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Validity of the Center for Epidemiological Studies Depression scale in Type 2 diabetes

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ABSTRACT

Objective: Depressive symptoms are common among people with Type 2 diabetes mellitus (T2DM). This study aimed to validate the 3-factor structure of the 14-item Center for Epidemiological Studies Depression (CES-D) scale proposed by Carleton et al. (2013) in a T2DM population.
Methods: The CES-D was administered to consecutive patients with T2DM entering a rehabilitation program. Construct validity was assessed using confirmatory factor analysis. Subscale viability, differential item functioning, and associations with clinical characteristics were tested in bifactor models.
Results: Among adults with T2DM ($n = 305$, age 56.9 ± 11.1, 44.9% male, duration of diabetes 7.8 ± 7.9 years, HbA1c 0.076 ± 0.014%), the construct validity of Carleton's 3-factor solution (negative affective, positive affective and somatic symptoms) was confirmed, although negative affective and somatic symptoms were highly correlated ($r = 0.926$). The CES-D items can be summed to arrive at a total score ($\omega_H = 0.869$), but not subscale scores ($\omega_S > 0.7$). Differential item functioning was not found based on age or body mass index (BMI), but Item 1 ("I was bothered by things that don't usually bother me") was inflated in women and Item 7 ("I felt that everything I did was an effort") was inflated in those with higher glycosylated haemoglobin (HbA1c). The general depression factor decreased with age ($\beta = -0.247$, $p < 0.001$) and increased with BMI ($\beta = 0.102$, $p = 0.041$) but not HbA1c ($\beta = 0.065$, $p = 0.461$). Negative affective symptoms ($\beta = 0.743$, $p = 0.001$), but not other depressive symptoms, were higher in women.
Conclusions: The 14-item CES-D retained construct validity in adults with T2DM. Depressive symptoms were associated with younger age, female gender and BMI, but not with glycemic control.

1. Background

Depressive symptoms are more prevalent in people with Type 2 diabetes than in the general population [1]. In Type 2 diabetes, depressive symptoms have been associated with poorer glycemic control [2,3], the development of diabetes-related complications [4] and mortality [5,6,7]. Evidence suggests that treatment of depression with antidepressants can improve clinical outcomes [8,9]; however, depression in Type 2 diabetes often goes undiagnosed [10,11,12] and untreated [10,11].

The Center for Epidemiological Studies Depression (CES-D) scale [13] is a widely used 20-item self-report instrument. The CES-D was designed to capture 4 factors: depressed affect (5 items), anhedonia (4 items), somatic complaints (6 items) and interpersonal concerns (2 items). Radloff generated the scale to study the epidemiology of depressive symptoms in the general population, combining items from previously validated longer scales such as the Beck Depression Inventory, Zung Self-Rating Depression Scale and the Raskin Depression Rating Scale [13]. Since its inception, at least 20 alternative factor solutions have been proposed, and many of the CES-D items have been found to function differently depending on gender, age and health status, or they have been found to unintentionally assess other constructs; for example, Item 17 "I had crying spells" has been found to be inflated in women [14,15,16] and somatic physical symptoms such as Item 7, "I felt that everything I did was an effort" in the elderly [14,17] and in

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chronic pain populations [14,18]. Additionally, questions 15 and 19 were shown to be more reflective of interpersonal disorders than of depression per se [14,19]. After performing a confirmatory factor analysis, and assessing differential item functioning, Carleton and colleagues proposed a 14-item 3-factor structure (Table 1) that measures somatic symptoms, negative affective symptoms and positive affective symptoms (anhedonia), which was found to be psychometrically robust, and considered to reflect current diagnostic criteria for depression [14].

Studies have subsequently validated Carleton's 14-item 3-factor structure for the CES-D in several populations, including those with chronic illnesses. For instance, in coronary artery disease, Harenberg and colleagues performed confirmatory factor analyses on 14 different models from the literature and demonstrated that the 14-item 3-factor model proposed by Carleton and colleagues fit most appropriately in a large sample of cardiac rehabilitation patients [20]. The current study evaluates the validity of the 14-item 3-factor model proposed by Carleton and colleagues, and criteria for invariance against gender, age, body mass index (BMI) and glycosylated haemoglobin (HbA1c) to determine if the construct is robust to these characteristics in people with Type 2 diabetes. The validity of the items to inform the three specific subscale factors is assessed. Further, the study describes the distribution of the general CES-D factor in a Type 2 diabetes population and the precision of the scale over the range of observed values. This study is intended to offer insight into the construct validity of the CES-D, and into the psychometric properties of the 14-item, 3-factor structure in people with Type 2 diabetes.

2. Methods

2.1. Participants

This retrospective analysis included a consecutive cohort of the most recent participants to enter the Diabetes, Exercise and Healthy Lifestyle Program, an exercise-based rehabilitation program tailored for diabetes management, at the University Health Network Toronto Rehabilitation Institute [21,22]. The University Health Network Research Ethics Board approved this study.

Table 1
Radloff's proposed 20-item CES-D 4-factor structure and Carleton's proposed 14-item 3-factor structure.

CES-D Items	Factor[a]	Factor[b]
1. I was bothered by things that usually don't bother me.	Somatic	Somatic
2. I did not feel like eating: my appetite was poor.	Somatic	Somatic
3. I felt that I could not shake off the blues, even with the help from family or friends.	Negative affect	Negative affect
4. I felt that I was just as good as other people.	Anhedonia	Anhedonia
5. I had trouble keeping my mind on what I was doing.	No factor	Somatic
6. I felt depressed.	Negative affect	Negative affect
7. I felt that everything I did was an effort.	Somatic	Somatic
8. I felt hopeful about the future.	Anhedonia	Anhedonia
9. I thought my life had been a failure.	No factor	–
10. I felt fearful.	No factor	–
11. My sleep was restless.	Somatic	Somatic
12. I was happy.	Anhedonia	Anhedonia
13. I talked less than usual.	No factor	–
14. I felt lonely.	Negative affect	Negative affect
15. People were unfriendly.	Interpersonal	–
16. I enjoyed life.	Anhedonia	Anhedonia
17. I had crying spells.	Negative affect	–
18. I felt sad.	Negative affect	Negative affect
19. I felt that people disliked me.	Interpersonal	–
20. I could not get "going."	Somatic	Somatic

[a] Original factor proposed by Radloff.
[b] Recent latent factor solution proposed by Carleton and colleagues. Abbreviations: CES-D = Center for Epidemiological Studies Depression scale.

2.2. Measures

The CES-D [13] was given to all participants entering rehabilitation at their intake visit by clinical staff and placed into their rehabilitation chart. Clinical staff also interviewed patients at entry into the program, and reviewed recent labs and letters from referring health professionals, to ascertain demographics, concomitant medications and diabetes characteristics. For this study, the individual CES-D items, demographics, concomitant medications and diabetes characteristics were recorded by review of the clinical rehabilitation charts by researchers.

2.3. Sample size

A sample size of at least 10 records per observed indicator (i.e., the 14 CES-D items) was considered to be the lower bound required to obtain adequate power [23]. However, to improve generalizability, and to perform invariance testing, we inflated the sample size to a target of at least 300 cases.

2.4. Statistical analyses

To evaluate the psychometric properties of the CES-D in people with Type 2 diabetes, we used confirmatory factor analysis fitting two multidimensional models; a correlated factors model used to reproduce and test the CES-D model underlying the 14 items proposed by Carleton and colleagues and b) a bifactor model and its derived indices to evaluate the reliability and viability of subscales derived from the correlated factors model. The bifactor model permits exploration of the degree to which items reflect a common trait (i.e. depression) as well as the set of subdomains (i.e. negative affect, positive affect and somatic symptoms). The value of the bifactor model to evaluate the plausibility of subscales has been rediscovered recently, determining the extent to which scores reflect a single variable even when the data are multidimensional, and evaluating the feasibility of applying a unidimensional item response theory measurement model [24]. The bifactor model is less restrictive than the second order model in which the specific factors are orthogonal to each other and with the general factor [25]. To evaluate the goodness of fit for both the correlated factors models and bifactor model, a non-significant ($p > 0.05$) chi-square (χ^2), a Confirmatory Fit Index (CFI), a Tucker-Lewis index (TLI) close to or >0.9, and the Root Mean Square Error of Approximation (RMSEA) close to or below 0.06 was tested. To estimate the magnitude of the factor loadings, a weighted least squares method with a diagonal weight matrix with standard errors adjusted for mean and variance was used [26,27].

Several indices derived from the bifactor model solution were used to measure subscale viability [28]. The coefficient, omega (ω) [29,30], a factor analytical model-based reliability estimate [31], was used to estimate the proportion of variance in the total scores attributable to all sources of common variance. The coefficient omega hierarchical (ω_h) [32,33], a model-based reliability index, was used to judge the degree to which composite scale scores are interpretable as a measure of a single common factor, computed by dividing the squared sum of the factor loadings on the general factor by the model estimated variances of total scores. The coefficient ω for each subscale (i.e. $\omega_{\text{negative affect}}$, $\omega_{\text{anhedonia}}$, $\omega_{\text{somatic symptoms}}$) was used to estimate reliability for a residualized subscale, controlling for that part of the reliability due to the general factor [34]. The explained common variance (ECV) was taken as the ratio of variance, explained by the general factor divided by the variance explained by the general plus the group factors.

Under bifactor models, we used Multiple Indicators Multiple Causes (MIMIC) to identify invariance (i.e. differential item functioning; DIF) against the background measures gender, BMI, HbA1c, and age. In other words, we tested formally if the CES-D items are functioning