

ORIGINAL PAPER

THE THAI VERSION OF DIABETES SELF-MANAGEMENT SCALE INSTRUMENT, AND ASSESSMENT OF ITS PSYCHOMETRIC PROPERTIES: A MULTI-CENTER STUDY

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Abstract

Aim: The objective of this study was to translate and evaluate the psychometric properties of the Thai version of the Diabetes Self-Management Scale (T-DSMS). **Design:** A cross-sectional study. **Methods:** This study was performed in two phases: 1) a forward-backwards translation of the existing version of the Diabetes Self-Management Scale (DSMS); and 2) evaluation of its psychometric properties using confirmatory factor analysis. Between February to June 2016, a total of 700 type 2 diabetes mellitus (T2DM) patients were recruited from outpatient diabetes clinics of both community and university hospitals in Khon Kaen and Bangkok province Thailand, using a self-administered questionnaire. **Results:** The results, based on confirmatory factor analysis using Unweighted Least Squares, confirmed the construct validity of the T-DSMS (CFI = 0.985; RMSEA = 0.258; TLI = 0.981; SRMR = 0.040). The T-DSMS contains 13 items across four domains: Diet, Blood, Exercise, and Foot care. **Conclusion:** We translated and appropriately validated the DSMS in Thai T2DM patients. The T-DSMS was shown to have good psychometric properties, including content validity and criterion validity. The T-DSMS is an adequate instrument with which to assess diabetes self-management in Thai T2DM patients, and can provide valuable insights into the epidemiology of diabetes self-management, and enable evaluation of prevention programs for diabetes self-management in T2DM patients.

Keywords: criterion validity, diabetes mellitus type 2, diabetes self-management, Diabetes Self-Management Scale psychometric properties.

Introduction

Diabetes is one of the deadliest preventable diseases worldwide. Diabetes prediction in 2030, based on 2010 data, shows that the number of diabetics will double to 439 million cases by 2030, with a share of 69% borne by developing countries (Shaw et al., 2010). It is estimated that in Asia cases will reach 180 million by 2030 (113 million cases in 2010) (Chan et al., 2009). This situation is also reflected in Thailand, a developing Asian country, in which type 2 diabetes mellitus (T2DM) has increased sharply in the last 14 years, from 2.3% in 1991 to 8% in 2015 (Aekplakorn et al., 2011), and the number of deaths by 1.84% per year (Pratipanawatr et al., 2010). Most Thai patients of T2DM face financial difficulties because of the high cost of treatment, with the cost of treating diabetes patients coming to 4.2 times that of non-diabetes patients (Chatterjee et al., 2011). A significant source of morbidity and mortality among patients of T2DM are chronic

downstream complications of T2DM such as diabetic retinopathy, nephropathy, and neuropathy, coronary artery disease, and peripheral arterial disease and stroke (Raman et al., 2012; Yamamoto et al., 2012).

Lifestyle changes in diabetic patients are proven to reduce the mortality rate of diabetes. Lifestyle includes the habit of taking medication, a particular diet for medical reasons, physical exercise, keeping a check on blood glucose, and care of healthy feet (Ruggiero et al., 1997). If such continuous activities became habitual behaviors, it would enable patients to achieve the goal of diabetes self-management, i.e., to monitor the metabolism of glucose and engage in behavioral changes for the improvement of glycated haemoglobin A1c (HbA1c) level, which is considered a significant contribution to reducing the occurrence of complications (American Diabetes Association, 2014; Bodenheimer et al., 2002; Ruggiero et al., 1997).

Therefore, it is necessary for health team members to evaluate and promote self-management in T2DM patients, which would involve nursing practices that provide support for patients dealing with their

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diabetes. In 1994, the Summary of Diabetes Self-care Activities Assessment (SDSCA), a multidimensional tool for diabetes self-care management (Toobert & Glasgow, 1994), was first developed for western patients (Toobert & Glasgow, 1994), and a revised version was released in 2000 (Toobert et al., 2000). All versions are specifically utilized to measure self-management of diet (general and specific), blood glucose testing, exercise, foot care, and cigarette smoking (Toobert & Glasgow, 1994; Toobert et al., 2000). The tool has been adapted for different cultures and different languages, such as Turkish (Kav et al., 2010), Spanish (Vincent et al., 2008), Portuguese (Bastos et al., 2007), Malaysian (Jalaludin et al., 2012), Korean (Choi et al., 2011), Italian (Ausili et al., 2015), German (Kamradt et al., 2014), and Arabic (endorsed by Morocco and Saudi Arabia) (AlJohani et al., 2016). Until now, there has been no psychometrically validated SDSCA instrument for the assessment of self-management in Thai patients with diabetes mellitus. Although the original version of SDSCA was used with Thai T2DM patients by Howteerakul et al. in 2007, their research did not involve a process of translation, or a thorough analysis of its psychometric properties (Howteerakul et al., 2007). However, studies indicate differences in the self-management of diabetics due to the influence of culture or sampling design. Consequently, adapted studies using this instrument have reported conflicting results thanks to underlying factor structures. (Ausili et al., 2015; Bastos et al., 2007; Jalaludin et al., 2012; Vincent et al., 2008). To date, the SDSCA has not been adequately or fully validated in any population.

Aim

Therefore, in this study, we wanted to fully validate the SDSCA for Thai T2DM patients, modify the name to the Thai Diabetes Self-Management scale (T-DSMS), and investigate the T-DSMS's relationship to patient characteristics.

Methods

Design

The design of our study was cross-sectional and was conducted as an observational-multi-center study.

Sample

The sample comprised a total of 700 T2DM patients living in both urban and rural areas of the Central and Northeastern regions of Thailand, including those who visited the ambulatory diabetes clinics of both community hospitals and University hospitals in the Khon Kaen and Bangkok province of Thailand, from

February to June 2016. All participants recruited were aged ≥ 20 years old, with type 2 diabetes mellitus diagnosed at least three years before, and with a recent HbA1c blood test, who could write and understood Thai, and participated willingly in the study. Patients with terminal stage of illness, cognitive impairments, or inability to complete the questionnaires were excluded. The questionnaire was distributed to all patients who met the selection criteria upon arrival at the selected ambulatory clinics during office hours. Out of 730 personally distributed questionnaires, 700 were completed, giving a response rate of 96%.

Data collection

A two-stage format was decided on for the study evaluating the psychometric properties of the T-DSMS. In Stage 1, we translated the existing English language version of the T-DSMS into Thai. The original 17-item SDSCA is a self-administered scale, containing five domains, namely: diet (general and specific), monitoring of hyperglycemia, exercise, podiatry, and cigarette smoking (Toobert et al., 2000). We used the forward and backward translation method to subsequently establish translational validity (Brislin, 1970). Two expert native Thai speakers from Khon Kaen University were in charge of translating the English questionnaire into Thai, while two native English speakers undertook the backward translation. The two native English speakers then compared the original and translated versions of the SDSCA. Finally, 20 T2DM patients were used to test face validity of the T-DSMS. In Stage 2, the study was concerned with examining the construct validity and reliability of the T-DSMS instrument.

The T-DSMS was designed as an instrument for measuring diabetes self-management behavior among Thai T2DM patients. The T-DSMS consists of 13 items addressing four domains, namely: *Diet* (five items), *Exercise* (two items), *Blood* (two items), and *Foot care* (four items). The domains of the T-DSMS were rated with responses ranging from 0 to 7. Fifteen questions related to socio-demographic factors: sex, marital status, age, education level, religion, monthly income, body mass index (BMI), family T2DM history, smoking, and alcohol use. Several glycemic control indicators also assessed comorbidities, duration of diabetes, type of diabetes treatment, and glycated hemoglobin (HbA1c).

Data analysis

Demographic data of the T2DM patients were presented using descriptive statistics with counts and percentages for categorical variables, mean, and standard deviation for continuous data.

Several fit indices were used for confirmatory factor analysis (CFA) namely: Comparative Fit Index (CFI) > 0.9; Root Mean Square Error of Approximation (RMSEA); Tucker-Lewis Index (TLI); Standardized Root Mean Square Residual; and, for conventional reasons, the χ^2 statistic, a poor measure of measurement model fit, was also included in this analysis (Hu & Bentler, 1999; Browne & Cudeck, 1992). Construct validity of the T-DSMS was measured using Bartlett's test of sphericity and the Kaiser-Meyer – Olkin (KMO), generated along with CFA (Kaiser, 1974).

Criterion validity was employed to determine the T-DSMS's ability when associated with a clinical target (HbA1c), based on cut-off points set using the receiver operating characteristic (ROC). Finally, the epidemiology of the T-DSMS's outcomes against patients' characteristics was undertaken through ordinal logistic regression. Cronbach's alpha was

used to evaluate internal consistency, and its values of 0.7–0.8 for all subscales were considered acceptable (Faraggi & Reiser, 2002). All analyses were conducted using the R statistical language (v3.2.0), the R library Epi, and the R library lavaan (Rosseel, 2012). A significance level of 0.05 was used for all analyses.

Results

A total of 700 men and women with type 2 diabetes completed all measurements (a response rate of 97.8%). Participants were, on average, 65 years old. The majority were female (70.29%), and the average length of diabetes duration was 13.53 years (SD = 8.34). The characteristics of T2DM patients are shown in Table 1.

Table 1 The characteristics of the study sample

Characters	n (%)	Characters	n (%)
Parts of Hospital		Family history of DM	
Phuphaman hospital	60 (8.6)	yes	370 (52.9)
Srinagarind hospital	78 (11.1)	no	330 (47.1)
Wechkaronrasm hospital	242 (34.6)	BMI (mean = 27.08; SD = 6.32)	
Chulalongkorn hospital	320 (45.7)	< 18.5	20 (2.8)
Sex		18.5–24.9	279 (39.9)
male	208 (29.7)	25–29.9	
female	492 (70.3)	≥ 30	182 (26.0)
Age (Years) (mean = 65.16; SD = 10.94; range 26–95)		Duration of DM (mean = 13.53; SD = 8.34)	
Marital Status		≤ 5 years	85 (12.1)
single	57 (8.1)	> 5 years	615 (87.9)
married	465 (66.4)	Comorbidity	
divorce	165 (23.6)	yes	658 (94.0)
separate	13 (1.9)	no	42 (6.0)
Education level		Treatment of DM	
no formal education	47 (6.7)	no drug	14 (2.0)
elementary school	381 (54.4)	OHA	408 (58.3)
high school	146 (20.9)	insulin sensitizer	94 (13.4)
bachelor degree	99 (14.1)	both OHA & insulin sensitivity	184 (26.3)
master degree	25 (3.6)	Smoking	
higher degree	2 (0.3)	no	589 (84.1)
Religion		previously	88 (12.6)
Buddhism	543 (77.6)	yes	23 (3.3)
Islam	152 (21.7)	Alcohol	
Christianity	5 (0.7)	no	569 (81.3)
Monthly income		previously	89 (12.7)
< 4,999 baht (less than 143 USD)	318 (45.4)	yes	42 (6.0)
5,000–9,999 baht (143 to 287 USD)	95 (13.6)	HbA1c (mean = 7.58; SD = 1.70)	
10,000–14,999 baht (287 to 413 USD)	86 (12.3)	≤ 7 mmol/l	317 (45.3)
15,000–19,999 baht (413 to 575 USD)	48 (6.9)	> 7 mmol/l	383 (54.7)
20,000–24,999 baht (575 to 718 USD)	48 (6.9)		
> 25,000 baht (more than 718 USD)	105 (15.0)		

BMI – body mass index; DM – diabetes mellitus; HbA1c – glicated haemoglobin; mmol/l – millimoles per liter; OHA – oral hyperglycemic agent; SD – standard deviation; USD – United States dollar

Psychometric properties of the T-DSMS

Confirmatory factor analysis revealed that the four-factor model fit the data adequately (CFI = 0.985; RMSEA = 0.258; TLI = 0.981; SRMR = 0.040). Table 2 provides items' standardized factor loading for the T-DSMS. Each subscale score in the T-DSMS

model ranged from 0.15 to 1.14 points, and its items loaded in their respective factor, except the constraint item of each subscale; see Table 2. The inter factor correlation is given in Table 3. The KMO was 0.6, and Bartlett's sphericity test was significant ($\chi^2 = 5391.319$; $df = 153$; $p < 0.001$).

Table 2 Factor loading for confirmatory factor analysis of the T-DSMS

Factors	Items	Diet	Exercise	Blood	Foot care
Diet (5 items)					
dsms1	In the past seven days, how many days did you follow your healthy diet plan?	0.993 [†]	-	-	-
dsms2	On the average, during the last month, how many days per week did you follow your healthy diet plan?	0.997	-	-	-
dsms3	In the past seven days, how many days did you eat five or more types of vegetables and fruit?	0.234	-	-	-
dsms4	In the past seven days, how many days did you eat foods containing high fats such as red meat or dairy products containing fats?	0.686	-	-	-
dsms14	In the past seven days, how many days did you avoid sugary and starchy foods all day?	0.899	-	-	-
Exercise (2 items)					
dsms5	In the past seven days, how many days did you exercise at least 30 minutes (exercising continuously, including walking)?	-	1.006 [†]	-	-
dsms6	In the past seven days, how many days did you exercise, for example, aerobic dancing, jogging, walking, and cycling, apart from exercising at home or at the workplace?	-	0.895	-	-
Blood (2 items)					
dsms7	In the past seven days, how many days did you check your blood sugar?	-	-	1.146 [†]	-
dsms8	In the past seven days, how many days did you check your blood sugar as suggested by health officials?	-	-	0.761	-
Foot care (4 items)					
dsms9	In the past seven days, how many days did you check your feet?	-	-	-	0.625 [†]
dsms10	In the past seven days, how many days did you inspect the inside of your shoes?	-	-	-	0.683
dsms18	In the past seven days, how many days did you clean your feet?	-	-	-	0.151
dsms20	In the past seven days, how many days did you dry the spaces between toes after cleaning your feet?	-	-	-	0.197

[†]item constraint (no significant test conduct)

The inter-factor correlation matrix indicated significant correlation between the subscales of the T-DSMS questionnaire. Table 3 shows that the diet subscale was weakly positively associated with the exercise and foot care subscales but negatively associated with the blood subscale. The exercise subscale was also weakly positively associated with blood subscale and weakly negatively associated with the foot care subscale.

After testing with confounder variables, the T-DSMS demonstrated good ability to discriminate between T2DM patients who did or did not keep to their diet, exercise, and drug blood sugar therapy regimens (Controlled: HbA1c \leq 7%; Uncontrolled: HbA1c $>$ 7%). In particular, diet is quite effective in discriminating between those with or without

concurrent blood sugar control. Table 4 presents the sensitivity, specificity, positive and negative predictive value, and positive and negative likelihood ratios for each subscale.

Cronbach's alpha was employed to examine the internal consistency reliability of the T-DSMS. The alpha value was 0.6, indicating sufficient reliability for the overall scale, except for the foot care subscale, whose Cronbach's alpha was 0.47.

Table 3 Inter-factor correlation of T-DSMS *

	Exercise	Blood	Foot care
Diet	0.17	-0.21*	0.09
Exercise	-	0.06	-0.21*
Blood	-	-	0.14

*Inter-factor correlation was statistically significant ($p < 0.005$)

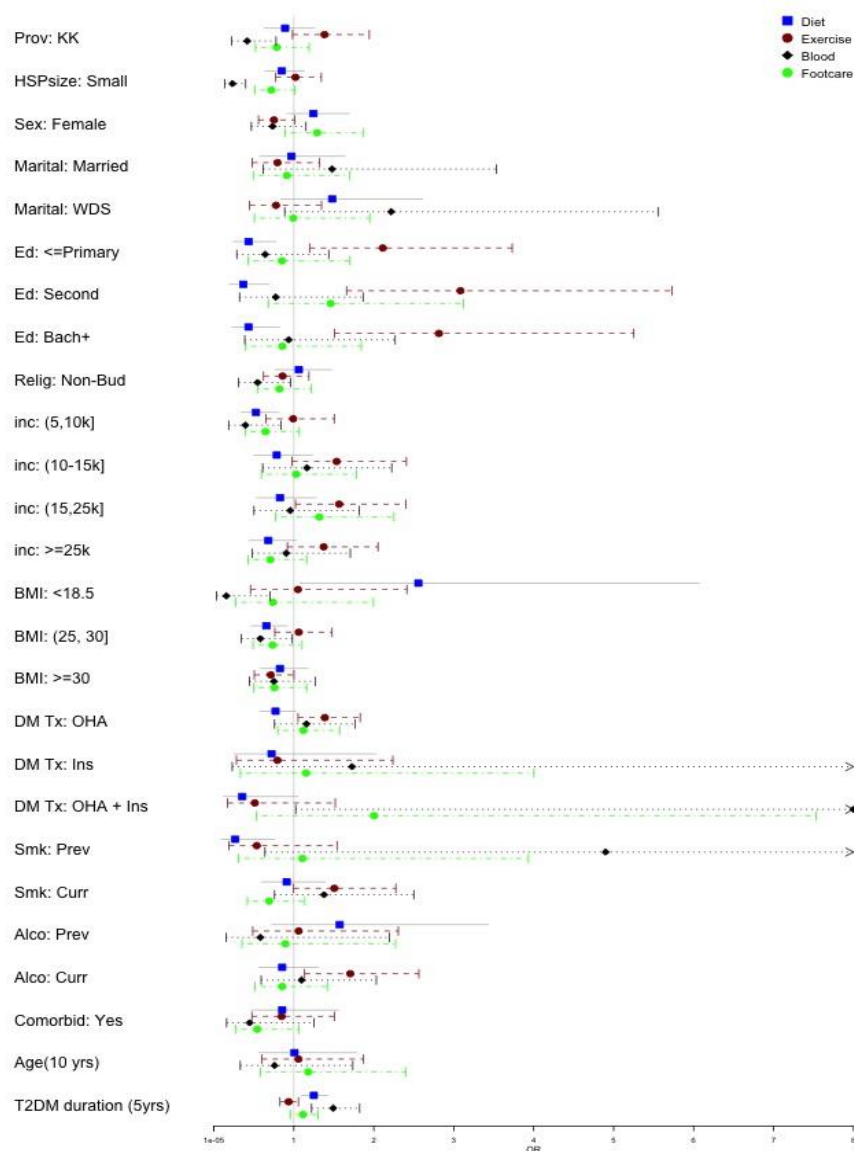
Table 4 The sensitivity, specificity, positive predictive value and negative predictive value, and the positive and negative likelihood ratios of the T-DSMS subscales

	Sensitivity	Specificity	PPV	NPV	LR+	LR-
DSMS Diet	0.92	0.78	0.79	0.91	4.25	0.11
DSMS Exercise	0.50	0.60	0.53	0.57	1.24	0.84
DSMS Blood	0.22	0.73	0.42	0.51	0.81	1.07
DSMS Foot care	0.54	0.47	0.48	0.53	1.02	0.97

LR+ – positive likelihood ratios; LR- –negative likelihood ratios; NPV – negative predictive value; PPV – positive predictive value

Figure 1 indicates that there were several patient characteristics associated with the T-DSMS subscale. Those living in Khon Kaen, receiving treatment at small (community) hospitals, who were non-Buddhist, or had a BMI < 18.5 kg/m² had a higher probability of imperfect blood self-management. Also, all levels of education, monthly income 5,000–10,000 bath (143 to 287 USD) or BMI 25–30 kg/m² were significantly related to poorer diet self-

management. However, all levels of education were related to better exercise self-management. In addition, better exercise and blood self-management were more likely in those who consumed alcohol and those who received oral hyperglycemic agents with insulin. Nevertheless, the duration of T2DM > five years was also related to both better diet and blood self-management.

**Figure 1** Forest plot of T2DM patients following ordinal logistic regression

Discussion

T2DM is a chronic illness proliferating rapidly all over the world. This disease can lead to the development of further complications, and rising healthcare costs. However, through self-management, patients with this disease can significantly mitigate the risk, or delay the onset of these complications. Before we can investigate which patients may or may not exhibit strong ability for self-management, it is necessary for health team members, with valid and appropriate tools, to evaluate and promote self-management of T2DM patients.

In this study, we developed the T-DSMS to evaluate self-management behavior among Thai T2DM patients. In the first stage, we adapted the original version of the SDSCA for the Thai T2DM patient population. In its original version (Toobert et al., 2000), it is one of the most widely used instruments for measuring diabetes self-management. Subsequently, cross-cultural validation studies of the SDSCA questionnaire have been widely recognized, adapted, and translated for a number of countries and cultures (Ausili et al., 2015; Bastos et al., 2007; Jalaludin et al., 2012; Kav et al., 2010; Vincent et al., 2008); however, its use in these settings has not often been supported by sufficient prior validation. Most studies have not been fully validated, or the validation process has been inadequate; for example, previous studies have not conducted a confirmatory factor analysis on the SDSCA only, restricting themselves to exploratory factor analysis. Usually, the CFA enables researchers to determine whether a theoretical measurement model is valid (Black & Babin, 2006). To date, the present authors are not aware of any study that has corroborated this factor structure. Thus, the study's essential contribution was using the CFA approach to construct validate the T-DSMS.

In demonstrating the T-DSMS to be predictive of (future) HbA1c, our findings provided more robust evidence of criterion validity. This result is in line with (Schmitt et al., 2013) who also demonstrated a strong association between HbA1c and overall SDSCA score. This contrasts with other studies which found that overall SDSCA scores were not related to the critical HbA1c target (Ausili et al., 2015; Kamradt et al., 2014), and subsequent studies have supported this result, generally finding low correlation between the SDSCA and HbA1c (Egede & Osborn, 2010; Howteerakul et al., 2007; Mayberry et al., 2013). The absence of a significant relationship between self-management behaviors (based on the measurement by the SDSCA) and HbA1c was reported in the initial assessment of the original

version of the SDSCA (Toobert & Glasgow, 1994). Nevertheless, the revised version did not utilize HbA1c to predict all SDSCA subscales (Toobert et al., 2000).

The present study demonstrated that Diet self-management was associated with achieving the blood sugar control target ($\text{HbA1c} \leq 7$). Our result is in line with a previous study which identified that diet control is an essential part of therapy for patients with T2DM (Norris et al., 2001). Diet is a necessary aspect of the management of a diabetic patient. The diabetic healthcare provider and the patient should understand the basic dietary needs of the patient (Asif, 2014).

In this study, we also investigated patient characteristics associated with the T-DSMS subscales, including diabetes self-management and province, hospital size, type of treatment, smoking, monthly income, BMI, duration of DM, and level of education.

A study by AlJohani et al. found the SDSCA had good psychometric properties and that certain patient characteristics, i.e., age, level of education, and time since diagnosis had a slight impact on total self-management scores (AlJohani et al., 2016). The original SDSCA subscales have been related to the characteristics of participants, including age, insulin status, gender, number of comorbidities, and diabetes duration; however, in general, very few significant correlations have been reported (Toobert et al., 2000).

Our study did have some limitations. First, in all our analyses, the outcome (e.g., Blood sugar control) was measured concurrently with the predictors. That is, blood sugar control and T2DM self-measurement were measured at the same time as Diabetes self-management, which in turn, was measured at the same time as demographic and disease status (i.e., comorbidities and T2DM complications).

Another possible limitation is the extent to which our results can be generalized. Our sample may not adequately represent Asian T2DM patients (in a similar setting), or even the Thai T2DM population. However, we did ensure sampling design included a broad spectrum of healthcare settings (clinics from both primary and tertiary care facilities) and socio-demographic characteristics (patients from both the most developed and less developed Thai provinces). In terms of strengths, our study sample was relatively large and multi-centered, whereas a large majority of previous studies of diabetes self-management have been based on a small sample of several hundred patients from a single clinic, with incomplete or inappropriate psychometric validation.

Conclusion

In conclusion, the T-DSMS demonstrated good psychometric properties and had good ability to discriminate T2DM patients who did or did not self-manage their disease, with regard to criterion validity. The instrument adequately assessed diabetes self-management in Thai T2DM patients and should provide valuable insights into the epidemiology of diabetes self-management, and enable evaluation of prevention programs for diabetes self-management in T2DM patients.

Ethical aspects and conflict of interest

The study protocol was approved by the Ethics Committee of Khon Kaen University (Number EC: HE581479). All participants were provided with written information regarding the purpose of this study, and were informed that their participation was voluntary, that they could withdraw from the study at any time, and that all data obtained would remain confidential. The authors have nothing to declare and have no conflict of interests associated with this study.

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Author contributions

All authors designed the study. MS and SS were involved in the study conception and design, analysis of data, and the drafting of the manuscript. All authors worked together to read, comment on and approve the final manuscript.

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