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Cross-cultural adaptation and validation of an Arabic version of the Cognitive-Affective Mindfulness Scale (CAMS-R)

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ABSTRACT

No Arabic version of the Revised Cognitive-Affective Mindfulness Scale (CAMS-R) was found, prompting this study's threefold objectives: first, to validate an Arabic translation of CAMS-R among Tunisian students; second, to assess its factor structure and reliability; and third, to explore its validity by investigating the relationship between CAMS-R scores, grit, and academic success. Cross-sectional online data were collected from 705 university physical education students (mean age 21.62 ± 1.38 years) in two distinct time periods, with participants divided into exploratory and confirmatory samples. The 12-item CAMS-R scale underwent both exploratory factor analysis and confirmatory factor analysis (CFA), confirming a second-order structure (χ^2 (53) = 77.997, $p = 0.014$; χ^2/df = 1.47; Comparative fit index (CFI) = 0.995; CFI = 0.994; RMSEA (90% confidence interval [CI] 0–0.013–0.042) = 0.029. Strong internal consistency was indicated by Cronbach α indices ranging from 0.865 to 0.880 for all subscales. Results from ROC curve analysis revealed the Arabic CAMS-R's ability to distinguish effectively between students with low and high-grade point averages (GPA; area under the curve [AUC] = 0.782, CI 95%: 0.726–0.838, $p < 0.001$), confirming its sensitivity. Convergent and discriminant validity were supported by the average variance extracted (AVE) of the four scale factors and adherence to the Fornell and Larcker discriminant validity criterion. Additionally, CAMS-R scores displayed positive associations with GPA and grit scores, establishing the concurrent validity of the scale. In conclusion, these findings collectively suggest that the Arabic version of CAMS-R is a recommended self-report assessment tool for mindfulness in Tunisia and other Arabic countries.

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Introduction

There are increasing concerns for the mental health of university students. Students in tertiary education settings are exposed to numerous academic, personal, social, and environmental stressors. These stressors can be regular inconveniences that arise during the day, which include continuous academic obligations (Rith-Najarian et al., 2019). Specifically, research in physical education suggests that university students experience mental fatigue, sleep disturbance, insomnia, and high levels of stress, as well as other emotional and developmental challenges that may impede their ability to learn and succeed

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(Pascoe et al., 2020). Some students see physical education as stressful due to the social, physical, organisational, and performance-related environmental stressors (Åsebø et al., 2022; Tudor et al., 2019).

In recent years, there has been an increased interest in the practice of mindfulness as one of the methods that may be utilised to both prevent and alleviate the negative effects of stress in academic contexts (Chmielewski et al., 2021; Miller et al., 2019; Hofmann & Gómez, 2017). Moreover, mindfulness-based cognitive behavioural therapies have become an increasingly popular treatment option (Grzybowski & Brinthaupt, 2022). The interest in mindfulness-based approaches has increased among scholars, clinicians, and members of the general public (Bravo et al., 2022). It has been defined as a present-moment attention and awareness with an accepting attitude (Sauer et al., 2013) emphasising the present-oriented attention that is non-judgmental in nature (Raphiphatthana et al., 2019). People who report having lower levels of mindfulness have been found to report higher levels of psychological discomfort and lower levels of psychological health (Vos et al., 2021; Matiz et al., 2020; Pleman et al., 2019).

Both contemporary and historical works on mindfulness define the practice of mindfulness as a method for calming the mind, alleviating pain, and improving quality of life (Al-Ghalib & Salim, 2018; Bazzano et al., 2018; Fajarini et al., 2020; Izgu et al., 2020; Li et al., 2019; McBee, 2003; Salmon et al., 2004). These benefits may be attained *via* regular practice of mindfulness.

The construct of mindfulness can be conceptualised as a state or a trait (Raphiphatthana et al., 2019) and it is predominantly measured by means of self-assessment instruments. Existing trait mindfulness scales primarily assess mindfulness as it occurs outside interpersonal contexts. Early work successfully operationalised the concept through a self-report trait measure of mindfulness. In addition, trait mindfulness appears to be associated with lower levels of negative affective symptoms (Karyadi et al., 2014). Interestingly, self-reports originally designed to assess mindfulness, such as the single-factor Freiburg Mindfulness Inventory (FMI) (Walach et al., 2006), was used to assess mindfulness in people practising meditation. The Kentucky Inventory of Mindfulness Skills (KIMS) (Baer et al., 2004) has a four-factor structure and assesses mindfulness skills. The Mindfulness Questionnaire (MQ) (Chadwick et al., 2005) uses 16 items to measure mindfulness in upsetting situations. The Five-Factor Mindfulness Questionnaire (FFMQ) was created from five other MQs (Baer et al., 2006, 2008). However, the most widely used instruments to assess the construct are the Mindful Attention Awareness Scale (MAAS) (MacKillop & Anderson, 2007) and the Cognitive-Affective Mindfulness Scale (CAMS) (Kumar et al., 2005; Feldman et al., 2005).

MAAS tests awareness using items devoid of specialised, metaphorical, and idiomatic language (Brown & Ryan, 2003). The MAAS covers attentional and awareness features of mindfulness, but not its acceptance and non-judgment components (Chambers et al., 2008; Christopher et al., 2009). In contrast, the CAMS is an 18-item self-report measure with a second-order structure, written in plain language that captures the multi-faceted concept of mindfulness (Feldman et al., 2022). Later, an improved version of the previous scale, known as the Revised Cognitive-Affective Mindfulness Scale, was proposed (CAMS-R) (Feldman et al., 2022). The components capture mindfulness, awareness, and non-judgmental acceptance of present-focused thoughts and emotions. During the revision process, an initial structure of 20 items was tested only using confirmatory factor analysis (CFA). This model included one second-order latent factor (mindfulness) and four first-order latent factors, each represented by specific items. However, this initial model demonstrated a relatively poor fit, as indicated by statistical indices: χ^2 (160) = 388.09, $p < 0.01$, RMSEA = 0.073, SRMR = 0.075 and CFI = 0.85. To refine the model, items were eliminated due to low loadings or redundancy. The final refined model, with fewer items, showed a significantly improved fit (χ^2 (50) = 81.04, $p = 0.004$, RMSEA = 0.050, SRMR = 0.051 and CFI = 0.95) (Feldman et al., 2022).

There is no mention of meditation, which makes the assessment acceptable also for non-meditating populations. Previous studies have shown several cross-cultural adaptations of the instrument, such as Turkish, Chinese (Chan et al., 2016), Italian (Veneziani & Voci, 2015), Portuguese (Teixeira et al., 2017), Indonesian (Sutarto et al., 2022) and Australian (Cayoun et al., 2022). The rationale for adapting the CAMS-R mindfulness instrument is that its theoretical model encompasses comprehensive indicators that can be used for intervention programs in both clinical and general populations.

Moreover, there may be significant cultural variations between Eastern and Western cultures, and these may be reflected in the apparent disparities related to the non-judging aspect of mindfulness. Eastern cultures are typically described as collectivistic (Kashima et al., 1995), which means that the

harmony of the society is prioritised over the goals and values of individuals, whereas Western cultures are typically described as individualistic, meaning that an emphasis is placed on the goals and values of individuals (Raphiphatthana et al., 2019).

Numerous beneficial correlations have been found between mindfulness and grit in previous studies (Raphiphatthana et al., 2019; Christopher et al., 2022; Lee, 2022). The results of one study, Raphiphatthana et al. (2018) showed that the most significant, positive predictors of grit were the mindfulness components of behaving with awareness and non-judgement.

In summary, mindfulness has been shown to be related to positive outcomes, such as lower levels of psychological distress. Mindfulness is instrumental in stress reduction, providing students with tools to manage stress. This reduction in stress can lead to improved mental health, creating a more conducive learning environment (Manocchi, 2017; Lampe & Müller-Hilke, 2021; Caballero et al., 2019). Furthermore, mindfulness fosters better emotional regulation, aiding students in navigating the social and emotional challenges of academic life, and potentially leading to improved academic performance and overall well-being (Sukhsarwala et al., 2015).

The CAMS-R is a promising measure for assessing mindfulness, but to date this measure has not yet been translated and adapted into Arabic, and its psychometric properties in the new language and cultural context need to be examined and reported. Adapting a mindfulness scale to Arabic culture is essential, as this culture embodies a unique blend of communal values and religious beliefs, significantly different from both Eastern and Western perspectives. Arabic culture, with its rich historical context and emphasis on community, spirituality and tradition (Awad et al., 2022), requires a tailored approach to mindfulness that respects and incorporates these cultural nuances.

To best our knowledge, no instrument that can assess mindfulness in Arab countries has been found. It has been argued in other research that physical education constitutes a complex framework characterised by specific demands and a blend of practical and theoretical knowledge (Tannoubi et al., 2022; Chalghaf et al., 2019; Alsalhe et al., 2021). Prior studies have indicated that students in this field encounter adverse conditions akin to those experienced by athletes (Guelmami et al., 2022). Moreover, this framework demands not only physical performance but also a diverse range of psychomotor, emotional and cognitive skills (Sahli et al., 2023). Consequently, it is essential for these students to possess heightened mindfulness. However, there appears to be a lack of studies that have attempted to validate a measurement instrument for this purpose in the Arabic language.

Therefore, the objectives of this study are (1) to validate an Arabic translation of the CAMS-R in a sample of Tunisian students, (2) to test its factor structure and reliability and (3) to explore its validity by examining the link between CAMS-R scores, grit and academic success.

Methods

Data collection

Cross-sectional data from 705 university physical education students were collected by means of an online questionnaire using the Google Forms application, and distributed *via* e-mails. The survey was conducted in two phases within the same academic year, spanning October 3–21 for the first phase and October 31–November 25 for the second phase. These two periods were distinctly separated by a scheduled examination interval.

Students (mean age 21.62 ± 1.38 years) were recruited from the high institute of sports and physical education of Kef. An exploratory sample ($n = 129$; 50.39% females) and a confirmatory sample ($N = 576$; 51.22% females; aged 21.07 ± 1.36 years) were used.

Translation of the CAMS-R

Initially, two English translators who were multilingual native Arabic speakers independently translated the scale into Arabic. Subsequently, a third native speaker of Arabic examined the two translated versions and resolved the differences or made the required adjustments to make a harmonised version

based on the two initial translations. This version of the instrument was back-translated by a scholar who was fluent in both English and Arabic and a native English speaker. Additionally, the translator had not seen nor had any knowledge of the original version. Then, a committee of three bilingual university professors who were native Arabic speakers assessed all translated versions and chose the best suitable one for each item or offered alternative translations. A professional English translator reviewed each of the prior translations, as well as the translators' feedback, and made any required adjustments to enhance the translations. The final Arabic version was then pilot tested on a convenience sample of 26 subjects. Each participant completed the questionnaire and was then asked to explain what he or she believed each item and response signified.

Ethical approval

Ethical approval of this investigation was given by the Ethics Committee of the Higher Institute of Sport and Physical Education of Kef, which is part of the University of Jendouba in Jendouba, Tunisia. Additionally, the project was approved by the Ethics Committee of the University of Jendouba. The ethical principles outlined in the Declaration of Helsinki in 2013 and any subsequent changes to those principles were respected in this research.

Instruments

The Arabic Cognitive and Affective Mindfulness scale-Revised (A-CAMS-R)

The Cognitive and Affective Mindfulness Scale-Revised (CAMS-R) is a 12-item multidimensional measure of mindfulness (Feldman et al., 2022). Items capture present-focused attention, awareness and non-judgmental acceptance of thoughts and emotions without mentioning meditation, making them acceptable for non-meditating populations. The measure has adequate internal consistency, substantial correlations with longer MQs, and is conceptually consistent connections with measures of distress, well-being, emotion regulation and reactivity (Iani et al., 2019; Nyklíček, 2011; Ünlü Kaynakçı & Yerin Güneri, 2023). CAMS-R's clinical value is reinforced by its sensitivity to change following mindfulness-based therapies and training (Greeson et al., 2011). The CAMS-R's shortness and conceptual breadth make it a useful stand-alone measure of dispositional mindfulness for nonclinical and clinical research (Feldman et al., 2022).

The physical education Grit scale (PE-Grit)

The PE-Grit is an Arabic self-report scale consists of 16 items, which measures grit through four context-specific dimensions, each comprising four items: interest in physical activity, interest in academic training, physical activity effort and academic effort (Guelmami et al., 2022; González-Bernal et al., 2022). Internal consistency coefficients for the four PE-Grit dimensions indicate the reliability of the scale. According to these results, the four dimensions of the scale showed good consistency (the McDonald's ω internal consistency indices for the four dimensions vary between 0.83 and 0.86. Moreover, exploratory factor analysis and second-order confirmatory analysis suggest an adequate structure (Chi2/DF = 1.36; CFI and TLI =1; RMSEA = 0.025).

Grade point average (GPA)

The data about participants' GPA were collected through students' self-report statements. Based on the grading system used in the Tunisian higher education, the minimum possible grade is 0 and the maximum is 20. The GPA was categorised into five distinct categories: The first category is below 10. The second category encompasses GPAs between 10 and 11.99. The third range includes GPAs from 12 up to 13.99. In the fourth category, GPAs fall between 14 and 15.99. Finally, the fifth category is reserved for the highest GPAs, which span from 16 all the way to 20.

Sociodemographic questionnaire

Information requested on socio-demographic variables had the age, sex, nationality, country of residence, religion, level of education (1/2/3), residence status (with family/rental/university hostel) and family income (coded low; medium and high).

Statistical analysis

Data analysis was performed in RStudio version 2022.7.1.554 (RStudio Team 2022). We used a set of packages to analyse the data (Guelmami et al., 2023). The 'EFAtools' package (Steiner & Grieder, 2020) and the 'Psych'package (Revelle & Revelle, 2015) were used to perform the descriptive statistics, while the 'Lavaan' package was used for the CFA. The Roc curves analysis was made using the 'Rocit' package. The exploratory factor analysis was performed with principal axis factoring and Promax rotation and Kaiser normalisation. The Kaiser–Meyer–Olkin (KMO) measure, the Bartlett's test and the parallel analysis were employed to examine the sampling adequacy for each variable. KMO must be bigger than 0.50 for the factorial solution to be accepted. Additionally, the significant chi-square value of the Bartlett sphericity test was used to test the adequacy of the factorial solution. The factors were extracted if the eigenvalues were larger than 1 and the number of factors in the scree plot was retained following the R algorithm. Moreover, an item was eliminated if its factor loading on the relevant factor was less than 0.50.

During the exploratory and confirmatory phases, the univariate normality of the data was evaluated using skewness and kurtosis tests. It was determined that asymmetry values greater than 7 or kurtosis values greater than 3 constituted non-Gaussian data, and that these values have low psychometric sensitivity. Multivariate normality was analysed by Mardia's coefficients. The structure of the CAMS-R in the confirmatory sample was performed by a second-order CFA, and diagonally weighted least squares (DWLS) were used in this study as an estimator procedure. Model fit was established by examining multiple indices, including: (1) the X2, (2) the X2/DF, (3) the Relative fit index (RFI) (4) the Incremental Fit Index (IFI), (5) the Parsimony-Adjusted Measures Index (PNFI), (6) the goodness-of-fit index (GFI), (7) the adjusted goodness-of-fit index (AGFI), (8) the comparative fit index (CFI), (9) the Tucker–Lewis index (TLI), (10) the root means square error of approximation (RMSEA) and (11) the standardised root mean residual. The X2 should not be significant; however, this criterion is highly criticised on large samples, whereas the X2/DF is widely used and should be less than or equal to 2 (Schermelleh-Engel et al., 2003). According to the recommendations of Hu and Bentler (1999), GFI, IFI and AGFI must have values greater than 0.90 to accept the model. RFI, TLI and CFI values greater than 0.95 represent a good model fit. While, RFI must be greater than 0.70. RMSEA should be <0.06 for a good model fit and <0.08 for an acceptable model fit (Hu & Bentler, 1999).

During the phase of confirmatory analysis, the Mardia coefficient of multivariate normality was also computed. To evaluate convergent validity, we focused on the strength and statistical significance of the loadings that link the first-order factors to the second-order factor. Calculating the average variance extracted (AVE) and comparing the square roots of the AVE values to the correlation coefficients were used to evaluate the discriminant validity (Cheung et al., 2023). The Pearson correlation matrix was used to analyse the correlations between scores. The ability of the questionnaire to discriminate mindfulness among physical education students was assessed using the area under the curve (AUC). The receiver-operating characteristic (ROC) curve is a method of assessing the discriminating level of a test used to classify individuals into two groups. It is calculated plotting the sensitivity against 1 – specificity, where sensitivity is the percentage of individuals correctly identified by the test and specificity is the percentage of individuals who had low GPA level and were correctly identified by the test. The area under the ROC curve was interpreted as the probability of correctly discriminating between students with high *versus* low GPA levels.

An AUC of 0.5 is interpreted as no discriminatory accuracy and 1.0 as perfect discrimination. As a general rule, an area under the ROC curve >0.70 with a confidence interval (CI) > 0.50 are commonly considered indicating acceptable discriminative ability. The concurrent validity of the scale was examined by Pearson correlations between scale scores with the total Grit score and Spearman correlations between CAMS-R Arabic version scores with GPA. A positive correlation is considered weak for a value less than 0.3, moderate for a value between 0.3 and 0.6 and strong for a value greater than 0.6 (Shrestha, 2021).

Results

The Bartlett's test of sphericity was significant (χ^2 (66) = 855.94, $p < 0.001$). Moreover, the overall KMO value for your data was meritorious (0.84) indicating a high probably that the data are suitable for factor analysis.

Parallel Analysis was performed using 1000 simulated random data sets and the Eigenvalues were found using The sequential Monte Carlo algorithm (SMC) with means as decision rules suggested four-factor solution as seen in scree plot (Figure 1).

The first factor explained 40.10% of the total variance; the second factor explained 12.30%. The third and fourth factors explained 11.10% and 6.20% of the total variance, respectively (Table 1).

Reliability

The internal consistency of the items belonging to each of the four factors and the set of all items were calculated by Cronbach α in both samples. For the exploratory sample, good internal consistency was supported by the Cronbach *α* indices, with values of 0.868, 0.880, 0.865, 0.865 and 0.862 for the Attention, Focus, Awareness, Acceptance and Complete scale, respectively. Moreover, the corrected item-total correlation was calculated for each latent variable. The results show that the values were adequate, since they were ranged between 0.736 and 0.768 for Attention, between 0.747 and 0.778 for Focus, between

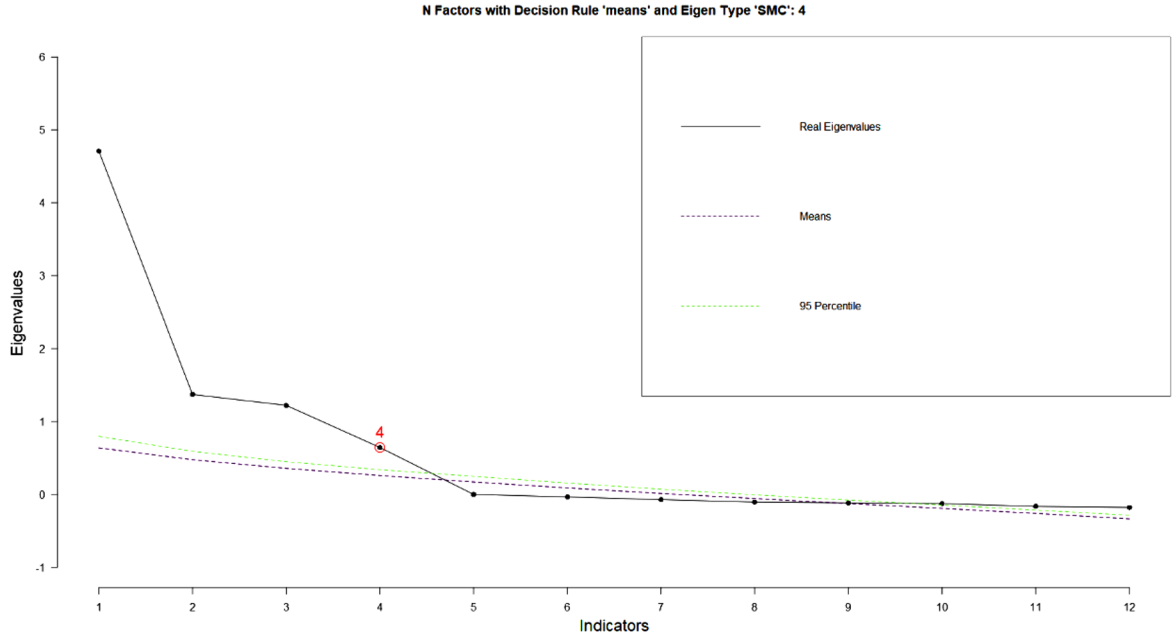

Figure 1. Scree plot of the Arabic CAMS-R.

Table 1. The factor loadings of the Arabic CAMS-R.

Items	Focus	Attention	Acceptance	Awareness
I1	0.038	**0.819**	−0.072	0.038
I2	−0.005	**0.791**	0.081	−0.018
I3	−0.029	**0.867**	0.012	−0.004
I4	**0.876**	−0.066	−0.031	0.056
I5	**0.836**	0.058	0.049	−0.050
I6	**0.804**	0.021	0.001	−0.004
I7	0.014	0.052	0.036	**0.809**
I8	0.026	−0.001	0.065	**0.776**
I9	−0.021	−0.022	−0.051	**0.849**
I10	0.014	0.043	**0.787**	0.016
I11	0.053	0.015	**0.786**	−0.014
I12	−0.045	−0.041	**0.871**	0.030

Entries in bold are primary factor loadings.

0.726 and 0.760 for the Awareness and between 0.736 and 0.753 for Acceptance. These results confirm that the instrument sub-scales have good reliability.

The data of the confirmatory sample indicates that the scale generally exhibits good internal consistency, with the overall Cronbach's Alpha for each subscale showing robust values: Attention (0.787), Focus (0.823), Awareness (0.810) and Acceptance (0.809). The corrected item-total correlation for each item suggests a strong relationship with the overall scale, and the Cronbach's Alpha values, if an item is deleted, are generally lower than the overall alpha, suggesting that each item is integral to the scale's consistency and reliability.

In addition, the total scale in two different samples shows high Cronbach's Alpha values: 0.875 for the exploratory sample and 0.862 for the confirmatory sample. These values are well above the accepted threshold of 0.7, indicating excellent internal consistency within the scale (Table 2).

Confirmatory factor analysis

Descriptive statistics, tests of normality (both univariate and multivariate), were carried out first, before moving on to the CFA. The univariate normality assessment suggested that the item distribution followed a Gaussian distribution (see Table 3).

Mardia's coefficients, b1p and b2p, are used to assess multivariate normality. The coefficient b1p measures multivariate skewness and in this case, a value of 5.97 indicates a substantial asymmetry in the data. The coefficient b2p assesses multivariate kurtosis; here, a value of 166.61 suggests a significant deviation from the kurtosis of a normal distribution, with a negative value indicating lighter tails (platykurtic distribution) (Cain et al., 2017). Given these insights into the data's distribution, we opted for the DWLS estimator (Li, 2016).

Figure 2 shows the results of the final CFA of the Arabic mindfulness scale. CFA statistics: χ^2 (53) = 77.997, $p = 0.014$; χ^2/df = 1.47; RFI = 0.982; IFI = 0.995, PNFI =0.791; Goodness-of-fit index = 0.993; AGFI

Table 2. Internal consistency of the Arabic CAMS-R.

		Scale mean if item deleted		Corrected item-total correlation		Cronbach's alpha if item deleted		Cronbach's alpha	
	Items	exploratory sample	confirmatory sample	exploratory sample	confirmatory sample	exploratory sample	confirmatory sample	exploratory sample	confirmatory sample
Attention	I1	5.33	5.63	0.736	0.605	0.829	0.736	0.868	0.787
	I2	5.38	5.65	0.749	0.643	0.813	0.694		
	I3	5.40	5.66	0.768	0.637	0.796	0.700		
Focus	I4	5.29	5.48	0.776	0.696	0.821	0.738	0.880	0.823
	I5	5.30	5.53	0.778	0.679	0.820	0.756		
	I6	5.29	5.48	0.747	0.660	0.847	0.774		
Awareness	I7	5.43	5.49	0.760	0.688	0.795	0.769	0.865	0.810
	I8	5.40	5.42	0.745	0.693	0.809	0.764		
	I9	5.36	5.43	0.726	0.691	0.827	0.766		
Acceptance	I10	5.40	5.37	0.743	0.660	0.810	0.737	0.865	0.809
	I11	5.40	5.32	0.736	0.663	0.818	0.735		
	I12	5.33	5.29	0.753	0.652	0.802	0.745		

Table 3. Descriptive statistics, Skewness and Kurtosis for the confirmatory sample.

	Mean	Std. deviation	Skewness	Kurtosis
I1	2.84	0.78	−0.14	−0.54
I2	2.82	0.87	−0.28	−0.64
I3	2.81	0.85	−0.15	−0.77
I4	2.77	0.94	−0.20	−0.94
I5	2.71	0.95	−0.17	−0.91
I6	2.76	0.92	−0.18	−0.88
I7	2.68	0.92	−0.10	−0.87
I8	2.75	0.93	−0.14	−0.93
I9	2.74	0.88	−0.20	−0.69
I10	2.62	0.91	0.02	−0.86
I11	2.67	0.85	−0.03	−0.68
I12	2.70	0.89	−0.07	−0.82

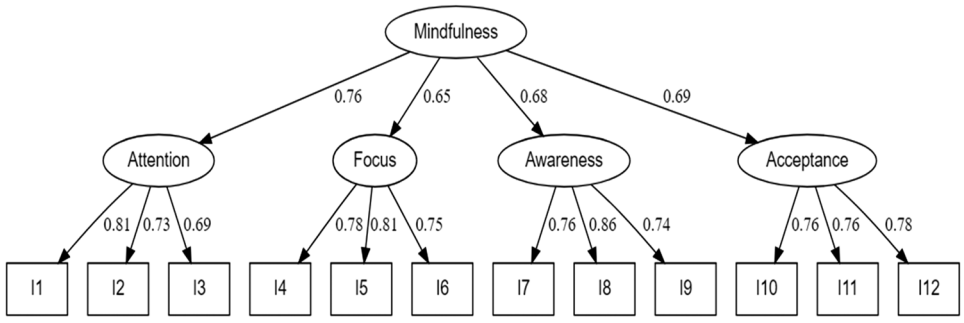

Figure 2. Confirmatory factor analysis of the Arabic CAMS-R.

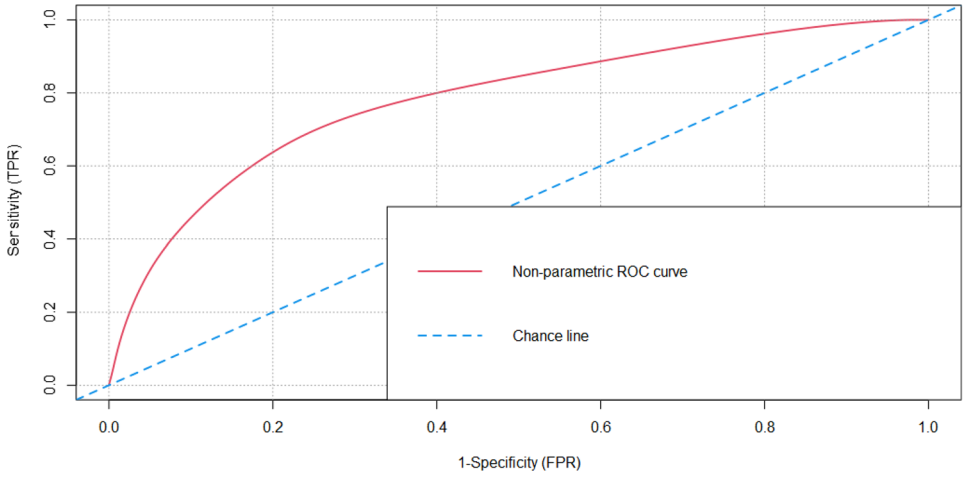

Figure 3. Receiver-operating characteristics (ROC) curve for the Arabic CAMS-R total scores separating between high and low GPA.

= 0.990; TLI = 0.994; Comparative fit index = 0.995; Root mean square error of approximation = 0.029 (90% CI 0–0.013–0.042); standardised root mean residual = 0.041.

Sensitivity

Before analysis, we examined the distribution of students across five GPA categories: The first category comprises 165 students, followed by 289 students in the second category. The third category contains 132 students, while the fourth category includes 112 students. Notably, the fifth category has only 6 students. Due to the low number in the fifth category, it has been merged with an additional category, forming a combined category of highest GPAs with a total of 118 students.

The ROC curve analysis was utilised to evaluate the ability of the CAMS-R latent scores to discriminate between students with the lowest and highest GPAs. The scale was considered to have acceptable discriminant ability, as the area under the ROC curve was 0.782 (CI 95%: 0.726–0.838, $p < 0.001$) (Figure 3).

Convergent and discriminant validity

To assess convergent validity we assessed the magnitude and significance of the loadings from the first-order factors to the second-order factor. The standardised factor loadings for the first-order factors range from 0.292 to 0.370 ($p < 0.001$), denoting a moderate to strong relationship between individual items (I1–I12) and their corresponding latent constructs. These loadings suggest that the items are effectively capturing the essence of their respective constructs. Moving to the second-order level, each of the first-order factors demonstrates significant standardised loadings on the overarching Mindfulness construct: Attention with a loading of 0.544, Focus with a loading of 0.579, Awareness with a loading of

0.469, and Acceptance with a loading of 0.463 (all $p < 0.001$). Focus emerges as the strongest contributor to the second-order Mindfulness construct, whereas Acceptance, though the least strong, still presents a considerable influence, affirming the multidimensionality of Mindfulness and underscoring the interrelatedness of its components. These findings not only underscore the validity of the individual items as indicators of their respective first-order factors but also reinforce the construct validity of the second-order model of Mindfulness. Likewise, the fit indices establish the convergent validity of a second-order factor model: the CFI and the TLI are both above 0.95, suggesting an excellent fit between the model and the observed data. The RMSEA is 0.038 with a 90% CI [0.025–0.050], providing further evidence that the model fits the data well. The SRMR has a value of 0.033, indicating a good fit. These fit indices suggest that the first-order factors are appropriately modeled as indicators of the second-order factor.

The results of discriminant validity showed that AVE values ranged from 0.56 for Attention to 0.62 for the Awareness dimension. Square root values of AVE reported on the diagonal line were as follows: 0.75 for attention, 0.78 for Focus, 0.79 for Awareness and 0.79 for the last dimension. The comparison of each Square root AVE value with correlation coefficients with the other constructs showed that they were of higher value, demonstrating good discriminant validity (see Table 4).

Concurrent validity

The Mindfulness latent total score was significantly and moderately associated with Grit scores ($r = 0.454$, $p < 0.01$) with a smaller correlation coefficient with the Attention dimension and a larger coefficient with the acceptance dimension.

However, the three dimensions Attention, Focus, and Acceptance of the Arabic version of CAMS-R showed weak correlations with GPA, while the Awareness dimension and the total score showed moderate associations: rho = 0.37 and rho = 0.37, respectively (see Table 5).

Discussion

The main goal of this study was to assess the psychometric properties of an Arabic version of the CAMS-R among physical education students in a Tunisian university. Consistent with theory, the initial factor structure of the CAMS tested with exploratory factor analyses in large student samples supported a four-factor structure (Feldman et al., 2022). The results of the ROC curve sensitivity analysis showed that the Arabic CAMS-R scale discriminated well between students with low and high GPA.

The 12-item scale was initially tested through exploratory factor analysis. The test supported the four-factor structure. Moreover, the EFA suggested that no items should be removed from the Arabic version of the scale. Subsequently, CFA validated the robustness of the instrument's second-order structure. The results also supported the construct validity of the scale by its convergent and discriminant validity, both of which were adequate. The reliability of the instrument examined Cronbach's Alpha

Table 4. Discriminant validity of the Arabic CAMS-R.

	Attention	Focus	Awareness	Acceptance
1. Attention	0.75	–	–	–
2. Focus	0.376**	0.78	–	–
3. Awareness	0.351**	0.420**	0.79	–
4. Acceptance	0.425**	0.339**	0.450**	0.77

**The square root of AVE lower than the correlation coefficients.

Table 5. Correlation matrix of the Arabic CAMS-R scores with Grit and GPA.

	Attention	Focus	Awareness	Acceptance	Mindfulness	Grit
Attention	1					
Focus	0.376**	1				
Awareness	0.351**	0.420**	1			
Acceptance	0.425**	0.339**	0.450**	1		
Mindfulness	0.712**	0.733**	0.755**	0.748**	1	
Grit	0.337**	0.321**	0.307**	0.379**	0.454**	1
GPA	0.293**	0.278**	0.305**	0.255**	0.370**	0.211**

internal consistency coefficient and the corrected item-total correlation demonstrated that the four dimensions and the total score of the instrument are reliable. Employing both total scores and subscale scores offers a multifaceted approach to assessment of mindfulness. The total score gives a broad, overarching view of this psychological cunstruct, while subscale scores provide detailed insights into specific dimensions of the scale.

In line with our work, the first version of CAMS-R (Feldman et al., 2007) had acceptable internal consistency among two separately and evidence of convergent and discriminant validity with concurrent measures of mindfulness, distress, well-being, emotion-regulation and problem-solving approaches in three samples of university students. The CFA conducted with maximum likelihood estimation suggest second-order model (Feldman et al., 2007).

Consistent with our findings, recent CAMS-R psychometric and clinical work has supported the reliability of the instrument with adequate internal consistency (Chan et al., 2016; Veneziani & Voci, 2015; Catak, 2012). In addition, concurrent validity was established by substantial correlations with other self-reported measures of mindfulness and associations with measures of distress, well-being and emotion regulation. In addition, the instrument was sensitive to change following mindfulness-based interventions (Gamaiunova et al., 2022; Howarth et al., 2019; Sarazine et al., 2021). In another work, two studies employing non-clinical Turkish samples explored the psychometric features of only 10-item CAMS-R. Both studies found adequate internal consistency and convergent and concurrent validity in the Turkish CAMS-R. Turkish CAMS-R demonstrated statistically significant correlations between mindfulness and depression, anxiety, well-being and perceived stress (Catak, 2012).

However, the principal component analysis of the Portuguese version of CAMS-R required the deletion of three items (Teixeira et al., 2017). Moreover, in another version adapted in Myanmar for HIV-positive patients (Huang et al., 2022), the adaptation of the instrument led to a self-report measure with 3 factors comprised by 9 items (the CAMS-R-M-2). The authors explained the differences by culture.

From another perspective, our results were in line with several studies that have examined the links between mindfulness and grit on the one hand, and mindfulness and GPA on the other. The findings have suggested positive links between mindfulness and grit (Lee, 2022; Raphiphatthana, 2018; Seek, 2020). Similarly, research has highlighted that mindfulness can influence academic results in primary and secondary schools (Brennan et al., 2018; Lin & Mai, 2018) and in university students in various disciplines (Lee, 2022; Rusadi et al., 2021; Vorontsova-Wenger et al., 2021).

The present findings should, however, be discussed in light of some limitations. First, the cross-sectional design limits any causal inferences. Second, we used self-report measures, which may lead to response and recall biases. Third, while providing valuable insights, is limited by its focus on Tunisian university physical education students, restricting the generalisability of the findings across the Arabic-speaking countries. Future research should aim to test the CAMS-R across varied demographics to enhance its applicability. Additionally, exploring the scale's use in various settings, such as different educational levels and psychological environments, could deepen our understanding of its effectiveness and inform more culturally attuned mindfulness practices and interventions.

Conclusion

Our findings strongly support the validity and reliability of the Arabic version of the CAMS-R as an effective self-report tool for assessing mindfulness in Tunisia. This endorsement is significant, as it marks a potential shift in mindfulness evaluation within Arabic-speaking populations. The adapted scale, valuable for clinicians and researchers, is set to significantly benefit the Arab communities by enriching our understanding of mindfulness in these cultural settings. Additionally, it is expected to stimulate increased mindfulness research, exploring its various impacts and applications.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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