire was verified by 2 endocrinologists and 3 nursing professors involved in research regarding the nursing care of diabetes patients.

2.3.2 | Depression

Participants' depression was measured using the Korean version of the Centre for Epidemiologic Studies Depression Scale, which Chon, Choi, and Yang (2001) found to be reliable and valid. This tool is based on the original scale developed by Radloff (1977). Responses are rated on a 4-point scale (0: not at all true, 3: always true), and the total score from the 20-item tool (0-60 points) represents participants' level of perceived depression; higher scores indicate a more severe perceived depression. Radloff (1977) suggested that a score ≥ 16 points was suitable for identifying clinical depression, and we used this cut-off point to classify patients as having or not

having self-perceived depression. The Cronbach α value for the original Korean Centre for Epidemiologic Studies Depression Scale was 0.91 (Chon et al., 2001), and the value in our study was 0.87.

2.3.3 | Diabetes-related distress

We used the Diabetes Distress Scale developed by Polonsky et al. (2005) and translated into Korean by Choi (2007). The original scale has 4 subscales, and 17 items are evaluated using a 6-point Likert scale: the EB subscale has 5 items, the PD subscale has 4 items, the RD subscale has 5 items, and the ID subscale has 3 items. Choi (2007) revised the response scoring to use a 5-point Likert scale, with a score of 1 indicating "no problems during the last month" and a score of 5 indicating "a serious problem during the last month." The total score range was 17 to 85, with higher scores indicating higher levels of total stress and/or subscale-specific stress. The construct validity of the Korean version of the diabetes distress scale has been confirmed among diabetes patients (Choi, 2007). Polonsky et al. (2005) reported that the Cronbach α value for the total score was 0.93, and values for the 4 subscales were 0.88 to 0.90. The Cronbach α value for the total score was 0.78, and values for the 4 subscales were 0.70 to 0.84.

2.3.4 | Glycaemic control

Glycaemic control was measured using HbA_{1c} levels, a valid index that reflects the average blood glucose levels during the last 2 to 3 months. According to the American Diabetes Association (2015) guidelines, we defined good glycaemic control as an HbA_{1c} level < 7% and poor glycaemic control as an HbA_{1c} level ≥ 7%.

2.3.5 | Demographic and clinical factors

We evaluated sex, age, marital status, highest education, employment status, and monthly income. Clinical factors included the duration of diabetes, presence of complications, smoking status, body mass index, and presence of hypoglycaemia. Complications were defined as a physician's diagnosis of hypertension and/or angina pectoris.

2.4 | Ethical considerations

Institutional review board approval was obtained for all study methods; participants gave written informed consent before initiation of data collection. Information about the study, the possibility of withdrawing at any time, and the fact that confidentiality was guaranteed were included in the letter that accompanied the questionnaire. All completed questionnaires were coded and recorded in an electronic file stored in a locked desk drawer.

2.5 | Statistical analysis

All data were analysed using SPSS software (version 18.0; SPSS Inc, Chicago, IL), and the level of significance was set to α < .05. Descriptive statistics were used to report data regarding demographic factors, clinical factors, self-care behaviours, depression, diabetes-related distress, and glycaemic control. The chi-square test was used to examine differences in glycaemic control according to the demographic factors, clinical factors, and depression. The *t* test was

used to examine differences in glycaemic control according to self-care behaviour adherence and diabetes-related distress. Logistic regression analyses were performed to identify factors independently associated with glycaemic control.

3 | RESULTS

The 171 participants included 117 men (68.4%) and 54 women (31.6%). Most participants were > 65 years old (119 participants, 69.6%), and patients' mean age was 59.55 ± 9.75 years. One hundred sixty participants (93.6%) were married and living with their spouse. Seventy-four participants (43.3%) graduated from high school, 50 (29.2%) graduated from a community college or higher education programme, and 47 (27.5%) achieved education no higher than elementary school. Eighty-eight participants reported being employed (51.5%), and 59 (34.5%) had a low income. Ninety-seven participants (56.7%) reported having diabetes for ≥ 10 years (mean duration 12.36 ± 8.53 years). One hundred ten participants (64.3%) were only receiving oral medication, and 107 (62.6%) had no complications. One hundred forty-two participants (83%) were nonsmokers, and 114 (66.7%) had a normal body mass index. Ninety-two participants (53.8%) reported experiencing hypoglycaemia during the last month (Table 1).

We found that the time since diagnosis, treatment type, and presence of complications were significantly associated with glycaemic control in univariate analyses. The group with poor glycaemic control had a longer time since diagnosis than the group with good glycaemic control (χ^2 = 6.502, P = .039). Compared with the group with good glycaemic control, the group with poor glycaemic control had higher proportions of patients receiving a combination of oral medication and insulin therapy (χ^2 = 5.742, P = .017) and patients with complications (χ^2 = 4.69, P = .03).

The mean total value for adherence to self-care behaviours was 4.62 points, with mean values of 6.34 points for medication adherence, 4.91 points for dieting, 3.40 points for exercising, and 2.82 points for blood glucose testing (Table 2). Twenty-two participants had depression (12.9%, score ≥ 16 points), and 149 (87.1%, score < 16 points) were categorized into the nondepressed group; the mean depression score was 6.86 points. The mean total diabetes-related distress score was 2.25 points, with mean scores of 2.46 points for EB, 2.41 points for RD, 2.14 points for ID, and 1.86 points for PD. Seventy-seven participants (45%) had good glycaemic control, and 94 (55%) had poor glycaemic control; the mean HbA_{1c} value was 7.37%. The group with poor glycaemic control exhibited significantly higher HbA_{1c} values than the group with good glycaemic control (8.08% vs 6.50%, respectively).

TABLE 1 Demographic and clinical characteristics (N = 171)

Characteristic		N (%)	HbA$_{1c}$ Level < 7% N (%)	HbA$_{1c}$ Level ≥ 7% N (%)	χ^2	P Value
Sex	Male	117 (68.4)	47 (61.0)	70 (74.5)	3.533	.060
	Female	54 (31.6)	30 (39.0)	24 (25.5)		
Age, y	< 65	119 (69.6)	52 (67.5)	67 (71.3)	0.280	596
	≥ 65	52 (30.4)	25 (32.5)	27 (28.7)		
Married	No	11 (6.4)	3 (3.9)	8 (8.5)	1.489	.222
	Yes	160 (93.6)	74 (96.1)	86 (91.5)		
Education	Primary school or less	47 (27.5)	26 (33.8)	21 (22.3)	3.663	.160
	High school or less	74 (43.3)	33 (42.8)	41 (43.7)		
	College or higher	50 (29.2)	18 (23.4)	32 (34.0)		
Employed	No	83 (48.5)	39 (50.6)	44 (46.8)	0.250	.617
	Yes	88 (51.5)	38 (49.4)	50 (53.2)		
Monthly income, won	< 1 000 000	59 (34.5)	30 (39.0)	29 (30.9)	2.250	.527
	1 000 000-1 999 999	22 (12.9)	8 (10.4)	14 (14.9)		
	2 000 000-3 999 999	44 (25.7)	21 (27.3)	23 (24.5)		
	≥ 4 000 000	46 (26.9)	18 (23.4)	28 (29.7)		
Time since diagnosis, y	> 5	38 (22.2)	23 (29.8)	15 (16.0)	6.502	.039
	5-9	36 (21.1)	18 (23.4)	28 (19.1)		
	≥10	97 (56.7)	36 (46.8)	61 (64.9)		
Treatment	Oral medication	110 (64.3)	57 (74.0)	53 (56.4)	5.742	.017
	Insulin ± oral medication	61 (35.7)	20 (26.0)	41 (43.6)		
Complications of diabetes	No	107 (62.6)	55 (71.4)	52 (55.3)	4.690	.030
	Yes	64 (37.4)	22 (28.6)	42 (44.7)		
Smoker	No	142 (83)	68 (88.3)	74 (78.7)	2.763	.096
	Yes	29 (17)	9 (11.7)	20 (21.3)		
Body mass index, kg/m^2	< 18.5	4 (2.3)	1 (1.3)	3 (3.2)	2.802	.436
	18.5-23	114 (66.7)	48 (62.3)	66 (70.2)		
	23-25	47 (27.5)	24 (31.2)	23 (24.5)		
	25-30	6 (3.5)	4 (5.2)	2 (2.1)		
Hypoglycaemia	No	79 (46.2)	37 (48.1)	42 (44.7)	0.194	.660
	Yes	92 (53.8)	40 (51.9)	52 (55.3)		

Abbreviation: HbA$_{1c}$: glycated haemoglobin A$_{1c}$.

TABLE 2 Self-care behaviours, depression, diabetes-related distress, and haemoglobin levels (N = 171)

Characteristic		N (%)	Mean ± Standard Deviation
Self-care behaviours			4.62 ± 0.88
Medication			6.34 ± 0.65
Diet			4.91 ± 1.40
Exercise			3.40 ± 2.14
Blood glucose testing			2.82 ± 2.38
Depression	No	149 (87.1)	6.86 ± 7.94
	Yes	22 (12.9)	
Diabetes-related distress			2.25 ± 0.56
Emotional burden			2.46 ± 0.85
Physician-related distress			1.86 ± 0.69
Regimen-related distress			2.41 ± 0.80
Diabetes-related interpersonal distress			2.14 ± 1.15
HbA_{1c} level			7.37 ± 1.27
<7%		77 (45.0)	6.50 ± 0.34
≥7%		94 (55.0)	8.08 ± 1.31

Abbreviation: HbA_{1c}: glycated haemoglobin A_{1c}.

Results of univariate analyses of the factors associated with glycaemic control showed that only diabetes-related distress had a significant association ($t = -2.33$, $P = .021$) (Table 3). Our analyses of the self-care behaviour subcategories demonstrated that only medication adherence was significantly associated with glycaemic control ($t = 8.95$, $P < .001$). Among the 4 subcategories of diabetes-related distress, the group with poor glycaemic control had a significantly higher average RD score than the group with good glycaemic control ($t = -2.30$, $P = .023$). There were no significant associations between glycaemic control and the other subcategories of diabetes-related distress.

We included the time since diagnosis, treatment type, presence of complications, medication adherence, and RD score in the multivariate logistic regression analysis because they were significant factors in univariate analyses (Table 4). Nominal variables were processed as dummy variables. Only medication adherence was independently associated with glycaemic control, and the odds ratio for good glycaemic control among patients with good medication adherence was 13.632 (95% CI, 5.842-31.81). Our regression model had a good fit (Hosmer-Lemeshow test: $P = .735$), and the Nagelkerke R^2 value was 0.482.

TABLE 3 Results of univariate analyses of the association of glycaemic control with self-care behaviours, depression, and diabetes-related distress (N = 171)

Variable	Category	HbA_{1c} Level < 7% N (%) or M ± SD	HbA_{1c} Level ≥ 7% N (%) or M ± SD	χ^2 or t Test	P Value
Self-care behaviours		4.75 ± 0.87	4.52 ± 0.89	1.68[a]	.094
	Medication	6.75 ± 0.40	6.01 ± 0.62	8.95[a]	< .001
	Diet	5.05 ± 1.35	4.80 ± 1.43	1.18[a]	.239
	Exercise	3.47 ± 2.17	3.35 ± 2.11	0.37[a]	.712
	Blood glucose testing	2.57 ± 2.30	3.03 ± 2.43	−1.28[a]	.202
Depression	No	70 (90.9)	79 (84.0)	1.780	.182
	Yes	7 (9.1)	15 (16.0)		
Diabetes-related distress		2.14 ± 0.52	2.34 ± 0.58	−2.33[a]	.021
	Emotional burden	2.35 ± 0.84	2.54 ± 0.85	−1.47[a]	.141
	Physician-related distress	1.82 ± 0.64	1.90 ± 0.73	−0.73[a]	.466
	Regimen-related distress	2.26 ± 0.73	2.54 ± 0.84	−2.30[a]	.023
	Diabetes-related interpersonal distress	2.01 ± 1.05	2.25 ± 1.22	−1.35[a]	.178
HbA_{1c} level		6.50 ± 0.34	8.08 ± 1.31	10.34[a]	< .001

Abbreviation: HbA_{1c}: glycated haemoglobin A_{1c}.

[a]Value of t test.

TABLE 4 Results of multivariate logistic regression analyses of the factors associations with glycaemic control (N = 171)

Variable	Category	B	Standard Error	Odds Ratio	P value	95% CI	
Time since diagnosis, y	< 5			1 (reference)			
	5-9	−0.776	0.610	0.460	.203	0.139	1.622
	≥ 10	−0.889	0.525	0.407	.087	0.145	1.140
Treatment	Oral medication			1 (reference)			
	Insulin ± oral medication	−0.357	0.428	0.700	.404	0.303	1.618
Complications of diabetes	No			1 (reference)			
	Yes	−0.399	0.427	0.671	.35	0.290	1.550
Medication		2.612	0.432	13.632	< .001	5.842	31.810
Regimen-related distress		−0.415	0.266	0.660	.118	0.392	1.111

4 | DISCUSSION

We found that 45% of participants had good glycaemic control (HbA$_{1c}$ level < 7%) and 55% had poor glycaemic control (HbA$_{1c}$ level ≥ 7%). Similar results have been reported by the Korean Diabetes Association (2015), which found that approximately 43.4% of Korean patients with diabetes had an HbA$_{1c}$ level < 7% in 2013, and by Ji (2015) who analysed 2012 National Health and Nutrition Survey data and found that approximately 45% of ≥ 40-year-old Korean patients with diabetes had good glycaemic control. These results suggest that less than half of Korean type 2 diabetes patients achieve appropriate glycaemic control, which indicates poor diabetes management. Thus, it is important to identify factors that affect glycaemic control, as these factors may be adjusted to promote active and systematic diabetes management.

When we examined the associations of glycaemic control with demographic and clinical factors among type 2 diabetes patients, we found that poor glycaemic control was associated with a prolonged duration of diabetes, the combination of oral medication and insulin therapy, and the presence of diabetic complications. Similarly, previous studies have found that poor glycaemic control was associated with receiving insulin therapy (vs only receiving oral medication), a prolonged duration of diabetes (Boo, 2012; Kang & Gu, 2012), and the presence of diabetic complications (J. Y. Park, Lee, Jang, & Oh, 2010).

Interestingly, we did not observe a significant association between total self-care behaviours and glycaemic control among type 2 diabetes patients, which agrees with the findings of Lee and Park (2014). However, our results conflict with Kang and Gu's (2012) finding that their group with poor glycaemic control exhibited markedly lower adherence to self-care behaviours and J. Y. Park et al.'s (2010) findings that the HbA$_{1c}$ level was lower among patients with higher adherence to self-care behaviours. In our study, the degree of adherence to self-care behaviours was moderate (Mean: 4.6 days per 7-day period; range, 0-7 d), which is similar to previous studies' results: 4.6 of 7 points (Kang & Gu, 2012), 3.4 of 5 points (Lee & Park, 2014), and 3.3 of 5 points (J. Y. Park et al., 2010). Therefore, future studies should clarify the associations between self-care behaviours and glycaemic control, as patient characteristics may be affected by unidentified factors. We also found that medication adherence exhibited the highest adherence value (6.3 d), followed by dieting (4.9 d), exercising (3.4 d), and blood glucose self-monitoring (2.8 d). These results agree with other studies' findings (Kang & Gu, 2012; Lee & Park, 2014; Osborn, Mayberry, & Kim, 2016; Sasi et al., 2013), which showed that type 2 diabetes patients exhibited the greatest values for medication adherence and relatively low adherence values for dieting, exercising, and blood glucose self-monitoring. The high value for medication adherence may be related to the relatively simple requirement to take a specific medication dose at the scheduled time; however, dieting, exercising, and blood glucose self-monitoring require more extensive habitual changes that are relatively difficult to perform (Lee & Park, 2014). Furthermore, we only found that medication adherence was significantly associated with glycaemic control, whereas previous studies have found significant differences in glycaemic control according to exercise and diet (Kang & Gu, 2012); medication and exercise

(Osborn et al., 2016); and medication, exercise, and diet (Sasi et al., 2013). These study-specific differences are presumably related to the use of different tools to measure self-care behaviours. Moreover, it is difficult to directly compare findings from these studies, based on differences in the study samples. Thus, further studies are needed to account for participants' characteristics in the analysis of glycaemic control and self-care behaviour.

In our study, clinically significant depression was more common in the group with poor glycaemic control than in the group with good glycaemic control, although the difference was not significant. In contrast, some previous studies have found significant differences (Calhoun et al., 2010; Y. S. Park et al., 2005), although other studies found higher, albeit insignificant, HbA$_{1c}$ levels among individuals with clinically significant depression (Parildar et al., 2015; Paschalides et al., 2004). Furthermore, studies have found that depression adversely affects the mental function of diabetes patients, although it did not directly affect metabolism and glycaemic control (Paschalides et al., 2004). These conflicting results may be related to differences in the participants' severity of basal depression or differences in the analytical methods. However, the relationship between depression and glycaemic control remains controversial, and further studies are needed to clarify this relationship.

Several studies have found that diabetes-related distress is significantly associated with glycaemic control among type 2 diabetes patients (Aikens, 2012; Fisher, Glasgow, & Strycker, 2010; Fisher et al., 2012; Fisher, Mullan, et al., 2010; Kang & Gu, 2012; Sasi et al., 2013; Strandberg et al., 2014); we found that greater diabetes-related distress was associated with poor glycaemic control. Diabetes-related distress encompasses patient's emotional reactions and responses to their diabetes (Strandberg et al., 2014), and it is related to their experiences with diabetes and its treatment and management (Fisher et al., 2012). Thus, health-care providers, including nurses, should help patients overcome or control their negative feelings regarding the challenges caused by their diabetes.

We found that only the RD subcategory of diabetes-related distress was significantly associated with glycaemic control. As the RD scale evaluates the patient's motivations and behavioural problems in the context of self-care behaviour, it seems logical that patients with poor glycaemic control would exhibit higher RD scores than their counterparts with good glycaemic control. A previous study also found that poor glycaemic control was significantly associated with higher RD and ED scores (Kang & Gu, 2012). Another study (Strandberg et al., 2014) found that demands from self-care play a key role in the relationship between diabetes-related distress and HbA$_{1c}$ levels; RD and ED scores exhibited univariate associations with HbA$_{1c}$ levels, but only RD scores exhibited an independent association with HbA$_{1c}$ levels. Thus, it is important for health-care providers to recognize the importance of RD in their treatment of patients with diabetes and to allow their patients to discuss their RD experiences, as simple verbal communication regarding their emotional experiences may relieve their stress and facilitate behavioural changes (Fisher et al., 2012). Fisher et al. (2012) also surveyed diabetes-related distress among type 2 diabetes patients using a diabetes distress scale (6-point Likert scale), and they found that high distress (≥ 3.0) was associated with poor clinical outcomes. Although it is difficult to interpret subcategory-specific

findings regarding the relationship of diabetes-related distress with health outcomes, a score of ≥2.5 points may be useful for identifying clinically meaningful distress in the present study, as we used a 5-point Likert scale. Interestingly, none of the subcategory scores reached a level of clinically meaningful distress in the group with good glycaemic control, although the RD and EB scores slightly exceeded 2.5 points in the group with poor glycaemic control. Therefore, health-care providers, including nurses, must aggressively use strategies to reduce RD and establish strategies to mitigate the psychological burden of diabetes and its management to promote health management among patients with type 2 diabetes and poor glycaemic control.

We also found that only medication adherence was independently associated with glycaemic control. No significant associations were observed between glycaemic control and the time since diagnosis, treatment type, presence of complications, or RD score. Thus, health-care providers, including nurses, should engage in further efforts to promote better medication adherence among type 2 diabetes patients to improve their glycaemic control. Hessler et al. (2014) performed a cross-sectional study to examine independent associations of glycaemic control with RD scores, medication nonadherence, diet, and physical activity. They found that higher RD scores and medication nonadherence were associated with poor glycaemic control among type 2 diabetes patients. Differences between their findings and ours are likely related to differences in the study populations, as Hessler et al. (2014) evaluated type 2 diabetes patients who exhibited moderate to severe RD, did not perform dieting and exercising for 3 to 4 days, and did not adhere to their medication for ≥ 2 days. Thus, we performed additional analyses to examine the associations among RD scores, medication adherence, and glycaemic control; the results showed that the RD score was significantly associated with medication adherence. A previous study reported similar findings (Aikens, 2012), and this relationship implies that RD can indirectly affect blood glucose levels by undermining medication adherence (Goldston, Kovacs, Obrosky, & Iyengar, 1995). Further studies are needed to examine the exact mechanism underlying this relationship, which should account for participants' degree of emotions and behaviours associated with their diabetic treatment regimens. Nevertheless, our findings demonstrated that RD scores and medication adherence were associated with glycaemic control among type 2 diabetes patients and medication adherence was the most important factor associated with glycaemic control. Therefore, nurses and other health-care providers should consider their patients' RD and stress in the context of medication adherence to promote effective glycaemic control among type 2 diabetes patients.

4.1 | Study limitations

This study has several limitations. First, we used a single-centre design, and participants were predominantly South Korean men, which limits the generalization of our findings to all diabetes patients. Second, although we surveyed self-care behaviours using reliable and valid scales, self-administered questionnaires have various inherent limitations that should be addressed in future studies. Third, our study's cross-sectional design precludes any conclusions regarding the causality of the relationships we observed or any longitudinal changes in these relationships. Thus, we suggest that future studies use a longitudinal design or structural equation modelling to provide more definitive data.

5 | CONCLUSIONS

Given the relatively high proportion of type 2 diabetes patients who maintain poor glycaemic control, it is important to identify key factors that can affect glycaemic control and be addressed in health management interventions. We believe that our findings provide meaningful information regarding self-care behaviours and diabetes-related distress subcategories that may be associated with glycaemic control. Therefore, we conclude that nurses and other health-care providers should highlight the importance of medication adherence to type 2 diabetes patients and attempt to effectively manage these patients to increase their medication adherence. It may also be useful to screen and manage patients' RD to promote better glycaemic control.

ETHICAL APPROVAL

This study was approved by the ethics review board of Kyungsung University (approval number: ksu-14-10-001).

AUTHORSHIP STATEMENT

W-H. C. designed the study, searched literature, and collected the data. Y-M. S. designed the study, analyzed the data, drafted, and edited the manuscript. Y. H. conducted the interpretation of data and initial review of the manuscript.

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