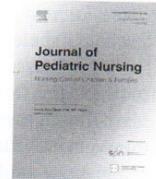




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Developing the Chinese version problem areas in diabetes-teen for measuring diabetes distress in adolescents with type 1 diabetes

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ABSTRACT

Purpose: To translate the 26-item English version Problem Areas in Diabetes-Teen (PAID-T) into a Chinese version and then to examine its psychometrical properties for measuring diabetes distress in adolescents with type 1 diabetes (T1D).

Design and methods: The 26-item English version PAID-T was translated into a Chinese version guided by the translation model for cross-cultural research. A cross-sectional design was used and 203 adolescents with T1D were recruited from four hospitals in Taiwan. Content validity, exploratory factor analysis, and item analysis were used to ensure the item quality and build the factor structure of the Chinese version PAID-T. Confirmatory factor analysis, concurrent validity, and reliability testing were also used to examine its psychometric properties. **Results:** The three second-order factors of the 18-item Chinese version PAID-T were developed. The correlation coefficients of the three-factor Chinese version PAID-T with self-management and glycosylated hemoglobin levels were all significant and ranged from -0.32 to -0.45 and 0.18 to 0.33 respectively. Cronbach's α and the test-retest reliability of the three-factor Chinese version PAID-T ranged from 0.85 to 0.93 and from 0.89 to 0.94 respectively.

Conclusions: The Chinese version PAID-T with good translation quality was a reliable and valid scale to screen and assess diabetes distress for adolescents with T1D.

Practice implications: Nurses could use the Chinese version PAID-T to track diabetes distress and tailor interventions for adolescents with T1D; also, the Chinese version PAID-T could facilitate the conducting of research on diabetes distress for adolescents with T1D.

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Introduction

Diabetes distress (DD) is an aggregation of negative emotional responses to the specific challenges related to diabetes (Skinner et al., 2020). DD is generated by the chronic nature of type 1 diabetes (T1D) including stigma of diagnosis, bothersome symptoms, demanding self-management, threats of complication, impairments of emotional state, and unsupportive interpersonal relationships (King et al., 2017; Snoek et al., 2015). DD is a vital marker for health outcomes about self-

management and glycemic control in adolescents with T1D (Hagger et al., 2016; Iturralde et al., 2019); meanwhile, measures of DD could identify specific sources of psychological issues associated with T1D as targets for intervention (Fisher et al., 2019). Within as clear targets of intervention in health outcomes of adolescents with T1D, DD is an important issue to provide health care for adolescents with T1D.

A systematic review concluded around one-third of adolescents experience DD (Hagger et al., 2016), showing a high prevalence of DD among the adolescents. However, adolescents expect to obtain respect as do adults and acquire smooth peer relationships, so they are less likely to disclose negative emotions including DD (Wang et al., 2012). Studies indicated the less self-disclosure adolescents exhibit, the more avoidant attitudes toward seeking help from nurses they have (Fan & Wang, 2019; Wang et al., 2012). Accordingly, DD of adolescents with T1D might not be recognized by nurses. If DD remains unrecognized and therefore cannot be addressed, it does not vanish over time

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(Iturralde et al., 2019). The International Society for Pediatric and Adolescent Diabetes (ISPAD) have suggested that screening and assessing DD for adolescents with T1D should be done at diagnosis and during routine care (Delamater et al., 2018). A validated scale to screen and assess DD will assist in identifying those who have DD and further tailor interventions for adolescents with T1D (Hilliard et al., 2018). The perspectives of adolescents must be considered in order to formulate and implement health promotion programs for adolescents (Parvizi & Hamzehgardeshi, 2014). To sum up, a well-established and self-reported scale is essential for screening and assessing DD in adolescents with T1D.

Scales mostly measuring DD for adolescents with T1D include the Problem Areas in Diabetes (PAID), the DD Scale (DDS), the Problem Areas in Diabetes-Pediatric version (PAID-Peds), and the 26-item Problem Areas in Diabetes-Teen (PAID-T). The PAID and the DDS were originally developed for adults with diabetes (Polonsky et al., 1995; Polonsky et al., 2005), while the PAID-Peds was developed for school-age children to adolescents (Markowitz et al., 2015). A scale clearly targeting adolescents will be more sensitive in detecting DD for adolescents with T1D (Hilliard et al., 2018). Using less sensitive scales might misestimate DD of adolescents with T1D and thus use ineffective interventions (Fisher et al., 2014; Fisher et al., 2019). PAID, DDS, and PAID-Peds might not be sensitive enough to assess developmental attributes of adolescents because they are not developed for adolescents with T1D, and are thus less suitable for measuring DD in adolescents with T1D. Based on adolescent developmental characteristics, the 26-item PAID-T was developed with reference to items of PAID and qualitative data from interviewing pediatric diabetes clinicians for targeting adolescents with T1D (Weissberg-Benchell & Antisdel-Lomaglio, 2011). The 26-item PAID-T was identified as a single-factor solution through exploratory factor analysis (EFA), significantly correlated with glycosylated hemoglobin (HbA1c) levels, and its Cronbach's α was 0.96 (Weissberg-Benchell & Antisdel-Lomaglio, 2011). In short, the 26-item PAID-T is an optimal scale to screen and assess DD of adolescents with T1D.

The prevalence of emotional problems appears threefold higher among adolescents with T1D in Taiwan, compared with their counterparts (Lu et al., 2017). Measures of emotional problems in Taiwanese adolescents with T1D usually used depression scales (Chen et al., 2017; Lu et al., 2017). Depression scales are used to assess a set of emotional disturbances, not to consider T1D-specific contexts (Snoek et al., 2015). Measurement of depression makes it difficult to develop interventions to improve T1D-specific sources of emotional problems (Fisher et al., 2014). Few studies on DD of adolescents in Taiwan have been conducted, and the scale used in these studies was the Chinese version of PAID (PAID-C) (Lin et al., 2021). The PAID-C was originally developed for Taiwanese adults, not for adolescents (Huang et al., 2010). These facts indicate that a scale to measure DD for Taiwanese adolescents with T1D is important and urgently required. Unfortunately, any appropriate scale like the 26-item PAID-T to screen and assess DD of adolescents with T1D is rare in Taiwan. Accordingly, the 26-item English version PAID-T appears optimal for translation into a Chinese version for screening and assessing DD in Taiwanese adolescents with T1D.

Although it appears optimal, one problem of the 26-item PAID-T needs to be addressed. Some items in the 26-item PAID-T might be redundant because its Cronbach's α is 0.96, higher than 0.95, indicating some items are redundant in examining the same concept (Tavakol & Dennick, 2011). This assumption was supported by the 14-item PAID-T. The 14-item PAID-T developed for American adolescents with T1D was yielded by discarding 12 items from the 26-item PAID-T (Shapiro et al., 2018). A study shortened the 20-item PAID-C to be short-form PAID-C developed for Taiwanese adults found that short-form PAID-C retained all items about food but short-form PAID developed for western populations did not (Hsu et al., 2013). The authors suggested the retained food items in the short-form PAID-C might differentiate from the short-form PAID because of cross-cultural differences (Hsu et al.,

2013). Considering the whole of the items in the original scale and cross-cultural differences, the 26-item PAID-T is more suitable to be translated into Chinese version than the 14-item PAID-T. Consequently, this study aimed to translate the 26-item English version PAID-T into a Chinese version and then examine its psychometrical properties.

Methods

A two-stage process was used to develop a Chinese version PAID-T from the 26-item PAID-T after permission was obtained from the original developers (Weissberg-Benchell & Antisdel-Lomaglio, 2011). In the first stage, it was translated into a Chinese version, which was then psychometrically tested in the second stage.

Stage I: Instrument translation

In this study, the translation procedures were guided by the translation model for cross-cultural research (Sousa & Rojjanasrirat, 2011). Two well-qualified bilingual translators independently forward-translated the 26-item PAID-T into separate Chinese versions. For achieving faithfulness of meaning and colloquialism, the two forward-translated versions were evaluated and discussed by a group whose members involved the research designers and both of the translators. A 26-item Chinese version PAID-T was yielded, then two other translators blindly translated this version back into English versions independently. Items were selected when they achieved equivalence between the backward-translated versions and the original 26-item PAID-T. Equivalence was assessed by the members of a group including the research designers and all of the translators based on the similarity between the backward-translated versions and the original 26-item PAID-T. Finally, an approved translation version of a 26-item Chinese version PAID-T was obtained.

Stage II: Psychometric testing

Ethical considerations

This study obtained permissions from the Institutional Review Boards of four hospitals in Taiwan. Pediatric endocrinologists identified those who were potential eligible participants and then referred them to a well-trained research assistant at outpatient clinics. The research assistant explained the study purpose to adolescents with T1D and their parents or legal guardians in a clinic waiting room. All participants and their parents or legal guardians were informed that no penalty would be incurred if they withdrew from the study anytime. They were also informed that adolescents with T1D needed to complete anonymous scales with coded number. The research assistant would mark the medical record number on it for collecting HbA1c level data from their medical records, when adolescents with T1D completed the coded scale. After collecting the HbA1c level data, the medical record number would be deleted from the coded scale. After volunteering, all adolescents with T1D and their parents or legal guardians individually signed informed assent and consent forms.

Design and sampling

This study applied a cross-sectional design. Data were collected from a convenience sample of adolescents with T1D in four hospitals in central and southern Taiwan. Adolescence is the period between ages 10 and 19 years (World Health Organization, 2021). The inclusion criteria were thus adolescents between ages 10 and 19 years who had been diagnosed as T1D for at least six months and could read and speak Chinese. Adolescents were excluded if they were pregnant, had severe learning disabilities, psychiatric diagnoses, or other severe medical diseases.

Content validity, EFA, and item analysis were used to ensure the quality and appropriateness of the items for a Chinese version PAID-T. EFA was used to explore the factor structure and then confirmatory

factor analysis (CFA) was conducted to confirm the factor structure for the Chinese version PAID-T. Concurrent validity and reliability testing were also used to examine the psychometric properties of this new version.

The minimum sample size for conducting CFA should be larger than 200 (Hair et al., 2010). Accordingly, the minimum sample size in this study was 200, and of the 224 eligible adolescents, 203 (90.62%) agreed to enrollment. Data were collected from the period 2015–2016.

Measurements

The structured scale and medical records were used for collection of data. The structured scale included demographic characteristics, a 26-item Chinese version PAID-T, and the 23-item Chinese version of the Self-Management of Diabetes for Adolescents (C-SMOD-A-23). The structured scale was completed by participants. The responses of participants were checked by a well-trained research assistant for missing data after participants had completed the scales. No missing data was found for the structured scale. The medical records were used to collect HbA1c levels of participants by a research assistant. Because higher DD is linked to suboptimal self-management and suboptimal HbA1c levels (Hagger et al., 2016; Iturralde et al., 2019), self-management and HbA1c levels were used to test the concurrent validity of the Chinese version PAID-T.

Demographic characteristics. The data of demographic characteristics included age, gender, diabetes duration, family type, and socioeconomic status. Socioeconomic status was categorized into high, medium and low levels according to educational levels and occupations of parents (Lin, 2005).

The Chinese version problem areas in diabetes-teen. A 26-item Chinese version PAID-T is a 6-point Likert scale rated from one to six, which is the same as the English version. Each item of the Chinese version PAID-T scores from “not a problem” (one points) to “serious problem” (six points), with higher scores indicating greater DD.

The 23-item Chinese version self-management of diabetes for adolescents. The C-SMOD-A-23 was used to measure self-management in adolescents with T1D (Lee et al., 2018). The C-SMOD-A-23 is a 4-point Likert scale rated from zero to three. Each item of the C-SMOD-A-23 scores from “never” (zero points) to “always” (three points), with higher scores indicating better self-management. Cronbach's α of the C-SMOD-A-23 was 0.91 (Lee et al., 2018).

Glycosylated hemoglobin levels. HbA1c levels are regarded as an objective guide to glycemic control over the recent three months for adolescents with diabetes (American Diabetes Association, 2021). After completing scales, latest HbA1c levels of participants were collected by a research assistant, with no missing data on HbA1c levels being found.

Data analyses

SPSS for Windows version 22.0 (SPSS Taiwan Corp., Taipei, Taiwan) was performed for examining descriptive statistics, EFA, item analysis, concurrent validity, and reliability. CFA was tested in the Mplus version 7.0 (Mplus, Muthe'n & Muthe'n, Los Angeles, CA, USA). Results with $P < .05$ were considered as statistically significant.

Content validities. A 26-item Chinese version PAID-T was evaluated by a psychologist, a pediatric endocrinologist, two diabetes researchers, two certificated diabetes educators, and three adolescents with T1D. Nine experts rated the contents of each item on a four-point scale, from “not appropriate” (one points) to “highly appropriate” (four points), based on clarity, duplication, and relevance of each item. For each item, the ratio of the number of experts giving a score of three or four to the total number of experts was calculated as the item-level content

validity indices (I-CVIs), whose value should be higher than 0.78 (Polit & Beck, 2006).

Exploratory factor analysis and corrected item-total correlations. EFA with a principal axis method and direct oblique rotation was conducted to explore the factor structure of a Chinese version PAID-T after content validity had been evaluated. Factors with eigenvalues were higher than one and scree plot provided information to decide how many factors to be applied (Brown, 2015). Factor loadings of each item on its corresponding factor should be 0.45 or higher, and each factor should also consist of a minimum three items (Hair et al., 2010). Corrected item-total correlations were subsequently conducted following the EFA. Corrected item-total correlations above 0.30 are good (Ferketich, 1991).

Confirmatory factor analysis and concurrent validity. For confirming the factor structure of the Chinese version PAID-T, CFA with weighted least square means and adjusted variance (WLSMV) estimation method was performed. A model is an acceptable fit if the ratio of chi-squared to the degrees of freedom (χ^2/df) is below 3.00; the Tucker Lewis index (TLI) and comparative fit index (CFI) are above 0.90; the standardized root mean square residual (SRMR) and the root mean square error for approximation (RMSEA) are below 0.08 (Brown, 2015; Hair et al., 2010). Convergent validity is verified by size of factor loadings, construct reliability (CR), and average variance extracted (AVE) (Hair et al., 2010). Factor loadings of each item should be 0.5 or higher and statistically significant; CR, measuring internal consistency of a set of items within the same latent factor, should be 0.70 or higher; while AVE, being a total estimate of convergence among a set of items within the same latent factor, should be 0.50 or higher (Hair et al., 2010). Discriminant validity among latent factors is also verified if the 95% confidence intervals of correlation coefficients among latent factors do not contain 1.00 (Hair et al., 2010). Concurrent validity was evaluated by computing the Spearman correlations between the Chinese version PAID-T and self-management as well as the Chinese version PAID-T and HbA1c levels.

Reliability testing. Internal consistency of the Chinese version PAID-T was examined by Cronbach's α . Test-retest reliability of the Chinese version PAID-T was examined by intraclass correlation coefficients (ICC) to 30 samples that were a subset of participants at a 2-week interval. A two-way mixed-effects model, absolute agreement definition, and type of a mean of multiple raters were used to calculate ICC values and the corresponding 95% confidence intervals (McGraw & Wong, 1996). ICC values higher than 0.75 indicate good reliability (Portney & Watkins, 2015).

Table 1
Distribution of demographic characteristics and correlations between demographic characteristics and diabetes distress ($N = 203$).

Participant Characteristics	n (%)	Mean	SD	r/ t/ F	P-value
Age (years)				$r = 0.08$	0.25
Range: 10.0–18.9		15.04	2.42		
Gender				$t = -1.33$	0.19
Male	99 (48.80)				
Female	104 (51.20)				
Diabetes duration (years)				$r = -0.08$	0.25
Range: 0.5–14.8		5.19	3.09		
Family type				$F = 0.38$	0.68
Nuclear family	108 (53.20)				
Extended family	63 (31.00)				
Single-parent family	32 (15.80)				
Socioeconomic status				$F = 1.88$	0.16
High	62 (30.50)				
Middle	53 (26.20)				
Low	88 (43.30)				

Note. $r = r$ -value in the Spearman correlation; $t = t$ -value in the independent t -test; $F = F$ -value in the analysis of variance (ANOVA).

* $P < .05$. ** $P < .01$. *** $P < .001$.

Results

Distributions of demographic characteristics and the relationships between demographic characteristics and diabetes distress

Table 1 demonstrates the distributions of demographic characteristics and the correlations with DD of participants. As demonstrated, age, gender, diabetes duration, family type, and socioeconomic status were not significantly correlated with DD.

Content validity, exploratory factor analysis, and corrected item-total correlations

Two items with I-CVIs <0.78 among 26 items of a Chinese version PAID-T were eliminated to be a 24-item Chinese version PAID-T. After EFAs on a 24-item Chinese version PAID-T was conducted, six items <0.45 were removed and 18 items were retained. A retained 18-item

Chinese version PAID-T identified three factors with eigenvalues higher than one, which explained 55.76% of the variance in the 18 items. These three factors were individually named the “emotional burden” (7 items), the “regimen-specific distress” (6 items), and the “interpersonal distress” (5 items). The emotional burden is the burden of negative emotions caused by diabetes-related problems; the regimen-specific distress stems from complex diabetes regimen; and the interpersonal distress comes from intrusiveness and over-watchfulness from parents, family or friends to diabetes-specific challenges.

Corrected item-total correlations were conducted, after an 18-item Chinese version PAID-T identified a three-factor structure. Each item in a three-factor 18-item Chinese version PAID-T ranged from 0.43 to 0.77, which satisfied the suggestion of Ferketich (1991), and thus all 18 items were retained. Finally, the Chinese version PAID-T, consisting of three factors and 18 items, was yielded. The process of developing the structure of the Chinese version PAID-T is summarized in Fig. 1. The means, standard deviations, factor loadings in EFA, and corrected

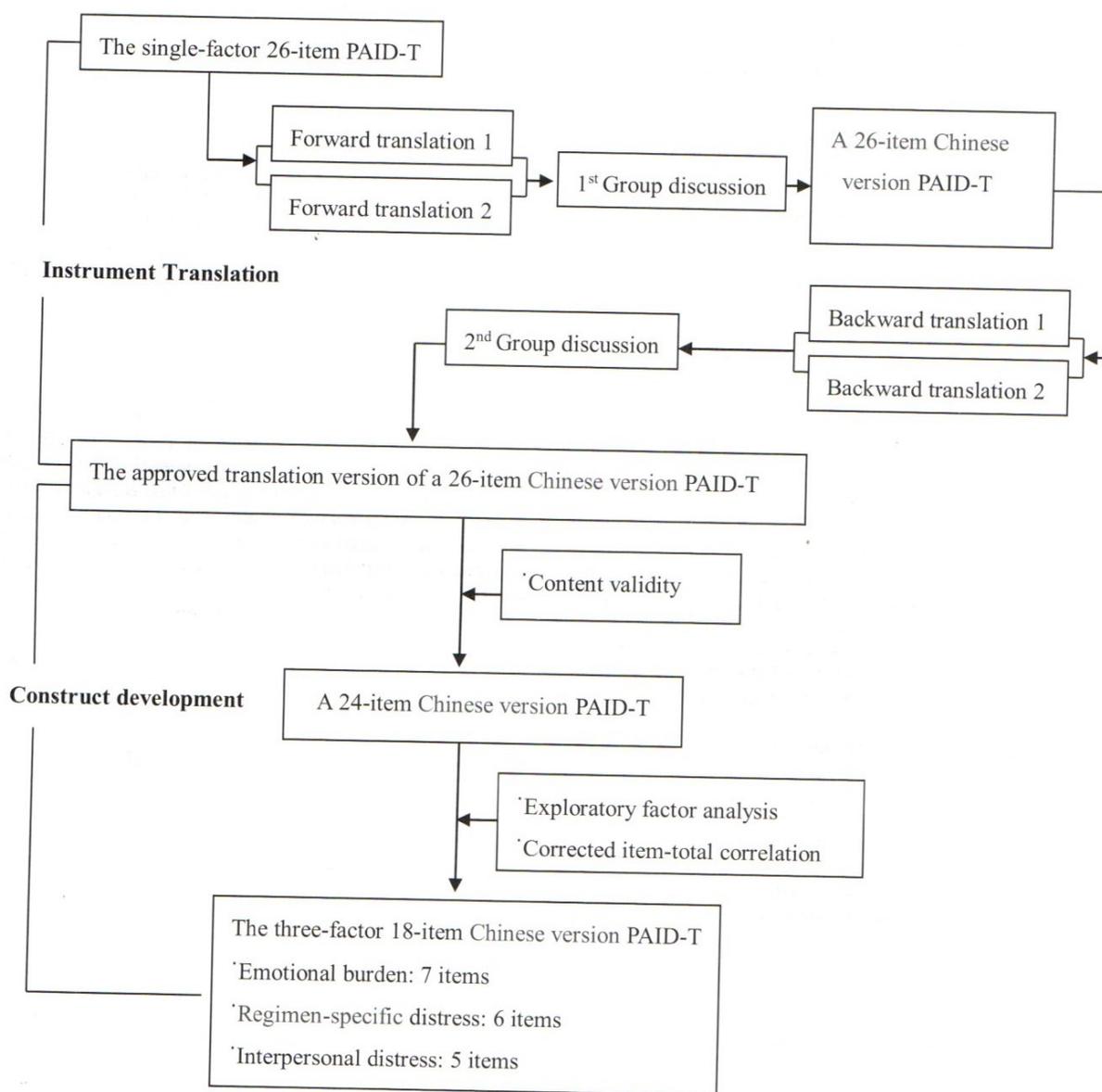


Fig. 1. The process of developing the structure of the three-factor 18-item Chinese version Problem Areas in Diabetes-Teen. Note. PAID-T= Problem Areas in Diabetes-Teen.

Table 2

Means, standard deviations, factor loadings in exploratory factor analysis, and corrected item-total correlation of each item within the Chinese version Problem Areas in Diabetes-Teen.

Subscale item	Mean (SD)	Factor loading	Corrected item-total correlation
Emotional burden	2.15 (0.91)		
1. Feeling sad when I think about having and living with diabetes.	2.16 (1.15)	0.82	0.74
2. Not knowing if the mood or feelings I am having are related to my blood sugar levels.	2.00 (1.09)	0.64	0.56
3. Feeling overwhelmed by my diabetes regimen.	1.75 (1.02)	0.82	0.72
4. Worrying about the future and the possibility of serious complications.	2.61 (1.40)	0.55	0.56
5. Feeling upset when my diabetes management is "off track".	2.45 (1.27)	0.75	0.70
6. Feeling "burned-out" by the constant effort to manage diabetes.	2.10 (1.29)	0.81	0.73
7. Worrying that diabetes gets in the way of having fun and being with my friends.	2.00 (1.44)	0.46	0.43
Regimen-specific distress	1.98 (1.01)		
8. Feeling unclear about exactly what or how much I should be doing to take care of my diabetes properly.	1.75 (1.11)	0.78	0.74
9. Not feeling motivated to keep up with my daily diabetes tasks.	1.84 (1.23)	0.78	0.74
10. Feeling I must be perfect in my diabetes management.	1.89 (1.26)	0.78	0.74
11. Missing or skipping blood sugar checks.	2.18 (1.39)	0.56	0.51
12. Feeling that I am often failing with my diabetes regimen.	1.89 (1.21)	0.81	0.74
13. Feeling that I can't control my eating.	2.30 (1.39)	0.82	0.77
Interpersonal distress	2.27 (1.15)		
14. Feeling that my friends or family act like "diabetes police".	2.54 (1.49)	0.79	0.69
15. Feeling like my parents don't trust me to care for my diabetes.	2.20 (1.45)	0.85	0.75
16. Feeling like my parents blame me for blood sugar numbers they don't like.	2.03 (1.40)	0.72	0.68
17. Feeling that my friends or family don't understand how difficult living with diabetes can be.	2.09 (1.40)	0.65	0.59
18. Feeling like my parents worry about complications too much.	2.47 (1.55)	0.64	0.58

item-total correlations of the Chinese version PAID-T are illustrated in Table 2.

Confirmatory factor analysis and concurrent validity

The WLSMV CFA was conducted with the Chinese version PAID-T. The fit indices of the first-order version were: $\chi^2/df = 2.287$, CFI = 0.969, TLI = 0.964, SRMR = 0.061, and RMSEA = 0.079 (90% confidence interval = 0.068–0.092), fitting the data well. A second-order factor analysis could be conducted when the values of the correlation coefficient between the first-order factors were above 0.50 (Brown, 2015). The correlation coefficients among the three factors in the first-order version ranged from 0.70 to 0.78 (Table 3), so the hypothesized second-order version underlying the three inter-correlated first-order factors was thus conducted and evaluated. This second-order version was equally good-fitting as the first-order one, because a three-factor second-order model will produce the same goodness of fit as a first-order model (Brown, 2015). The standardized factor loadings of each item on its corresponding first-order factor and each first-order factor on its second-order factor were statistically significant and higher than 0.50 (Fig. 2). The values of CR and AVE were higher than 0.70 and 0.50 respectively (Table 4). The second-order factor DD explained 71.5%, 84.3%, and 68.1% of the variance for the first-order factors of emotional burden, regimen-specific distress, and interpersonal distress respectively.

The mean and range of self-management were 1.68 ± 0.54 and 0.09–2.96 respectively. The mean and range of HbA1c levels were $8.34 \pm 1.84\%$ (67.60 ± 20.10 mmol/mol) and 5.40–14.50% (35.52–134.97 mmol/mol) respectively. The correlation coefficients between self-management and the Chinese version PAID-T and its three factors were all significant and ranged from -0.32 to -0.45 ; the Chinese version PAID-T and its three factors were significantly associated with HbA1c levels ranging from 0.18 to 0.33 (Table 4).

Table 3

Correlation coefficients and 95% confidence interval among factors within the first-order Chinese version Problem Areas in Diabetes-Teen.

Factor		Correlation coefficient	95% CI
Emotional burden	↔	0.78	(0.69, 0.87)
Regimen-specific distress	↔	0.76	(0.68, 0.84)
Interpersonal distress	↔	0.70	(0.61, 0.79)

Note. ↔ = correlations between two factors.

Reliability testing

Cronbach's α and test-retest reliability for the Chinese version PAID-T and its three factors are listed in Table 4. For Cronbach's α , the Chinese version PAID-T and its three factors were in the range of 0.85 to 0.93. For test-retest reliability using ICCs, the Chinese version PAID-T and its three factors were in the range of 0.89 to 0.94. The 95% confidence intervals of all of the ICCs ranged from 0.76 to 0.97.

Discussion

The results demonstrated the Chinese version PAID-T with good translation quality was a reliable and valid scale to screen and assess DD for Chinese-speaking adolescents with T1D. Translation of scales requires good translation techniques and evaluation of applicability to the population of the target culture (Sousa & Rojjanasrirat, 2011). In this study, the well-established guidelines based on Sousa and Rojjanasrirat (2011) for cross-cultural research were adopted, and well-qualified translators were chosen to support the translation quality of a Chinese version PAID-T.

Content validity, EFA, and corrected item-total correlations in turn were used to delete eight redundant items and also ensure the quality and appropriateness of the items to finally yield the 18-item Chinese version PAID-T. Both the 18-item Chinese version PAID-T developed for Taiwanese adolescents and the 14-item PAID-T developed for American adolescents (Shapiro et al., 2018) were derived from shortening the 26-item PAID-T. However, some items differed between them except for 12 items. The difference in items might be due to cross-cultural differences; for example, in Chinese culture, people are more accustomed to suppressing stronger negative emotions such as anger, to maintain interpersonal harmony (Fan & Wang, 2019) so the item "Feeling angry when I think about having and living with diabetes" was discarded in the 18-item Chinese version PAID-T but

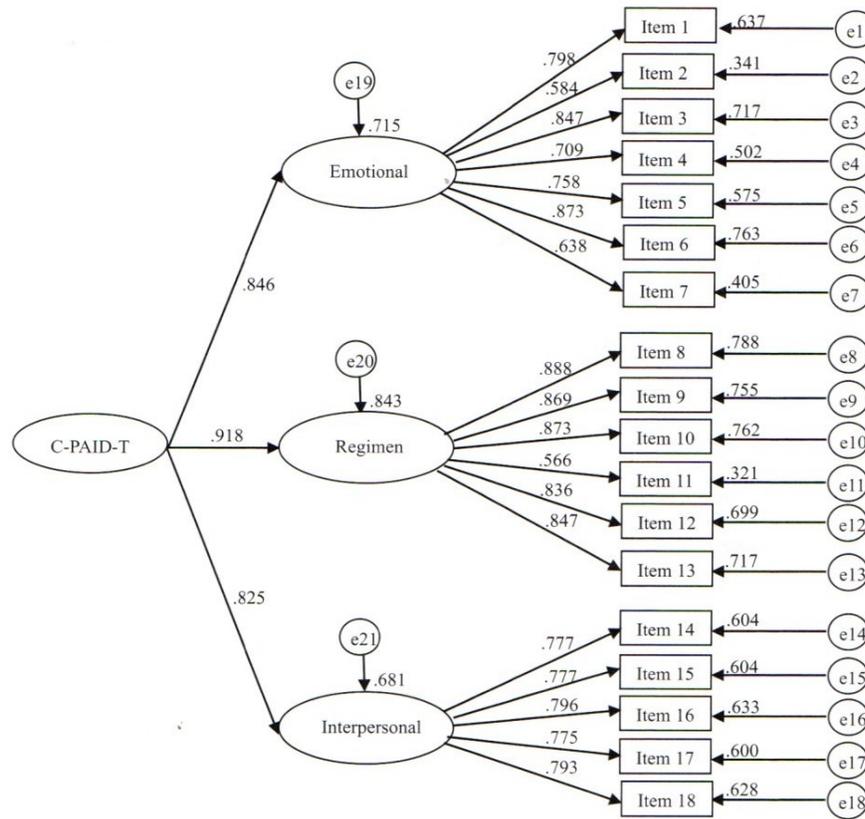


Fig. 2. Three second-order structures of the Chinese version Problem Areas in Diabetes-Teen. Note. C-PAID-T = Chinese version Problem Areas in Diabetes-Teen; Emotional = emotional burden; Regimen = regimen-specific distress; Interpersonal = interpersonal distress. The parameters are standardized estimates.

was remained in the 14-item PAID-T; also, eating is an important event for Chinese people (Fan & Wang, 2019) so the item “Feeling that I can’t control my eating” was remained in the 18-item Chinese version PAID-T but was discarded in the 14-item PAID-T. The 18-item Chinese version PAID-T might be more concise than the 26-item PAID-T and more suitable for adolescents with T1D residing in Chinese culture than the 14-item PAID-T, but additional testing is necessary to validate this hypothesis. The three factors of the Chinese version PAID-T explored by EFA, consisting of emotional burden, regimen-specific distress, and interpersonal distress echoed the research on multidimensional facets of negative emotional responses to the specific challenges related to T1D (King et al., 2017; Snoek et al., 2015).

CFA confirmed the second-order structure of the Chinese version PAID-T with the three factors explored by EFA. The standardized factor loadings of each item on its corresponding first-order factor higher than 0.50, CR higher than 0.70, and AVE higher than 0.50 achieved all

required levels of the convergent validity (Hair et al., 2010). These results indicated each item of the Chinese version PAID-T was a valid indicator on its corresponding first-order factor. The 95% confidence interval of the correlation coefficients among the three factors of the Chinese version PAID-T did not contain 1.00 (Table 3), satisfying the level of the adequate discriminant validity (Hair et al., 2010). The evidence indicated that each factor in the Chinese version PAID-T could individually display specific subdomains of DD to help identify specific sources of DD. The standardized factor loadings of each first-order factor, ranging from 0.825 to 0.918, loaded strongly on the second-order factor DD. The second-order factor DD explained 68.51%–84.3% of the variance in the three first-order factors, indicating the contribution of DD on its three factors was good (Hair et al., 2010). The configurable invariance of the Chinese version PAID-T was thus supported, and the data supported construct validity. These results also reflected the conceptual nature of DD as an overarching structure with multidimensional facets (Polonsky et al., 2005; Shapiro et al., 2018). In short, the

Table 4
Reliabilities and correlations with self-management and glycosylated hemoglobin levels for the Chinese version Problem Areas in Diabetes-Teen.

	CR	AVE	Self-management	HbA1c	Cronbach’s α	ICC (95% CI)
C-PAID-T			–0.45***	0.28***	0.93	0.92 (0.83, 0.96)
EB	0.90	0.56	–0.32***	0.18*	0.86	0.94 (0.87, 0.97)
RSD	0.92	0.67	–0.44***	0.33***	0.89	0.92 (0.82, 0.96)
ID	0.89	0.61	–0.40***	0.25***	0.85	0.89 (0.76, 0.95)

Note. C-PAID-T = Chinese version Problem Areas in Diabetes-Teen; EB = emotional burden; RSD = regimen-specific distress; ID = interpersonal distress; CR = construct reliability; AVE = average variance extracted; HbA1c = glycosylated hemoglobin; ICC = intraclass correlation coefficients.

*P < .05. **P < .01. ***P < .001.

three second-order factor of the Chinese PAID-T was well supported by both theoretical and empirical considerations.

The Chinese version PAID-T and each factor exhibited satisfactory concurrent validity and reliability. As expected, the relationships between the Chinese version PAID-T and its three factors were all significantly correlated with self-management and HbA1c levels, with correlation coefficients ranging from -0.32 to -0.45 and 0.18 to 0.33 respectively. The results were supported by the findings of the narrative review on 25 years of DD research that had found small-moderate effect sizes when correlating DD with self-management and HbA1c levels (Skinner et al., 2020). The small-moderate effect sizes might be caused by the interaction among DD, self-management, and HbA1c levels, but this has not yet been confirmed (Skinner et al., 2020). The Chinese version PAID-T could be used to clarify the mechanism of DD, self-management, and HbA1c levels in further studies. Cronbach's α of the Chinese version PAID-T and its three factors ranged from 0.85 to 0.93 , revealing they had good internal consistency (Tavakol & Dennick, 2011), while the ICCs of the Chinese version PAID-T and its three factors were higher than 0.70 , indicating they were stable (Portney & Watkins, 2015).

The mean scores of the Chinese version PAID-T and its three factors were close, ranging from 1.75 to 2.54 , and these results were consistent with the findings of a systematic review indicating adolescents reported a low level of DD (Hagger et al., 2016). Studies have demonstrated even at low levels that DD still played an important role in health outcomes for adolescents with T1D (Hagger et al., 2016; Skinner et al., 2020). Additionally, low level DD was more easily improved through intervention than high level DD (Iturralde et al., 2019). Therefore, it is important to screen and assess DD in identifying it at low levels earlier so that DD can be addressed in a more timely manner to improve health outcomes.

Practice implications

The 18-item Chinese version PAID-T is a concise and convenient scale that can help nurses and researchers more easily assess or track DD in Chinese-speaking adolescents with T1D in clinical settings. Nurses could use it to identify, monitor, and track DD and tailor interventions for adolescents with T1D. The Chinese version PAID-T could also facilitate the conducting of research on DD for Chinese-speaking adolescents with T1D. Researchers could use it to understand the incidence and severity of DD in Chinese-speaking adolescents with T1D and explore the influencing factors and their relationships to establish risk factors and protective factors for DD in such adolescents. These research results could expand the DD-related literature and enhance a more complete nursing knowledge system for adolescents with T1D.

Limitations

A limitation of this study is that findings might not generalize to populations of other geographical regions because the adolescents in this study were sourced from four hospitals in central and southern Taiwan. Future studies are warranted to test the Chinese version PAID-T for adolescents with T1D living in other areas, such as district hospitals and countries. In addition, conducting CFA on the same dataset as EFA might lead to danger of overfitting (Fokkema & Greiff, 2017). Hence, this version requires analysis of diverse groups of adolescents with T1D to examine and confirm measurement invariance.

Conclusions

The results supported the reliability and validity of the Chinese version PAID-T. It is a validated and ease-to-use scale that can screen and assess adolescents with T1D in a more timely manner to prevent or improve DD. Also, it could help researchers further understand the impact of DD on the health outcomes in adolescents with T1D. The distinct

subscales of the Chinese version PAID-T could evaluate specific domains of DD and aid nurses in identifying specific sources of DD to provide future direction in developing interventions for adolescents with T1D.

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None.

Conflicts of interest

The authors declare no conflicts of interest regarding this research.

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