Original Article

The Study of Medication Understanding and Medication Adherence in Chinese Patients with Type 2 Diabetes Mellitus

Ying Hu, PhD student[1,2], Kornkaew Chanthapasa, PhD[1], Areewan Cheawchanwattana, PhD[1], Jian Su, PhD[3]

[1] Faculty of Pharmaceutical Sciences, Khon Kaen University, Khon Kaen, Thailand

[2] Faculty of Pharmacy, Guangxi University of Chinese Medicine, Nanning, China

[3] Guangxi Scientific Research Center of Traditional Chinese Medicine, Guangxi University of Chinese Medicine, Nanning, China

Background: Medication adherence (MA) is a key component to prevent complications of diabetes mellitus. Patients with better medication understanding (MU) showed higher MA. While there were numerous studies of MA in Chinese patients, there has not been any MU study.

Objective: To assess the associations of MA and MU in Chinese patients with type 2 diabetes mellitus (T2D). To translate and validate the Chinese version of the Medication Understanding Questionnaire (C-MUQ).

Materials and Methods: A cross-sectional study was conducted in 384 Chinese T2D patients. The MA was assessed using the proportion of days covered (PDC), and the MU was assessed using the C-MUQ. The multiple logistic regression was applied to simultaneously assess the association of MA (good or poor MA) with MU and other contributing factors including the sociodemographic characteristics and clinical conditions of patients.

Results: The average PDC of study patients was 89.78% (SD 14.75%), and 77.08% of the patients were classified into the good MA group (PDC is 80% or greater). Based on multiple logistic regression as good MA as dependent variable, factors significantly associated with good MA were not long durations of diabetes, not using traditional Chinese medicine (TCM) products, and the interaction effect of high education level and good MU. The adjusted odd ratio (AOR) were 0.28 (95% CI 0.10 to 0.79) for 25 years or more of diabetes durations, 0.33 (95% CI 0.12 to 0.89) for using TCM products, 3.28 (95% CI 1.94 to 8.62) for high education with poor MU, 4.09 (95% CI 1.46 to 7.36) for low education with good MU, and 5.32 (95% CI 2.49 to 11.34) for high education with good MU, respectively.

Conclusion: To achieve good MA, the Chinese health professionals should concern about improving MU, especially in the low education patients.

Keywords: Medication understanding, Medication adherence, Type 2 diabetes

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Diabetes mellitus (DM) is an important chronic disease that leads to a significant number of mortality and morbidity[1]. The prevalence of DM in Chinese adults was 11.6%[2], and the World Health Organization predicted that there would be over 150 million DM patients in China by 2040[3]. Approximately 90% to 95% of the patients are type 2 diabetes mellitus (T2D)[4]. The fluctuations of blood glucose would lead to complications in DM patients. Chinese T2D patients who reach the target level of HbA1c (less than 7%) were only 35.28%, 32.33%, 31.77%, and 30.15% between 2009 and 2012, respectively[5]. Evidence indicates the impact of medication adherence (MA) on health outcomes in several chronic diseases, such as DM and cardiovascular diseases[6,7]. The patient self-care and MA have been recognized as key components to preventing DM complications and improving

Correspondence to:

Chanthapasa K.

Faculty of Pharmaceutical Sciences, Khon Kaen University, Mittraphap Road, Muang District, Khon Kaen 40002, Thailand.

Phone: +66-43-202378, **Fax**: +66-43-202379

Email: korcha@kku.ac.th

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health outcomes[8]. However, previous reports showed 53.1% to 72.2% of medication non-adherence rates in Chinese T2D patients[9,10].

While there are many ways to assess MA, there is still no consensus on the best method[11]. Among numerous MA measures, the proportion of days covered (PDC) has commonly been used[11]. The PDC is aimed to assess patients' continuation and timeliness of refill medications. In the United States, PDC has been recommended for assessing MA by Pharmacy Quality Alliance, especially in cases of frequently switched medications[12]. The PDC was selected to assess MA in the present study.

Numerous MA studies were found in Chinese patients[13,14], however, there has not been any medication understanding (MU) reported. The MU is a crucial component to control chronic diseases[15]. Patients with better MU had higher MA levels, fewer drug-related problems, and lessen of emergency department visits[15]. MU could be defined as knowledge of the indication, dose, frequency, and special instructions for certain medications[16]. A variety of similar approaches has been used to assess MU[17-19]. The Medication Understanding Questionnaire (MUQ)[19] assesses patients' understanding on indication, strength, unit, and frequency of medications. The MUQ was selected to use in the present study, because of its simple and direct approach properties. The authors translated and adapted the MUQ into Chinese language with the permission of Dr. Sumil Kripalani.

Materials and Methods

The present study was a cross-sectional quantitative study, approved by the Center for Ethics in Human Research, Khon Kaen University (Reference No. 4.3.01:39/2018, HE612309). The study was conducted at the endocrinology department of a traditional Chinese medicine (TCM) tertiary hospital, which is affiliated with Guang Xi University Chinese Medicine in Nanning, China. The study patients were Chinese T2D patients who visited the DM outpatient clinic in February 2019. The inclusion criteria were 1) aged of 18 years or older, 2) be diagnosed as Type 2 DM, 3) be prescribed at least one oral diabetes medication, either TCM, or Western medicine (WM), or both TCM & WM, 4) be prescribed the regimens for more than six months, 5) can communicate in mandarin (national language of China), and 6) can describe how to take their medication. The exclusion criteria were 1) not self-management of their medications, 2) serious psychiatric illnesses or dementia, 3) pregnancy or lactation women, or 4) declined to participate in the present study. The sample of 383 patients was based on sample size calculation formula[20] with 0.05 alpha (2-sided test), 90% power, and the poor MA proportion of 0.531[10].

The author (Hu Y) asked for patient consent before being interviewed. Patients were approached when they waited to see the doctors at the DM outpatient clinic of study hospital. Patients were screened for the inclusion and exclusion using the screening questions list, and patient medical records. The eligible patients were interviewed face-to-face using a structured questionnaire created by the author (Hu Y). The questionnaire consisted of socioeconomic demographic data of patients and Chinese Medication Understanding Questionnaire (C-MUQ). The socioeconomic and demographic variables were gender, age, urban or rural residential area, living with family or living alone, insurance scheme (Urban Employee Basic Medical Insurance [UEBMI] scheme or other medical insurance scheme), education level (low group, which is less than or equal to nine-year compulsory education, or high group, which is greater than the nine-year compulsory education), and personal income per month (low group, which is less than 3,000 Yuan; or high group, which is equal to or greater than 3,000 Yuan, the cut-off point is based on average monthly income of Chinese population in 2018).

Apart from the interview data, the PDC and clinical data were retrieved from the patient medical records by the author (Hu Y). The clinical data, based on physician diagnosis and treatments, were duration of DM, number of comorbidity diseases (gout, arrhythmia, coronary heart diseases, cerebral infarction, epilepsy, or hepatitis), DM complications (numbness or edema of hands and feet, blurred vision, retinopathy, or ketoacidosis), number of all oral medications and specified medications as oral antidiabetic drugs, metformin, gliclazide, glipizide, glimepiride, pioglitazone, acarbose, insulin, and traditional Chinese medications, random blood glucose tests, and types of visiting physicians (TCM physician, WM physician).

Medication adherence

The MA was evaluated in term of the PDC. The PDC is the number of days, supply divided by refill or fixed interval[11]. The refilled medications data were used to calculate PDC. The author (Hu Y) retrieved the data of supply days and the time interval

based on the last visit date from the patient medical records.

Medication understanding

The C-MUQ was translated and adapted according to recommended guidelines[21,22]. In brief, two-forward and one-backward translations with consensus of expert meetings were applied. The adaptation was needed because the limitation to assess patient understanding of the 'strength' item in case of TCM products. Based on the adaptation, the new scoring method was as follow, the score of each medication ranges from 0 to 4 based on the sum score of the 'correct' answer as follows, 'name' (1 point), 'indication' (1 point), 'units' (1 point), and 'frequency' (1 point). The C-MUQ score of each patient was the average of every medication scores. If the patients received more than five medications, then five out of the total medications were randomly sampled and assessed. This was according to the original MUQ methodology[19]. The reliability of C-MUQ was assessed by the interclass correlation coefficient (ICC). The reliability was satisfied if ICC values were 0.70 or above[23]. The validity was assessed using the known-group validity such that patients with poor MU would be poor MA, and they could not control diabetes. The C-MUQ scores were used to classify patients into good MU (C-MUQ equal to 4) and low MU (C-MUQ less than 4), since the score of 4 indicated perfect understanding of medication use. The authors applied the cut-point level of 80% PDC[24] to indicate good MA, then the patients were classified as good MA patients (PDC equal to or greater than 80%) and poor MA patients (PDC less than 80%). The authors hypothesized that the percentage of poor MA would be greater in the poor MU group than the good MU group. To indicate the patients who extremely failed to control diabetes, the present study applied a very high cut-point level of greater than 11 mmol/L that was based on random blood glucose tests. Then the authors hypothesized that the percentage of extremely failed to control diabetes patients would be greater in the poor MU group than the good MU group as well.

Statistical analysis

Appropriate descriptive statistics were used as required, frequency and percentage were used for categorical variables, mean and standard deviation were used for continuous variables. To test between groups, independent student's t-test was used for continuous variables, and chi-square test was used for categorical variables. To examine the contributing factors of good MA (PDC equal to or greater than 80%), the multiple logistic regression was applied for simultaneous analyzing of all contributing independent variables. Each independent variable was analyzed as univariate by simple logistic regression and resulting crude odds ratios with p-values were reported. The independent variables were selected as candidate variables in the multivariate model when their p-values were less than 0.25 or considered as relevant in this context. All analyses were done according to recommendations in the applied logistic regression textbook[25]. All analyses were done by Stata Statistical Software, version 10 (StataCorp LP, College Station, TX, USA), and significant level was set at 0.05.

Results

Patient characteristics

Three hundred eighty-four Chinese T2D patients (200 males, 184 females) participated in the present study. The average age of sample patients was 65.47 (SD 9.79) years, and the average duration of diabetes was 10.80 (SD 8.55) years. Most of the patients lived in urban area (97.14%) and lived with their family (95.04%). Most of the patients (79.69%) had UEBMI scheme. Approximately half and half of the patients were found in low and high groups of education and income levels. Only 12.24% of patients had three diseases or more, and 29.95% of the patients had two diabetes complications or more. Most of the patients received less than five oral medications (63.54%), and less than three oral antidiabetic drugs (78.65%). More than half of the patients (63.54%) used insulin injection. Among the oral antidiabetic drugs prescribed, the three most prescribed drugs were acarbose (66.02%), metformin (51.21%), and gliclazide (22.23%). The percentage of patients who visited TCM physicians was 54.43%. The rest (45.57%), visited WM physicians. Only 8.07% of the patients used TCM products. Most of the patients (86.46%) had blood glucose test values of less than 11 mmol/L. Thirteen point fifty-four-percent of the patients extremely failed to control diabetes (blood glucose test values of equal to or greater than 11 mmol/L). The average C-MUQ was 3.46 (SD 0.90) (scores range 0 to 4), and 59.11% of the patients were classified into good MU group (C-MUQ equal to 4). The average PDC was 89.78% (SD 14.75%), and 77.08% of the patients were classified into good MA group (PDC equal to or greater than 80%) (Table 1).

Table 1. Demographic characteristics of study patients that classified groups according to MU and MA (n=384)

Characteristic	Total sample (n=384) n (%)	C-MUQ=4 (n=227) n (%)	C-MUQ<4 (n=157) n (%)	p-value[b]	PDC≥80% (n=296) n (%)	PDC<80% (n=88) n (%)	p-value[b]
Sex							
Male	200 (52.08)	118 (51.98)	82 (52.23)	0.962	149 (50.34)	51 (57.95)	0.209
Female	184 (47.92)	109 (48.02)	75 (47.77)		147 (49.66)	37 (42.05)	
Age; mean±SD	65.47±9.79	65.26±9.78	65.78±9.83	0.609[c]	65.64±9.93	64.90±9.33	0.534[c]
<60 years	101 (26.30)	58 (25.55)	43 (27.39)	0.618	75 (25.34)	26 (29.55)	0.654
60 to 69 years	153 (39.84)	96 (42.29)	57 (36.31)		116 (39.19)	37 (42.05)	
70 to 79 years	97 (25.26)	53 (23.35)	44 (28.03)		78 (26.35)	19 (21.59)	
≥80 years	33 (8.59)	20 (8.81)	13 (8.28)		27 (9.12)	6 (6.82)	
Residential area							
Urban	373 (97.14)	223 (98.24)	150 (95.54)	0.119	287 (96.96)	86 (97.73)	0.705
Rural	11 (2.86)	4 (1.76)	7 (4.46)		9 (3.04)	2 (2.27)	
Living situation				0.070			0.838
Alone	19 (4.96)	15 (6.64)	4 (2.55)		15 (5.07)	4 (4.55)	
With family	364 (95.04)	211 (93.36)	153 (97.45)		280 (94.59)	84 (95.45)	
Education level[a]							
Low	191 (49.74)	100 (44.05)	91 (57.96)	0.007	139 (46.96)	52 (59.09)	0.046
High	193 (50.26)	127 (55.95)	66 (42.04)		157 (53.04)	36 (40.91)	
Insurance scheme							
UEBMI scheme	306 (79.69)	192 (84.58)	114 (72.61)	0.004	234 (79.05)	72 (81.82)	0.571
Others	78 (20.31)	35 (15.42)	43 (27.39)		62 (20.95)	16 (18.18)	
Personal monthly income							
<3,000 Yuan	172 (44.79)	92 (40.53)	80 (50.96)	0.043	136 (45.95)	36 (40.91)	0.404
≥3,000 Yuan	212 (55.21)	135 (59.47)	77 (49.04)		160 (54.05)	52 (59.09)	
Duration of diabetes; mean±SD	10.80±8.55	11.36±8.41	9.98±7.72	0.103[c]	10.65±8.17	11.30±8.13	0.515[c]
<5 years	109 (28.39)	65 (28.63)	44 (28.03)	0.095	87 (29.39)	22 (25.00)	0.771
5 to 14 years	146 (38.02)	80 (35.24)	66 (42.04)		113 (38.18)	33 (37.50)	
15 to 24 years	93 (24.22)	54 (23.79)	39 (24.84)		70 (23.65)	23 (26.14)	
≥25 years	36 (9.38)	28 (12.33)	8 (5.10)		26 (8.78)	10 (11.36)	
Number of comorbidity diseases							
<3 diseases	337 (87.76)	202 (88.99)	135 (85.99)	0.378	257 (86.82)	80 (90.91)	0.305
≥3 diseases	47 (12.24)	25 (11.01)	22 (14.01)		39 (13.18)	8 (9.09)	
Number of diabetes complications							
<2 complications	269 (70.05)	168 (74.01)	101 (64.33)	0.042	209 (70.61)	60 (68.18)	0.663
≥2 complications	115 (29.95)	59 (25.99)	56 (35.67)		87 (29.39)	28 (31.82)	
Visiting physician							
TCM physician	209 (54.43)	123 (54.19)	86 (54.78)	0.909	152 (51.35)	57 (64.77)	0.026
WM physician	174 (45.57)	104 (45.81)	71 (45.22)		144 (48.65)	31 (35.23)	
Number of all oral medications							
<5 items	244 (63.54)	150 (66.08)	95 (60.51)	0.264	198 (66.89)	46 (52.27)	0.012
≥5 items	140 (36.46)	77 (33.92)	62 (39.49)		98 (33.11)	42 (47.73)	
Number of oral antidiabetic drugs							
<3 items	302 (78.65)	195 (85.90)	107 (68.15)	<0.001	242 (81.76)	60 (68.18)	0.006
≥3 items	82 (21.35)	32 (14.10)	50 (31.85)		54 (18.24)	28 (31.82)	
Insulin							
Use	244 (63.54)	149 (65.64)	95 (60.51)	0.332	188 (63.51)	56 (63.64)	0.983
Do not use	140 (36.46)	78 (36.46)	62 (39.49)		108 (36.49)	32 (36.36)	
Traditional Chinese medications							
Use	31 (8.07)	16 (7.05)	15 (9.55)	0.780	17 (5.74)	14 (15.91)	0.002
Do not use	353 (91.93)	211 (92.95)	142 (90.45)		279 (94.26)	74 (84.09)	
Blood glucose test							
Level <11 mmol/L	332 (86.46)	203 (89.43)	129 (82.17)	0.068	257 (86.46)	75 (85.23)	0.701
Extremely high level ≥11 mmol/L	52 (13.54)	24 (10.57)	28 (17.83)		39 (13.18)	13 (14.77)	
C-MUQ; mean±SD	3.46±0.90	4±0.00	2.68±0.98	<0.001[c]	3.58±0.75	3.05±1.21	<0.001[c]
Poor MU (<4)	157 (40.89)	-	-		106 (35.81)	51 (57.95)	<0.001
Good MU (=4)	227 (59.11)	-	-		190 (64.19)	37 (42.05)	
PDC (%); mean±SD	89.78±14.75	92.71±12.12	85.55±17.07	<0.001[c]	96.87±5.54	65.94±10.40	<0.001[c]
Poor MA (<80%)	88 (22.92)	37 (16.16)	51 (32.90)	<0.001	-	-	
Good MA (≥80%)	296 (77.08)	192 (83.84)	104 (67.10)		-	-	

C-MUQ=Chinese Medication Understanding Questionnaire; PDC=proportion of days covered; UEBMI=Urban Employee Basic Medical Insurance; TCM=traditional Chinese medicine; WM=Western medicine; MU=medication understanding; MA=medication adherence; SD=standard deviation

[a] Low education=less than or equal to 9 years compulsory, High education=above 9 years compulsory; [b] Chi-square tests were used to compare between groups (C-MUQ=4 vs. C-MUQ<4, PDC≥80% vs. PDC<80%); [c] Independent student's t tests were used to compare between groups (C-MUQ=4 vs. C-MUQ<4, PDC≥80% vs. PDC<80%)

Table 2. Multiple logistic regression analysis of factors associated with medication adherence using PDC≥80% as the dependent variable (n=384)

Independent variables[a]	Crude odds ratio	95% CI	p-value	Adjusted odds ratio	95% CI	p-value
Sex: male	0.74	0.45 to 1.19	0.210	0.67	0.38 to 1.18	0.166
Age						
60 to 69 years	1.08	0.61 to 1.94	0.778	1.06	0.54 to 2.11	0.849
70 to 79 years	1.42	0.73 to 2.78	0.303	1.67	0.77 to 3.59	0.190
≥80 years	1.56	0.58 to 4.20	0.379	1.57	0.52 to 4.74	0.424
Residential area in urban	0.74	0.16 to 3.50	0.706	0.68	0.12 to 3.73	0.655
Living alone	1.25	0.43 to 3.65	0.680	0.94	0.28 to 3.18	0.921
Urban Employee Basic Medical Insurance scheme	0.84	0.46 to 1.54	0.572	0.64	0.31 to 1.33	0.299
Personal monthly income ≥3,000 Yuan	0.81	0.50 to 1.32	0.405	0.70	0.38 to 1.31	0.265
Duration of diabetes						
5 to 14 years	0.87	0.47 to 1.59	0.642	0.70	0.36 to 1.39	0.311
15 to 24 years	0.77	0.40 to 1.49	0.439	0.65	0.30 to 1.44	0.294
≥25 years	0.66	0.28 to 1.56	0.343	0.28	0.10 to 0.79	0.017
Oral antidiabetic drugs ≥3 items	0.48	0.28 to 0.82	0.007	0.78	0.38 to 1.51	0.428
Use insulin	1.01	0.61 to 1.65	0.983	1.24	0.70 to 2.18	0.463
Use traditional Chinese medications	0.44	0.25 to 0.79	0.006	0.33	0.12 to 0.89	0.028
Number of comorbidity diseases ≥3	1.52	0.68 to 3.38	0.307	1.52	0.68 to 3.38	0.307
Number of diabetes complications ≥2	0.89	0.53 to 1.49	0.663	0.86	0.44 to 1.68	0.653
Visiting traditional Chinese medicine physician	0.57	0.35 to 0.94	0.027	0.60	0.34 to 1.05	0.073
Blood glucose test level <11 mmol/L	1.14	0.58 to 2.25	0.701	0.87	0.41 to 1.83	0.706
High education	1.63	1.01 to 2.64	0.047	-	-	-
Good C-MUQ	2.47	1.52 to 4.01	<0.001	-	-	-
Interaction of education level[b] and C-MUQ						
High education with poor C-MUQ	-	-	-	3.28	1.94 to 8.62	0.004
Low education with good C-MUQ	-	-	-	4.09	1.46 to 7.36	<0.001
High education with good C-MUQ	-	-	-	5.32	2.49 to 11.34	<0.001

C-MUQ=Chinese Medication Understanding Questionnaire; CI=confidence interval

[a] Reference groups are female, age <60 years, residential area in rural, living with family, other insurance scheme, personal monthly income <3,000 Yuan, diabetes duration <5 years, oral hypoglycemic drug <3 items, not use traditional Chinese medications, not use insulin injection, <3 diseases, <2 complications, visiting Western medicine physician, extremely high level of blood glucose test ≥11 mmol/L, low education with poor C-MUQ; [b] Low education=less than or equal to 9 years compulsory, High education=above 9 years compulsory

Reliability and validity of C-MUQ

The reliability of C-MUQ was good with an ICC of 0.72. The result showed that the percentage of poor MA in the poor MU group (32.90%) was two-times greater than the good MU group (16.16%), and the differences was statistically significant (p<0.001). Additionally, the percentage of patients with extremely high blood glucose level in the poor MU group (17.83%) was also greater than in the good MU group (10.57%). The difference was close to significant level (p=0.068). The results were as hypothesized, and these supported the known-groups validity (Table 1).

Factors associated with MU and MA

When the patients were classified into good and poor MU group, the statistical tests showed significant greater proportions of good MU in high education (p=0.007), UEBMI scheme (p=0.004), income of 3,000 Yuan or more (p=0.043), less than two diabetes complications (p=0.042), less than three oral antidiabetic drugs (p<0.001), and good MA (p<0.001). When the patients were classified into good and poor MA group, the statistical tests showed significant greater proportions of good MA in high education (p=0.046), visiting WM physician (p=0.026), less than five oral medications (p=0.012), less than three oral

antidiabetic drugs (p=0.006), not using TCM products (p=0.002), and good MU (p<0.001). The above results were bivariate analyses between each independent variable with the dependent variable (MU or MA). Then the authors applied multiple logistic regression to simultaneously analyze all independent variables with the good MA as the dependent variable (Table 2). Factors significantly associated with good MA were not long durations of diabetes, not using TCM products, and the interaction effect of high education level and good MU. The adjusted odd ratio (AOR) of patients with diabetes duration of 25 years or more was 0.28 (95% CI 0.10, 0.79, p=0.017), based on the reference group of less than five years of diabetes duration. Patients who used TCM products had AOR of 0.33 (95% CI 0.12, 0.89, p=0.028), when compared with those who did not use TCM products. The AOR of less than one indicated that when compared with the reference groups, the proportions of good MA were lower in patients with longer durations of diabetes and those who used TCM products. The interaction of education and MU indicated that good MA patients were high education with good MU. When compared with low education and poor MU patients, AORs were 3.28 (95% CI 1.94, 8.62, p=0.004) for high education with poor MU, 4.09 (95% CI 1.46, 7.36, p<0.001) for low education with good MU, and 5.32 (95% CI 2.49, 11.34, p<0.001) for high education with good MU.

Discussion

The association of MA and MU found in the present study was similar to a previous study in HIV, hypertension, and psychiatric patients[7]. Additionally, the association of MA and education was previously reported in elderly patients[26]. However, the authors found an interesting result that the effect of education and MU towards the MA was interactive. Therefore, healthcare professionals should not overlook MU, even in patients that have high education, since both education and MU are simultaneously associated with MA. The C-MUQ could be used to assess MU in Chinese DM patients since the results of the present study supported the reliability and validity of C-MUQ. The present study was limited to specific Chinese T2D patients considered to be the high socioeconomic group. The future research based on larger and more representative samples of Chinese patients would be needed.

Conclusion

Apart from patient education level, the MU is an important factor associated with MA, then health education especially on the prescribed medications should be of great concern. The good MU should lead to the better MA and better glucose control, and then these would lead to less morbidity and mortality of diabetes patients in the future.

What is already known on this topic?

In DM patients, MA is a key component to preventing DM complications and improving health outcomes. Patients with better MU showed higher MA, fewer drug-related problems, and less emergency department visits. In China, numerous studies of MA were found, however MU has never been examined in Chinese population.

What this study adds?

Factors significantly associated with good MA were shorter diabetes durations, not using TCM products, and the interaction effect of higher education level and better MU. The interaction effect of education level and MU indicated that these two factors were working together. To achieve good MA, MU should be assessed and improved, even in Chinese DM patients with high education level.

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Conflicts of interest

The authors declare no conflict of interest.

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