

# Quantitative scale validation of the Dimensional Anhedonia Rating Scale in the treatment of Chinese patients with major depressive disorder

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## ABSTRACT

**Background** The patient-reported Dimensional Anhedonia Rating Scale (DARS) has been adapted into Chinese, so there is a need to evaluate its measurement properties in a Chinese population.

**Aims** To evaluate the reliability and validity of the DARS among Chinese individuals with major depressive disorder (MDD) and its treatment sensitivity in a prospective clinical study.

**Methods** Data were from a multicentre, prospective clinical study (NCT03294525), which recruited both patients with MDD, who were followed for 8 weeks, and healthy controls (HCs), assessed at baseline only. The analysis included confirmatory factor analysis, validity and sensitivity to change.

**Results** Patients' mean (standard deviation (SD)) age was 34.8 (11.0) years, with 68.7% being female. 75.2% of patients with MDD had melancholic features, followed by 63.8% with anxious distress. Patients had experienced MDD for a mean (SD) of 9.2 (18) months. DARS scores covered the full range of severity with no major floor or ceiling effects. Confirmatory factor analysis showed adequate fit statistics (comparative fit index 0.976, goodness-of-fit index 0.935 and root mean square error of approximation 0.055). Convergent validity with anhedonia-related measures was confirmed. While the correlation between the DARS and the Hamilton Depression Rating Scale was not strong ( $r=0.31$ , baseline), the DARS was found to differentiate between levels of depression. Greater improvements in DARS scores were seen with the Hamilton Rating Scale for Depression responder group (effect size 1.16) compared with the non-responder group (effect size 0.46).

**Conclusions** This study comprehensively evaluated the measurement properties of the DARS using a Chinese population with MDD. Overall, the Chinese version of DARS demonstrates good psychometric properties and has been found to be responsive to change during antidepressant treatment. The DARS is a suitable scale for assessing patient-reported anhedonia in future clinical trials.

## INTRODUCTION

The current Diagnostic and Statistical Manual of Mental Disorders, fifth edition (DSM-5), designates anhedonia as a major symptom of

## WHAT IS ALREADY KNOWN ON THIS TOPIC

- ⇒ There is much evidence to support anhedonia as a core feature of major depressive disorder (MDD). The Dimensional Anhedonia Rating Scale (DARS) was designed to assess anhedonia in MDD, particularly to increase scale generalisability while maintaining specificity. The DARS has been shown to be reliable and valid in North America and Europe.
- ⇒ There is a need to assess the reliability and validity of the DARS in a Chinese population with MDD as well as treatment sensitivity in a prospective clinical study.

## WHAT DOES THIS STUDY ADD

- ⇒ The DARS demonstrates good psychometric properties and has been found to be responsive to change in a Chinese population with MDD.

## HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE, OR POLICY

- ⇒ The findings show that the DARS is a suitable assessment of anhedonia for clinical trials in Chinese patients.
- ⇒ The DARS is a good tool for measuring anhedonia in the Chinese population with MDD for both clinical practice and research.

depression and a negative symptom of schizophrenia.<sup>1</sup> Historically, anhedonia describes the feeling of decreased capacity to experience pleasure<sup>2,3</sup>; it has recently been defined as being multifaceted to include hedonic functions, such as desire, effort/motivation, anticipation and consummatory pleasure.<sup>4</sup>

The underpinning theory of anhedonia is reward processing. Krings and Barch<sup>5</sup> described the process as initially building a stimulus-reward association, which then leads to interest/desire (wanting a reward), anticipation (state of readiness for a reward), motivation (initial energy expenditure to attain a reward) and effort (sustained energy feedback integration (updating reward

presence and values). There is mounting evidence that different facets of reward processing map onto partially dissociable neural pathways and signalling.<sup>6</sup> The contribution of factors outside the brain, including the endocrine and immune systems, to reward processes is receiving more attention, particularly the gut microbiome, which influences reward circuits throughout life and those related to MDD.<sup>7–10</sup> A more multifaceted and precise definition of anhedonia behaviour would then be critical to capture the complex construct of hedonic function.<sup>4,11</sup>

The greatest challenge in measuring anhedonia is the ability to accurately tap into the subjective nature of what individuals find enjoyable, pleasurable or interesting. The development of the DARS was driven primarily by the need for a self-reported instrument to assess interest, motivation, effort and pleasure to ensure that all facets of anhedonia in patients with MDD were included. The original development and validation of the DARS was performed in three studies: (Study 1) item selection and preliminary internal reliability testing within a sample of community patients; (Study 2) cross-validation of reliability estimates from Study 1 and convergent and discriminant validity assessment in an online study using community patients and (Study 3) reliability and validity testing of the DARS using patients with unipolar and bipolar depression and healthy controls (HCs).<sup>12</sup> These three studies were conducted in North America (Canada), where the DARS was found reliable and valid.<sup>4,13</sup>

The DARS was designed to assess anhedonia in MDD, particularly to increase scale generalisability while maintaining specificity. Compared with the construct of consummatory pleasure of the Snaith-Hamilton Pleasure Scale (SHAPS),<sup>14</sup> DARS is designed to encompass a refined conceptualisation incorporating the current understanding of anhedonia through reward responses. The DARS allows participants to provide their own examples within each domain (hobbies, food/drink, social activities and sensory experience), which further minimises bias from factors such as culture. DARS has been explored in several language versions and cultural populations, such as English,<sup>12</sup> German,<sup>15</sup> Spanish<sup>16</sup> and Chinese.<sup>17,18</sup> It has been reported that ‘the associations of anhedonia and depressed mood with positive emotions and life satisfaction differed across cultural groups, and these symptoms were associated with dampened positive emotions in the Asian American group only’.<sup>19</sup> To assist the development of effective antianhedonic treatment in Asia, it is vital to have a proper scale for assessing anhedonia; thus, understanding the performance of DARS in the Asian population is needed. This work provides evidence from patients with MDD in the Chinese mainland based on the simplified Chinese version of DARS following the MDD treatment trajectory of Chinese outpatients.

## METHODS

In this secondary analysis, data were taken from a multicentre, prospective single-arm, open-label study—Towards Neurobiology-based Diagnosis and Treatment of Affective Disorders project—which recruited outpatients with MDD (who were followed over time) and HCs (only assessed at baseline). The inclusion and exclusion criteria were described previously.<sup>17</sup> The study included an 8-week acute treatment, an 8-week adjunctive treatment and a 16-month follow-up period. Patients were treated with antidepressants following the Guidelines for the Diagnosis and Treatment of Depressive Disorders in China (second edition).<sup>20</sup> For this validation analysis, only data on demographics, symptoms and cognition assessments from patients at baseline and week 8 and the baseline measures of HCs were used. Specifically, the DARS, Positive and Negative Affect Schedule (PANAS), Clinician’s Global Impression-Severity (CGI-S), and Hamilton Rating Scale for Depression (HAMD) data at baseline and week 8 were analysed, including other available data as grouping factors.

### Transparency and openness

We followed the Journal Article Reporting Standards. Data were analysed using SAS statistical software V.9.4 (SAS Institute, Cary, North Carolina, USA) to perform psychometric evaluations. A description of the main assessment instruments used, including the DARS, HAMD, PANAS and CGI-S, as well as the statistical procedures, is detailed in the online supplemental materials.

## RESULTS

### Sample characteristics

Demographic characteristics are presented in [table 1](#) for all patients with MDD who received at least one dose of medication and completed both the baseline (n=533) and the week 8 assessments (n=358, patient attrition due to loss to follow-up, see [figure 1](#)). At baseline, patients’ mean age was 34.8 years, with an average body mass index (BMI) of 22.2. The majority of the sample was female (68.7%); 59.3% were married, and 65.5% were employed full-time. Demographics for the HCs (n=123) are also included in [table 1](#). HCs were younger, had a higher percentage of males and were more educated, with a higher percentage having full-time employment than patients with MDD. All patients reported one (72.0%) or two (28.0%) MDD episodes.

### Descriptive summary of the DARS

Descriptive statistics for the DARS total, domain and facet scores are presented in [table 2](#). The number of patients who completed the DARS scale assessment at the end of the eighth week of treatment was 341 ([figure 1](#)). In general, higher DARS total scores, domain scores and facet scores were observed in week 8 compared with baseline, suggesting improvements in anhedonia. Higher scores for the DARS reflect less anhedonia.

**Table 1** Demographic characteristics and psychiatric history at baseline and week 8

	Patients with MDD at baseline (n=533)	Patients with MDD at week 8 (n=358)*	HCs at baseline (n=123)
Age (years), mean (SD)	34.8 (11.0)	35.2 (10.9)	31.2 (8.8)
Gender (% female)	68.7%	69.3%	61.8%
BMI, mean (SD)	22.2 (3.3)	22.2 (3.2)	22.8 (3.6)
Education (% college or above)	56.8%	57.0%	78.1%
Employment (% employed full-time)	65.5%	67.6%	89.4%
Marriage (% married)	59.3%	61.7%	50.4%
Number of MDD episodes (%)			
Single episode	72.0%	72.9%	NA
Two episodes	28.0%	27.1%	NA
Duration of the current episode (months), mean (SD)	7.2 (15.9), n=122	8.2 (18.6), n=78	NA
Total disease duration (months), mean (SD)	9.2 (18.0), n=155	9.6 (18.8), n=102	NA

\*The number of patients with MDD with at least one assessment among CGI-S, HAMD and DARS at week 8.

BMI, body mass index; CGI-S, Clinician's Global Impression-Severity; DARS, Dimensional Anhedonia Rating Scale; HAMD, Hamilton Rating Scale for Depression; HCs, healthy controls; MDD, major depressive disorder; SD, standard deviation.

At baseline, patients responding with the highest possible score (ie, no anhedonia) for the total, domain and facet scores ranged from 3.9% (hobbies) to 0.4% (total score). The proportion of ceiling effects was similar in week 8 compared with baseline, but floor effects (greatest anhedonia) decreased from baseline to week 8, with the social activities domain having the largest decrease (12.6% at baseline to 0.3% at week 8). The HCs, as expected, had large ceiling effects on the DARS.

For most individual items, baseline responses among patients with MDD were predominantly at the low end of the response scale and moved to the higher end of the scale at week 8 (data not shown). Some exceptions include item 11, Social—Motivation, which had a high response of 'Not at all' and 'Slightly' at baseline (71.5%). The largest floor effect at baseline was item 11, Social—Motivation (36.4%), and the largest ceiling effect at week 8 was item 6, Foods/Drinks—Enjoy (21.6%).

### Confirmatory factor analysis (CFA)

Results from the CFA of the DARS domains showed adequate fit statistics. The comparative fit index (CFI) was 0.976, and the goodness of fit (GFI) index was 0.935, both over the optimal threshold of 0.90. The root mean square error of approximation was 0.055, which was in the acceptable range of 0.05 and 0.08. Additionally, the  $\chi^2/\text{df}$  was 2.6265. These fit indices provide strong evidence that the study data fit the measurement model for the domains identified from the original development of the DARS (note that the DARS facets were not tested).

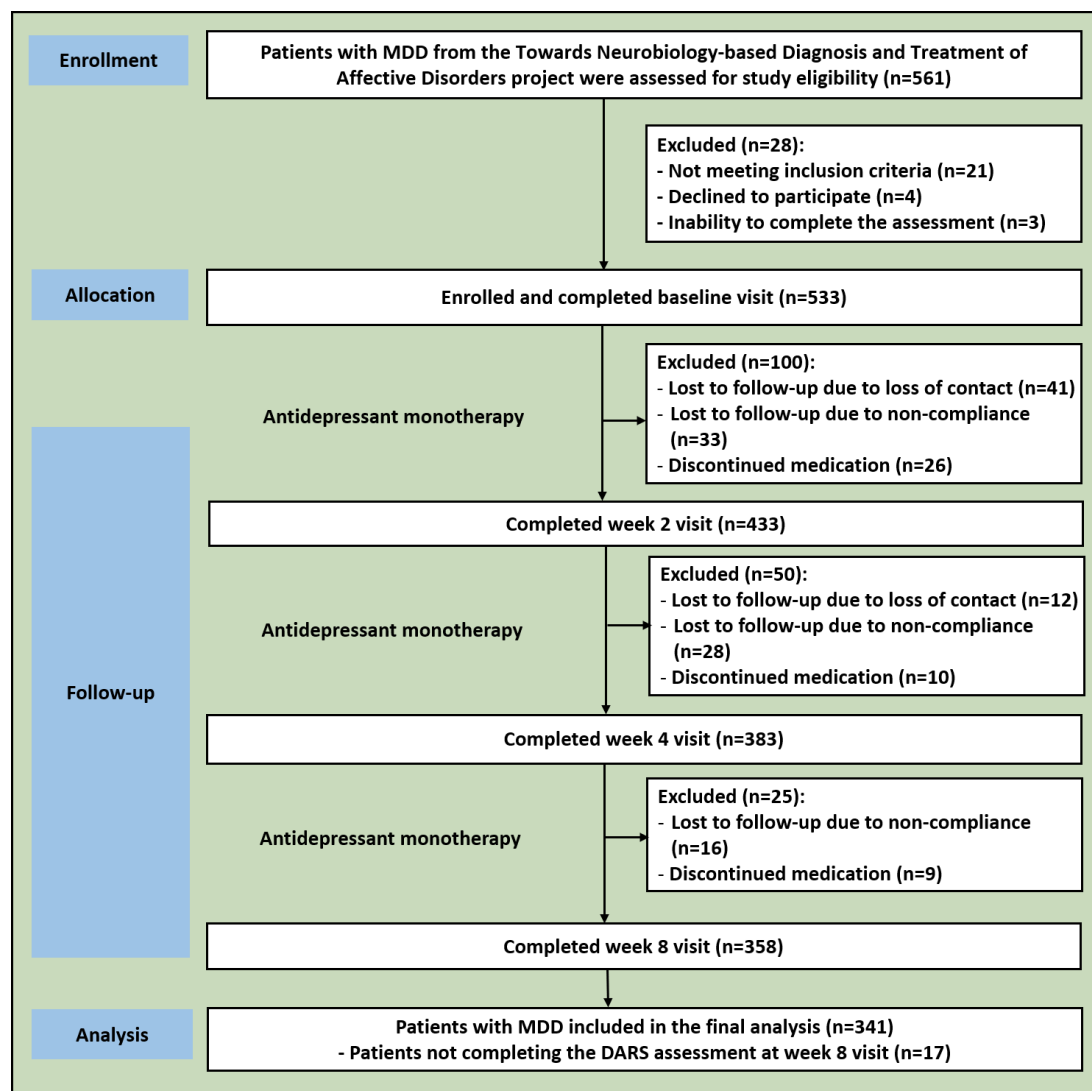
### Psychometric evaluation of the DARS

#### Internal consistency reliability

Internal consistency reliability of the DARS was examined at baseline and week 8 to assess the consistency of multiple items that measure the same concept using Cronbach's alpha coefficients. All alpha values were higher than 0.70 (range: 0.72–0.95), indicating good-to-excellent internal consistency reliability of the DARS in the analysis population (see online supplemental table 1). Alpha coefficients were similar between baseline and week 8. The motivation facet had the lowest alpha coefficient at 0.72 for both baseline and week 8; however, it is high enough to demonstrate that the set of items that make up this facet is still fit for purpose and provides good internal consistency and reliability.

#### Convergent and divergent validity

To assess cross-sectional construct validity, the relationship between DARS and selected items and/or domains of the HAMD, PANAS and CGI-S measures was examined at baseline and week 8, with results in online supplemental table 2. Relationships between the DARS and the PANAS positive domain and items 1 (interested), 3 (excited) and 9 (enthusiastic) were all as predicted (at least moderate with correlations between 0.25 and 0.49). As we had predicted, the relationship between the DARS and the PANAS negative domain was weaker. All associations between the DARS and the HAMD were as predicted (total score and domains), except for the HAMD item 7 (work and activities) at baseline, which had weaker correlations than were expected (<0.20); the week



**Figure 1** Flowchart for the enrolment and follow-up (8 weeks) of subjects with MDD. MDD, major depressive disorder; DARS, Dimensional Anhedonia Rating Scale.

8 post-treatment associations between the DARS and the HAMD met predictions. Finally, though moderate correlations between DARS and CGI-S were predicted, weak associations were found.

#### Known-groups validity

There was a significant baseline difference (analysis of variance (ANOVA), unadjusted) between the mild, moderate and severe groups, with anhedonia increasing as depression became more severe (DARS total  $F=12.11$ ,  $p<0.001$ ). The F-value increased when adjusted for age ( $F=13.93$ ,  $p<0.001$ ). Pairwise significance was seen between the mild and severe depression groups and the moderate and severe depression groups (figure 2A).

There were marked improvements at week 8 in all HAMD groups, with a large shift to 'No Depression' (n=239) (figure 2B). Again, anhedonia (DARS total score) increased as depression became more severe, with significant week 8 differences (ANOVA, unadjusted): DARS total score ( $F=10.05$ ,  $p<0.001$ ). No differences

were seen when adjusting for age and sex, but there was pairwise significance seen between the 'no depression' group and the 'mild depression' group ( $p<0.01$ ), the 'no depression' group and the 'moderate depression' group ( $p<0.001$ ) and the 'no depression' group and the 'severe depression' group ( $p<0.001$ ) (figure 2B).

For all DARS domains (data not shown), there was also a significant change from baseline (ANOVA, unadjusted). F values increased when adjusting for age. Pairwise significance was seen between mild-to-severe and moderate-to-severe depression. Again, large improvements were seen in week 8. Anhedonia increases as depression becomes more severe. The DARS Social Activities domain scores are similar for both the moderate and severe groups.

Because the correlation between the DARS and CGI-S was below 0.30, the CGI-S was not analysed as a known group.

Finally, the DARS total score, domain and facet scores were compared between patients with MDD and HCs (see



**Table 2** Descriptive statistics of the DARS scores at baseline and week 8

Baseline scores of patients with MDD							
	n	Mean (SD)	Median	Range	Floor*, n (%)	Ceiling†, n (%)	Missing‡, n (%)
Total score	533	27.7 (14.3)	27	0–68	8 (1.5%)	2 (0.4%)	0 (0.0%)
Domain—hobbies	533	6.8 (4.2)	6	0–16	42 (7.9%)	21 (3.9%)	0 (0.0%)
Domain—social activities	533	5.5 (3.9)	5	0–16	67 (12.6%)	10 (1.9%)	0 (0.0%)
Domain—food/drink	533	6.9 (3.8)	7	0–16	27 (5.1%)	9 (1.7%)	0 (0.0%)
Domain—sensory experience	533	8.6 (5.1)	8	0–20	31 (5.8%)	9 (1.7%)	0 (0.0%)
Facet—desire	533	10.2 (5.3)	10	0–24	13 (2.4%)	4 (0.8%)	0 (0.0%)
Facet—motivation	533	4.4 (2.6)	4	0–12	24 (4.5%)	5 (0.9%)	0 (0.0%)
Facet—effort	533	6.0 (3.4)	6	0–16	20 (3.8%)	3 (0.6%)	0 (0.0%)
Facet—consummatory pleasure	533	7.1 (3.6)	7	0–16	14 (2.6%)	6 (1.1%)	0 (0.0%)
Week 8 scores of patients with MDD							
	n	Mean (SD)	Median	Range	Floor*, n (%)	Ceiling†, n (%)	Missing‡, n (%)
Total score	341	41.8 (11.5)	43	8–67	0 (0.0%)	0 (0.0%)	17 (4.7%)
Domain—hobbies	341	10.1 (3.2)	11	0–16	3 (0.8%)	14 (3.9%)	17 (4.7%)
Domain—social activities	341	9.3 (3.1)	9	0–16	1 (0.3%)	8 (2.2%)	17 (4.7%)
Domain—food/drink	341	9.9 (3.0)	10	0–16	1 (0.3%)	8 (2.2%)	17 (4.7%)
Domain—sensory experience	341	12.6 (4.0)	13	2–20	0 (0.0%)	13 (3.6%)	17 (4.7%)
Facet—desire	341	15.3 (4.3)	16	3–24	0 (0.0%)	3 (0.8%)	17 (4.7%)
Facet—motivation	341	6.8 (2.1)	7	0–12	1 (0.3%)	4 (1.1%)	17 (4.7%)
Facet—effort	341	9.5 (2.7)	10	1–16	0 (0.0%)	2 (0.6%)	17 (4.7%)
Facet—consummatory pleasure	341	10.2 (3.0)	11	2–16	0 (0.0%)	6 (1.7%)	17 (4.7%)
Baseline scores of HCs							
	n	Mean (SD)	Median	Range	Floor*, n (%)	Ceiling†, n (%)	Missing‡, n (%)
Total score	123	53.1 (12.0)	55	19–68	0 (0.0%)	14 (11.4%)	0 (0.0%)
Domain—hobbies	123	13.3 (3.0)	14	2–16	0 (0.0%)	50 (40.7%)	0 (0.0%)
Domain—social activities	123	12.6 (3.2)	13	4–16	0 (0.0%)	38 (30.9%)	0 (0.0%)
Domain—food/drink	123	11.9 (3.2)	12	4–16	0 (0.0%)	26 (21.1%)	0 (0.0%)
Domain—sensory experience	123	15.3 (4.1)	15	2–20	0 (0.0%)	29 (23.6%)	0 (0.0%)
Facet—desire	123	19.3 (4.2)	20	5–24	0 (0.0%)	24 (19.5%)	0 (0.0%)
Facet—motivation	123	8.6 (2.7)	9	1–12	0 (0.0%)	22 (17.9%)	0 (0.0%)
Facet—effort	123	12.0 (3.0)	12	4–16	0 (0.0%)	19 (15.4%)	0 (0.0%)
Facet—consummatory pleasure	123	13.2 (2.8)	14	4–16	0 (0.0%)	26 (21.1%)	0 (0.0%)

Percentage=the number of patients analysed/the total number of patients remaining at this time point. Higher scores are better (reflective of less anhedonia).

\*Definition of floor effects=the lowest possible score.

†Definition of ceiling effects=the highest possible score.

‡Patients remained at this time point but did not provide DARS scores.

DARS, Dimensional Anhedonia Rating Scale; HCs, healthy controls; MDD, major depressive disorder; SD, standard deviation.

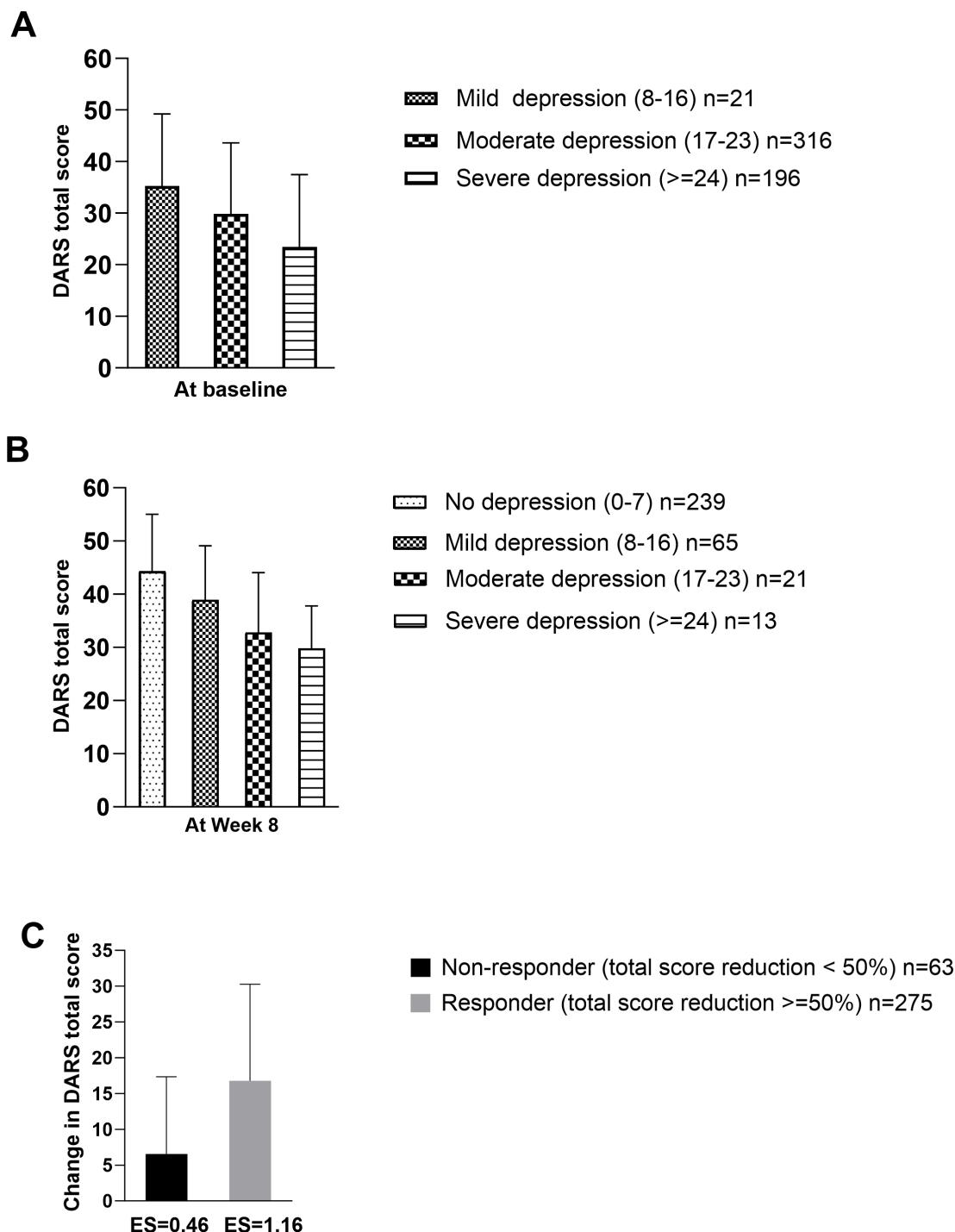
online supplemental table 3). Patients with a clinical diagnosis of MDD both at baseline and after 8 weeks of treatment had significantly greater anhedonia, as reflected in the DARS total score and all domains and facet scores, than the HC group ( $p<0.001$ ) (see online supplemental table 3).

### Sensitivity to change

Numerical improvements between baseline and week 8 were seen for all DARS scores, with the DARS total score changing by 14.8 points (table 3). Domain change scores ranged between 3.1 for food/drink and 4.1 for sensory experience. Facet change scores ranged between 2.5 for motivation and 5.3 for desire. The effect size for the

DARS total score (1.0356) was smaller than the HAMD total score (−3.0585) or CGI-S (−2.8790).

Online supplemental table 4 shows the changes in the DARS total score by depression severity groups defined by the HAMD baseline total score (see online supplemental table 3) for HAMD and CGI-S actual changes. DARS score improvements increased as depression severity increased; in other words, those classified as ‘severe depression’ showed greater improvements in anhedonia from baseline to week 8. Likewise, effect sizes for the DARS total score changes increased as depression severity increased (mild depression 0.75, moderate depression 1 and severe depression 1.20 for DARS total score). The DARS detects



**Figure 2** DARS total score by HAMD (at baseline and week 8) and change in DARS total score by HAMD responder status. (A) DARS total score varies significantly among different levels of depression, defined by the total score of HAMD-17 at baseline (ANCOVA: F value=12.11,  $p<0.001$ ). Two of the pairwise comparisons showed significance (mild vs severe: Scheffe's statistic=2.72, adjusted  $p<0.001$ ; moderate vs severe: Scheffe's statistic=0.58, adjusted  $p<0.05$ ). (B) The DARS total score varies significantly among different levels of depression, defined by the total score of HAMD-17 at week 8 (ANCOVA F-value: 10.05,  $p<0.001$ ). Three of the pairwise comparisons showed significance (no depression vs mild: Scheffe's statistic=0.75, adjusted  $p<0.01$ ; no depression vs moderate: Scheffe's statistic: 2.62, adjusted  $p<0.001$ ; no depression vs severe, Scheffe's statistic: 4.12, adjusted  $p<0.001$ ). (C) A significant difference was observed between responders (change of total HAMD-17  $\geq 50\%$ ) and non-responders (change of total HAMD-17  $< 50\%$ ) (ANCOVA: F-value=12.28,  $p<0.001$ ). ANCOVA, analysis of covariance; DARS, Dimensional Anhedonia Rating Scale; ES, effect size (Cohen's  $d$ ); HAMD, Hamilton Rating Scale for Depression.

**Table 3** Change in DARS scores, HAMD total score and CGI-S from baseline to week 8

Measures (range)	Change from baseline to week 8, n mean (SD)	Cohen's <i>d</i>
Total score (0–68)	341 14.8 (13.8)	1.035 6
Domain—Hobbies (0–16)	341 3.6 (4.0)	0.868 2
Domain—social activities (0–16)	341 3.9 (4.2)	1.021 6
Domain—food/drink (0–16)	341 3.1 (3.7)	0.817 7
Domain—sensory experience (0–20)	341 4.1 (5.0)	0.793 6
Facet—desire (0–24)	341 5.3 (5.1)	0.983 9
Facet—motivation (0–12)	341 2.5 (2.6)	1.030 6
Facet—effort (0–16)	341 3.7 (3.5)	1.053 2
Facet—consummatory pleasure (0–16)	341 3.3 (3.5)	0.908 0
HAMD total score (0–54)	353 –15.4 (6.1)	–3.058 5
CGI-S (0–7)	323 –2.4 (1.2)	–2.879 0

Cohen's *d*=(the mean of the score at week 8–the mean of the score at baseline)/the SD of the score at the baseline. *n* for Cohen's *d* is the same as the *n* for change from baseline to week 8.  
CGI-S, Clinician's Global Impression-Severity; DARS, Dimensional Anhedonia Rating Scale; HAMD, Hamilton Rating Scale for Depression; SD, standard deviation.

a greater change in those with more severe depression, for there is more room for improvement.

The changes in the DARS total score by responder status based on the HAMD (non-responder: total score reduction <50% vs responder: ≥50%) are shown in figure 2C. Improvements in DARS scores were significantly greater in the HAMD responder group compared with the non-responder group (effect size for the responder group: 1.16, non-responder group: 0.46,  $p<0.001$ ). DARS domain scores were sensitive to change defined by HAMD responder status (all domains  $p<0.001$ ). Effect sizes for the HAMD responder group were hobbies (1), social activities (1.15), food/drink (0.93) and sensory experience (0.87). The largest effect size for the non-responder group was 0.48 (social activities); the others were smaller. DARS facet scores are sensitive to change as defined by HAMD responder status (all facets  $p<0.001$ ). Effect sizes for the HAMD responder group were desire (1.12), motivation (1.15), effort (1.18) and consummatory pleasure (1.02). The largest effect size for the non-responder group was <0.53 (motivation); the others were smaller.

Finally, the correlation between the change in the DARS total score and the changes in the HAMD total score and CGI-S score (baseline to week 8) were –0.34 and –0.30, respectively. These moderate correlations support the position that anhedonia measures a different construct from depression.

## DISCUSSION

### Main findings

The DARS was developed to capture patient-reported information relevant to the measurement of anhedonia. Using a momentary assessment at specified time points, the DARS allows the assessment of change in anhedonia over time in a comprehensive, consistent and structured way. When completing the DARS, information for individual ratings is obtained from a patient's self-report. The primary outcomes for the DARS are a total score and four domains: hobbies, social activities, food/drink and sensory experience. Four facets—desire, motivation, effort and consummatory pleasure—are also scorable, although data suggests this scoring is less robust.

This psychometric study further evaluated the measurement properties of DARS by using the data collected in a Chinese clinical trial to enhance the knowledge of DARS performance in a Chinese population. This analysis focused on the baseline and week 8 assessments and included an HC group (baseline only) for comparison purposes.

Overall, the DARS total and item scores provided adequate anhedonia measurement across two time points. Floor effects from patients with MDD reporting the greatest anhedonia decreased from baseline to week 8, with the social activities domain having the largest decrease (12.6% at baseline to 0.3% at week 8). Meanwhile, the ceiling effects of patients with MDD at week 8 did not show a notable increase compared with their baseline (the largest ceiling from the hobbies domain was 3.9%). No major floor or ceiling effects were evident on patient data, indicating an adequate range to accommodate this study's standard of care-induced change. The big difference between the ceilings of patients with MDD at week 8 and HC shows an additional range to measure possible further treatment improvement. These DARS item results provide initial evidence of sensitivity to change with decreases in floor effects.

Results from the confirmatory factor analysis showed adequate fit statistics. These fit indices indicate that the study data fit the original measurement model reflecting the four domains (hobbies, social activities, food/drink and sensory experience) developed in the DARS.

Internal consistency reliability of the DARS was examined at baseline and week 8 using Cronbach's alpha coefficients. All alpha values exceeded 0.70 (range: 0.72–0.95), indicating good-to-excellent internal consistency reliability of the DARS in the analysis population. It is noted that the alpha values for the facets are lower than that of the total and domains, most likely because the facets measure more distal feelings (desire, motivation, effort and consummatory pleasure) across the domains of hobbies, social activities, food/drink and sensory experiences; they are less distinct with an overlap in desire, motivation, effort and pleasure.

As expected, the DARS was strongly correlated with positive affect (PANAS). Weaker associations were found with HAMD and CGI-S. This is not surprising, noting the

conceptual differences between anhedonia (as measured by DARS) and general depression (as measured by HAMD and CGI-S). Furthermore, there typically is a weak association between patient-reported outcomes and clinician assessment. Weaker than expected associations were also found with the HAMD item 7 (work and activities), possibly due to the relatively younger age and earlier stage of the illness. The DARS was found to differentiate between levels of depression as measured by the HAMD: anhedonia increases as depression becomes more severe.

In comparing the Chinese version of DARS assessed in Chinese patients with MDD to the original English version assessed in English-speaking patients with the same illness in Canada (84.6% Caucasian, no Asians), total score means were similar ( $27.7 \pm 14.3$  vs  $30.2 \pm 16.9$ , respectively) as was the internal consistency (Cronbach's alpha) (0.95 vs 0.96, respectively).<sup>12</sup> Validity comparisons cannot be made as different construct measures and known-groups variables were used in each study. English validation studies used anhedonia-related scales, while the Chinese study included depression/anxiety scales.

The DARS was sensitive to changes within this treatment trial. There were numerical improvements between baseline and week 8 for all DARS scores. Change in DARS scores also varied among HAMD-defined depression severity levels, as well as between HAMD responder status, with larger effect sizes in patients with more severe MDD and responders to antidepressants.

### Limitations

There are several limitations to this study. The data were from an observational (real-world), open-label, single-arm study investigating standard-of-care treatments, not a controlled trial. No anchor variable directly related to anhedonia, such as behavioural measures or neuroimaging data, was available. While applicable for referential evidence, HAMD and PANAS do not precisely measure anhedonia-related concepts. Other anhedonia assessment tools, such as the SHAPS, were not included in the study, so comparisons between the DARS and other assessment tools could not be made. Due to the nature of the study, this study enrolled patients who were younger, early in their illness and had higher educational levels. Also, the sociodemographic features were not considered and balanced. Caution should be taken when comparing the effect size observed with other study designs or populations with depression. Future research should expand the study population to include people of different ages, stages of illness and educational backgrounds to generalise the results to all individuals with MDD.

### Implications

This study evaluated the measurement properties of the DARS using a Chinese population with MDD in a real-world setting. Overall, the DARS demonstrates good psychometric properties and has been found to be responsive to change. The results support the construct validity and responsiveness to change in the DARS scores.

The DARS is a suitable patient-reported assessment of anhedonia for clinical trials.

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