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Cornell's Depression for Dementia Scale: A psychometric study among Norwegian nursing home residents

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ABSTRACT

Background: Depression is common among residents in long term-care facilities. Therefore, access to a valid and reliable measure of depressive symptoms among nursing home (NH) residents is highly warranted.
Aim: The aim of this study was to test the psychometrical properties of the Norwegian version of the Cornell Scale for Depression in Dementia (CSDD).
Methods: A sample of 309 NH residents were assessed for depressive symptoms using the CSDD in 2015-2016. Data on CSDD were missing for 64 residents, giving an effective sample of 245 (79.3%). Principal component and confirmatory factor analysis were used.
Results: A five-dimensional solution yielded the best fit with the data (χ^2=174.927, df=94, χ^2/df=1.86, p=0.0001, RMSEA=0.058, p-value for test of close fit=0.152, CFI=0.94, TLI=0.92 and SRMR=0.056). As expected, higher depressive symptoms correlated positively with higher scores on the Minimum Data Set Depression Rating Scale (MDSDRS) and correlated negatively with Quality of life assessed with the Quality of Life in Late Stage-Dementia Scale.
Limitations: The excluded residents (n=64, 20.7%) had lower cognitive function, which may limit the generalizability of the study results.
Conclusion: This study suggests a five-dimensional solution of the CSDD scale. Sixteen of the 19 original items showed highly significant loadings, explaining a notable amount of the variation in the CSDD-construct. Further development and testing of a well-adapted scale assessing depression in the nursing home population with and without dementia is required.

1. Introduction

Depression in old age is common and affects quality of life negatively. The diagnostic pooled prevalence of depression in community-living older adults is estimated to 7% (Luppa et al., 2012) and a higher prevalence (ranging between 11%-40%) has been reported in community-living older adults with mild cognitive impairment (MCI) (Panza et al., 2010). European studies of older adults with dementia receiving home care have found the screened prevalence of clinically significant depressive symptoms to range between 11% to 60% when using score $\geq$ 10 on the Cornell Scale for Depression in Dementia (CSDD) (Giebel et al., 2016; Nikmat, Hawthorne, & Al-Mashoor, 2015). European studies of older nursing home (NH) residents with dementia have shown the prevalence of clinically significant depressive symptoms (CSDD $\geq$ 10) to range from 10% to 52% (Giebel et al., 2016). The CSDD is known to correlate positively with other screening tools used to assess depressive symptoms (Debruyne et al., 2009; Knapskog, Barca, & Engedal, 2013; Korner et al., 2006; Lim, Hong, Won, Hahn, & Lee, 2012; Lin & Wang, 2008). The CSDD has been extensively used to explore prevalence of clinically significant depressive symptoms and factors associated to such symptoms in NH residents with and without dementia in cross-sectional and longitudinal studies (Giebel et al., 2016; Nikmat et al., 2015;Chau, Kissane, & Davison, 2018; Lolk & Andersen, 2015; Barca, Engedal, Laks, & Selbaek, 2010; Barca, Selbaek, Laks, & Engedal, 2009; Borza et al., 2015; Erdal et al., 2017; Iden, Engedal, Hjorleifsson, & Ruths, 2014).

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A recent review among older adults with dementia expressed a general concern about the state of knowledge regarding the psychometrical properties of scales used to screen for depressive symptoms in persons with dementia (Perrault, Oremus, Demers, Vida, & Wolfson, 2020). This review reported that studies exploring the construct validity of the CSDD revealed both four- and five-factor solutions. However, none of the studies in this review explored construct validity of the CSDD in NH residents with and without dementia.

Several psychometrical analyses of CDDS including NH residents with and without dementia have been published. In a Norwegian study of a sample with 902 NH residents without and with dementia, principal component analysis (PCA) suggested a 5-factor structure explaining 52 % of the variance; in this Norwegian study item8 "loss of interest" and item7 "physical complains" were troublesome (Barca, Selbaek, Laks, & Engedal, 2008). In a more recent Norwegian study published in 2015, both explorative (explaining 50.4 % of the variance) and confirmatory factor analyses supported a five-factor solution (Barca et al., 2015) showing an adequate fit among NH residents with dementia (n=932) and memory clinic patients with dementia (n=750). Correspondingly, also this study revealed two problematic items; item7 "physical complaints" and Item5 "agitation" did not load substantially on any dimension. Moreover, the structure of the loadings differed distinctively compared to previous findings by the same first author (Barca et al., 2008).

An American study assessing the psychometric properties of the CSDD among 642 NH residents with moderate cognitive impairment reported a four-factor structure (Kurlowicz, Evans, Strumpf, & Maislin, 2002), explaining 45.6% of the variance. In this American study three items disclosed no substantial loadings at any of the four factors (item12 "diurnal variation", item7 "multiple physical complaints" and item8 "loss of interest"). A Chinese study of 145 institutionalized older adults with dementia suggested a five-factor structure explaining 61.2 % of the variance using PCA (Lin & Wang, 2008); in this study item8 revealed cross-loadings. In Thailand, a study from 2013 including 84 NH residents displayed both a four- ((confirmatory factor analysis (CFA)) and a five-factor solution (PCA) (Wongpakaran, Wongpakaran, & van Reekum, 2013); however, without a good fit. In this Thai study, the structure of the measurement model differed substantially from previous international studies among long-term care residents. Further, a two-factor structure including a mood and a non-mood factor has been suggested among NH residents (Borza et al., 2015). Psychometrical studies of out-clinic patients have shown both a four- (Knapskog et al., 2013; Ownby, Harwood, Acevedo, Barker, & Duara, 2001; Schreiner & Morimoto, 2002) and a five-factor structure (Ben Jemaa, Marzouki, Fredj, Le Gall, & Bellaj, 2019).

Summarized, this literature review reveals that the dimensionality of the CSDD is unclear and demonstrates that some items do not load at all, or do not load on the intended factor. Therefore, the present study examines the Norwegian version of the CSDD among NH residents with and without dementia.

1.1. Aims

The present study aimed to assess the psychometric properties of the Norwegian version of the CSDD scale in a NH population with and without dementia. The research question was three-fold; (a) how well does the original five-factor measurement model of the CSDD fit to the observed data? (b) does a 4-factor structure fit better? and (c) does the CSDD reveal good reliability and construct validity in a NH population with and without dementia? We expected the CSDD to correlate with some established concepts; thus, the following hypotheses were tested:

Hypothesis 1 (H1): Higher depressive symptoms assessed with CSDD is negatively correlated with Quality of life assessed with the Quality of Life in Late Stage-Dementia Scale (QUALID, i.e. higher QUALID score).

Hypothesis 2 (H2): Higher depressive symptoms assessed with CSDD is positively correlated with the Minimum Data Set Depression Rating Scale (MDSDRS) score.

In this study, we addressed the dimensionality, reliability and the construct validity, all of which considered interrelated measurement properties. The research question was addressed in accordance to the Standards for Educational and Psychological Testing (American Educational Research Association., American Psychological Association., National Council on Measurement in Education., & Joint Committee on Standards for Educational and Psychological Testing (U.S.), 1999; Goodwin & Leech, 2003; Netemeyer, Bearden, & Sharma, 2003).

2. Methods

2.1. Design and ethical considerations

The present data come from a cross-sectional study. The Inclusion criteria were: (i) registered as long-term patients; (ii) had stayed in the NH for more than 60 days; (iii) provided an informed consent signed by either the patient or next-of kin on behalf of the patient, and (iv) had a life expectancy longer than 6 months (stated by the registered nurses).

The Registered Nurses (RN) were trained to collect data; the training was organized by the first author in groups of 4-8 RNs in each of the NHs, lasting for about four hours. As part of the training the RNs observed one patient as an example case. The NHs were also given a handbook with detailed instructions for how the assessment should be done and how to fill in the forms.

Approval by the Regional Ethics committee for Medical Research in Western Norway (2014/1642), as well as from the Management of the 17 NHs were obtained. Each participant was informed and signed a written consent form, or an informed consent was given by the next-of kin if the participant was not able to consent.

2.2. Participants

The total sample consisted of 309 long-term NH patients from 17 NHs across three counties in Mid-Norway. The data were collected during 2015-2016 and long-term care was defined as 24-hour care.

2.3. Measurements

Depressive symptoms were assessed with CSDD (Alexopoulos, Abrams, Young, & Shamoian, 1988). The CSDD consists of 19 items, with each item rated as 0 (absent), 1 (mild), 2 (severe) or "symptom is not possible to evaluate". The sum-score ranges between 0 to 38. If one of the items in CSDD were scored as "not possible to evaluate", the participant was excluded from the analysis.

The Physical Self Maintenance Scale (PSMS) (Lawton & Brody, 1969) assessed the performance of activities of daily living. The PSMS consists of six items scaled from 1 to 5, ranging from total independence (1) to total dependence (5). The total score ranges between 6 to 30, where a high score indicates higher dependence.

The Minimum Data Set Depression Rating Scale (MDSDRS) comprises seven items regarding: (1) giving negative statements, (2) anger and irritability with self or others, (3) expressing unrealistic fears, (4) repetitive health complaints, (5) repetitive anxious complaints, (6) facial expressions of sadness, being pained, or worried, and (7) crying, tearfulness. Scoring is based on observed behavior last 30 days:'0' = not exhibited; '1' = 1-5 times a week; '2' = exhibited daily or almost daily). A cut off score of '3' is suggested to maximize sensitivity for mild and moderate depression (Burrows, Morris, Simon, Hirdes, & Phillips, 2000).

Severity of dementia was assessed using the Clinical Dementia Rating (CDR) scale, which covers six domains (memory, orientation, judgment and problem solving, community affairs, home and hobbies, and

personal care). Each domain had five response categories (0, 0.5, 1, 2, 3) (Hughes, Berg, Danziger, Coben, & Martin, 1982; Morris, 1993). The CDR standard global score is calculated by means of an algorithm giving priority to memory (https://www.alz.washington.edu/cdrnacc.html).

Quality of life (QoL) was assessed by means of the Norwegian version of the Quality of Life in Late-Stage Dementia (QUALID) scale. The frequency of 11 observable behaviours were registered for each patient during the previous week (range 11-55). A high score indicates poor QoL (Roen et al., 2015; Weiner et al., 2000).

2.4. Data analysis

Descriptive statistics and PCA were performed with IBM SPSS version 25, while CFA was performed with Stata 15.1 (StataCorp, 2017). We investigated the underlying dimensionality of the data and the adequacy of each item. As this is considered central, PCA and CFA can provide complementary perspectives on data and can give different pieces of information (Hurley et al., 1997; Netemeyer et al., 2003). A wide perspective on the observed data using PCA followed by the confirmation procedure was therefore used.

CFA is a sub-model in structural equation modeling (Brown, 2006), and derives a more accurate evaluation of the psychometric properties of the scales used. A high loading of an item indicates that there is much in common between the factor and the respective item (Sharma, 1996). Loadings are considered either poor (< 0.32), fair (≥0.45), good (≥0.55), very good ≥0.63, or excellent (>0.71) (Sharma, 1996).

The model fit adequacy was assessed by χ^2-statistics and various fit indices. In line with the 'rules of thumb' given as conventional cut-off criteria (Mehmetoglu & Jakobsen, 2017) the following fit indices were used: χ^2-statistics, the Root Mean Square Error of Approximation (RMSEA) and the Standardized Root Mean Square Residual (SRMS) with values below 0.05 indicating good fit, whereas values smaller than 0.10 is interpreted as acceptable (Mehmetoglu & Jakobsen, 2017). Further, the Comparative Fit Index (CFI) and the Tucker-Lewis Index (TLI) with acceptable fit set at 0.95 and good fit at 0.97 (Acock, 2013; Mehmetoglu & Jakobsen, 2017; Schermelleh-Engel, Moosbrugger, & Müller, 2003) were used. Skewness and kurtosis were significant. Therefore, the Satorra-Bentler corrected χ^2 was applied which is recommended when analyzing non-normal continuous endogenous variables (Kline, 2011).

3. Results

3.1. Descriptive analysis

3.1.1. Participants

Participants ages ranged between 62-104 years, with a mean age of 85.4 years (SD=8.1) and 220 were women (71%). In total, 19 (6.1%) participants had missing data and 45 (14.6 %) participants had one or more items that were not possible to evaluate using CSDD. In total 245 (79.3%) participants had a complete evaluation of depressive symptoms using the CSDD. Those excluded did not differ in age or gender but had a statistically significant lower physical function and lower cognitive function (p=0. 001) (Table 1).

The CSDD 19-items mean-score was 0.237 (SD=0.263), ranging between 0.00-1.74, while the sum-score showed that 261 (84.47%) scored <10 which is interpreted as no depression, and 48 (15.5%) scored ≥10 indicating depression. Table 2 lists the means (M), standard deviation (SD), Cronbach's alpha and correlation matrix for the constructs of QUALID, MDSDRS while Appendix 1 displays the distribution of the CSDD-SUM scores. The alpha levels for the various measures indicated an acceptable inter-item consistency with Cronbach's alpha coefficients of 0.77-0.86. The correlations between CSDD and QUALID as well as MDSDRS (positive correlation means inverse relationship) (Table 2) supported the hypotheses H1 and H2, both of which concerning discriminant and convergent validity of the CSDD.

Table 1
Patient characteristics and mean scores for PSMS, CDR, QUALID, CSDD, MDSDRS and CDR distribution.

	Total (n=309)	Included (n=245)	Excluded (n=64)	P value Included vs. Excluded
Patients characteristics				
Gender				
Women n (%)	220 (72.2)	175 (71.4)	45(70.3)	0.86[a]
Men	89 (28.8)	70 (28.6)	19 (29.7)	
Mean age ±SD, years	85.4±8.1	85.7±7.7	83.8±9.7	0.15[b]
Mean stay time±SD, months	36.3±29.3	36.3±28.7	36.2.±32.0	0.25[b]
CSDD		5.0±5.2		
PSMS	17.2±5.3	16.6±5.2	19.6±5.0	0.001[b]
CDR categorical		n (%)		
No dementia	5 (1.6)	4 (1.6)	1 (1.6)	
Very mild	57 (18.4)	47 (19.2)	10 (15.6)	
Mild	65 (21.0)	60 (24.5)	5 (7.8)	
Moderate	105 (34.0)	86 (35.1)	19 (29.7)	
Severe	77 (24.9)	48 (19.6)	29 (45.3)	

Note: Legends: PSMS: Physical Self Maintenance Scale, CDR: Clinical Dementia Rating scale, QUALID: Quality of Life in Alzheimer Disease, CSDD: Cornell Depression Rating Scale, CDR distribution (Washington University CDR-assignment algorithm).
[a] p value for χ2 test;
[b] p value for independent t-test,[1]Values are given as mean sum ± SD.

Table 2
Distribution of the CSDD scores, Means (M), Standard deviations (SD), Cronbach's alpha, Correlation coefficients for CSDD to MDSDRS and QUALID.

Distribution of the CSDD scores				
CSDD score N=245 100%	0.-0.99 11 (6.1%)	1.0-1.75 77 (42.5%)	1.75-3.0 0 (0%)	
Variable (number items)	Cronbach's Alpha (α)	Mean (M)	Std.Dev. (*SD*)	*Correlations (r^2) rho CSDD (19)*
CSDD (19)	0.86	0.2369	0.2632	1.00
MDSDRS (7)	0.77	0.4200	0.3965	0.66**
QUALID (11)	0.80	1.7450	0.6004	0.62**

Note: CSDD= Cornels Depression for Dementia Scale, MDSDRS=Minimum Data Set Depression Rating Scale, QUALID= Quality for life in late Alzheimer's disease, Listwise N=245.
** p-value ≤ 0.01.

3.2. Principal Component Analysis (PCA)

We used PCA to explain as much of the total variance as possible with as few factors as possible. The Kaiser-Meyer-Olkin measure of sampling adequacy surpassed the recommended value of 0.60 (0.84) and Bartlett's test of sphericity showed statistical significance (p<0.0001), supporting the factorability of the correlation matrix (Netemeyer et al., 2003). Using the recommended value for the minimum loading of 0.32 (Tabachnick & Fidell, 2013) which equates to approximately 10% overlapping variance with the other items in the factor, we searched for the cleanest structure of the concept under investigation. Based in the evidence we expected the CSDD to contain five or four dimensions with correlated factors. Hence, an oblique rotation such as ProMax is expected to give a more accurate solution (Costello & Osborne, 2005). Therefore, PCA with ProMax rotation and Kaiser Normalization was used. Five factors were extracted (all with eigenvalue ≥1.0) (Appendix 2), showing factor loadings ranging from 0.31-0.88. Appendix 3 shows the scree-test of the CSDD data retaining five factors explained 59.04 % of the variance. Factor1 explained 29.2% of the variance,

Factor2 contributed with 10.78 %, while Factor3, 4 and 5 explained 7.87, 5.86 and 5.37%, respectively. This PCA-suggested solution revealed four substantial factors comprising between 6-3 items, and one weak factor containing 2 items. Except this last dimension with 2 items (α=0.44), the factors displayed good/acceptable Cronbach's alpha coefficients ranging between 0.66 and 0.79. Table 3 lists the loadings and variance for this rotated 5-factor solution of the CSDD. The PCA clearly suggested that item4 *(Irritability: easily annoyed. short-tempered)* did not belong to the 'mood'-dimension as suggested in the original version of the scale. Item4 loaded along with item5 *(Agitation: restlessness. hand wringing. hair pulling)* and item7 *(Multiple physical complaints)* on the 'behavioral disturbance' dimension.

Some previous studies have reported a 4-factor-solution (Perrault et al., 2020; Wongpakaran et al., 2013); thus, we set the factors to retain to four, and ran PCA ones more. This 4-factor solution, explaining 53.67 % of the variance (Factor1: 29.2%; Factor2: 10.76%; Factor3: 7.87%; Factor4: 5.86%) disclosed loadings between 0.32-0.85, and four cross-loadings.

Hence, the dimensionality of the CSDD construct seemed unclear. Substantial conclusions based solely on PCA should not be drawn (Costello & Osborne, 2005). Therefore, we turned to CFA.

3.3. Confirmatory Factor Analysis (CFA)

The first factor (Mood) originally comprises of items 1-4. However, since the PCA clearly pointed at item4 as barely correlated with items 1-3, we ran CFA checking the 'mood-dimension' including items 1-4. The CFA exposed some misspecification: χ^2=21.103, df=2, χ^2/df=2.088, p=0.0001, RMSEA=0.181, p-value for test of close fit=0.001, CFI=0.93, TLI=0.79, SRMR=0.054; item4 (R^2=0.24) seemed troublesome. The present PCA indicated that item4 belonged to the 'behavioral-factor' and that item8 had its place in the 'physical-factor'. Including these aspects, we worked further on the original 5-factor solution. The χ^2-test, RMSEA and the SRMS revealed acceptable estimates, while CFI and TLI indicated some troubles (χ^2=295.767, df=142, χ^2/df=2.30, p=0.0001, RMSEA=0.066, p-value for test of close fit=0.0001, CFI=0.89, TLI=0.87, SRMR=0.070). Consequently, we tested the 5-factor solution suggested by PCA based on eigenvalues ≥1, as shown in Appendix 2 (Factor1: items 1, 2, 16, 17, 18, 19 with eigenvalue 5.54; Factor2: items 4, 5, 7, 12 with eigenvalue 2.05; Factor3: items 9, 10, 11 with eigenvalue 1.50; Factor4: items13, 14, 15 with eigenvalue 1.11; Factor5: items 3 and 6 with eigenvalue 1.02). Running CFA, this 5-factor-model showed signs of an acceptable fit (χ^2=244.727, df=125, χ^2/df=2.088, p=0.0001, RMSEA=0.062, p-value for test of close fit=0.050, CFI=0.91, TLI=0.89, SRMR=0.076). However, still CFI and TLI were too low, signifying some misspecifications. Therefore, we turned back to the original five-dimensional model for further investigation.

Table 3
Goodness-of-fit measures for CSDD measurement model. Confirmatory Factor Analysis for Model-1, Model-2 and Model-3.

Fit Measure	Model-1 5-factors	Model-2 5 factors	Model-3 5 factors
	N=245 19 items	N=245 17 items	N=245 16 items
χ^2 *Satorra Bentler*	295.767	220.419	174.927
p-value	0.0001	0.0001	0.0001
$\frac{x^2}{df}$ *Satorra Bentler*	2.08 (Df[1]=142)	2.02 (Df=109)	1.86 (Df=94)
RMSEA	0.066 (CI: 0.055-0.078)	0.064 (CI: 0.052-0.076	0.058 (CI: 0.045-0.072)
p-value (close fit test)	0.0001	0.030	0.152
SRMR	0.070	0.060	0.056
CFI	0.89	0.92	0.94
TLI	0.87	0.89	0.92
$\rho c = \frac{(\sum \lambda)^2}{[(\sum \lambda)^2 + \sum(\theta)]}$	0.46-0.76	0.61-0.80	0.63-0.82

Note: CSDD = Cornell's Scale of Depression for Dementia. RMSEA=Root Mean Square Error of Approximation. SRMS=Standardized Root Mean Square Residual, CFI=The Comparative Fit Index, TLI= Tucker-Lewis Index,

[1] Df=Degrees of freedom, ρc=Composite reliability, Raykov's factor reliability coefficient.**Model-1:** 19 items 5-factor solution (item4 is dismissed), **Model-2**: 17-items 5-factor solution (item 6 and 12 are dismissed). **Model-3**: 16 items 5-factor solution (items 6, 8 and 12 are dismissed). Listwise N=245.

3.3.1. Model-1: 19-items five-dimensional version of the CSDD

Model-1 comprising the original 19 items gave significant t-values for all estimates. The completely standardized factor loadings ranged from 0.20 to 0.79 and squared multiple correlations (R^2) ranged between 0.04-0.62. The items 6 and 12 disclosed extremely low R^2-values (0.04 and 0.14) implying that these items were in-reliable indicators of depression in this population. The model fit was poor (χ^2=295.767, df=142, χ^2/df=2.082, p=0.0001, RMSEA=0.066, p-value for test of close fit=0.007, CFI=0.89, TLI=0.87, SRMR=0.070) (Table 3). However, composite reliability showed good estimates for four out of the five factors (ρ_{mood}=0.76, $\rho_{behavioral}$=0.57, $\rho_{physical}$=0.76, ρ_{cyclic}=0.76, $\rho_{ideational}$=0.74).

Even if, the standardized residuals were not statistically significant, seven modification indices (MIs) were higher than 9, indicating misspecifications. The pairs of item9-10 (MI=23.10) and item8-11 (MI=15.45) revealed the highest MIs. Item9 covers appetite loss, while item10 assesses weight loss. Consequently, it is reasonable that these items are highly correlated and thus share error variance. Including a correlated error term between the items 9-10 is therefore theoretically rational. However, this nested version of Model-1 only marginally improved the fit (χ^2=373.919, df=141, χ^2/df=2.65, p=0.0001, RMSEA=0.062, p-value for test of close fit=0.0039, CFI=0.90, TLI=0.88, SRMR=0.067). Furthermore, the pair of item1 and item14 exposed a significantly high MI (MI=10.72) and letting these errors correlate is reasonable. Nevertheless, this nested version of Model-1 involving two correlated error terms gave only a slightly improved model fit (χ^2=262.857, df=140, χ^2/df=1.88, p=0.0001, RMSEA=0.060, p-value for test of close fit=0.0077, CFI=0.91, TLI=0.89, SRMR=0.067). Consequently, we assessed the reliability by inspecting the factor loadings and the R^2-values.

3.3.2. Model-2: 17-items 5-factor solution

The items 6 and 12 disclosed extremely low multiple squared correlations (R^2 = 0.062 and 0.14) explaining practically none (0.003% and 0.02%, respectively) of the variance in the CSDD construct. This denotes that these items were not reliable indicators of the CSDD-construct. Item6 (*Retardation: slow movement. slow speech or slow reactions)* and item12 (*Diurnal variation of mood: symptoms worse in the morning*) were removed, one by one; this 17-items model revealed a better fit with the data (χ^2=220.419, df=109, χ^2/df=2.35, p=0.0001, RMSEA=0.064, p-value for test of close fit=0.030, CFI=0.91 TLI=0.89, SRMR=0.060). This 5-factor solution including 17 items gave good/acceptable composite reliability for all the five factors (ρ_{mood}=0.76, $\rho_{behavioral}$=0.61, $\rho_{physical}$=0.76, ρ_{cyclic}=0.80, $\rho_{ideational}$=0.74). Including the correlated error terms between the items9-10 and items1-14 gave only a faintly improved fit shown in Table 3; CFI and TFI still implied some misspecification (χ^2=188.492, df=107, χ^2/df=2.24, p=0.0001, RMSEA=0.055, p-value for test of close fit=0.238, CFI=0.94, TLI=0.92, SRMR=0.056).

3.3.3. Model-3: 16-items 5 factor solution

A further scrutinizing of the MIs disclosed that item8 was troublesome, sharing variance with several items (1, 9, 10, 11, 17) and thus blurring the dimensionality. Hence, dismissing the inadequate

indicators 6 and 12 along with item8 resulted in a 16-items 5-factor solution showing good composite reliability coefficients: ρ_{mood}=0.75, $\rho_{behavioral}$=0.63; $\rho_{physical}$=0.72; ρ_{cyclic}=0.80 and $\rho_{ideational}$=0.77. Fig. 1 portrays this model, which stands out as the most parsimonious and best fitting solution (χ^2=174.927, df=94, χ^2/df=1.86, p=0.0001, RMSEA=0.058, p-value for test of close fit=0.152, CFI=0.94, TLI=0.92, SRMR=0.056) (Table 3), while Table 4 lists the estimated parameters, standardized loadings, t-values, R^2, and composite reliability. Still, CFI and TLI were low. Including correlated error terms between the items9-10 and items1-14 did not increase CFI and TLI satisfactorily (χ^2=164.955, df=92, χ^2/df=1.79, p=0.0001, RMSEA=0.056, p-value for test of close fit=0.232, CFI=0.94, TLI=0.92, SRMR=0.054).

4. Discussion

Two questions are important when evaluating a measurement scale: (1) the underlying dimensionality of data (not too many, not too few factors), and (2) the adequacy of the individual items (Hair, Black, Babin, & Anderson, 2010; Netemeyer et al., 2003). In the present study we assessed how the original five-factor as well as a former published four-factor measurement model of the CSDD fit with the observed data. Furthermore, we assessed the reliability and construct validity of the CSDD in a Norwegian NH sample of residents with and without dementia. The research question addressed the dimensionality, reliability and construct validity of the CSDD scale.

4.1. Dimensionality

The scree-test (Appendix 3) indicated that the number of factors to retain was five. Even so, three factors had eigenvalues substantially higher than one, while the fourth and fifth factors were close to one (1.11, 1.02, respectively), and the next factors displayed eigenvalues of 0.97, and 0.84, respectively. However, it seems not rational to consider the fifth factor with eigenvalue of 1.02 as 'major' and the sixth with eigenvalue of 0.97 as 'trivial'. Using Kaiser's method (K1) can sometimes be problematic and inefficient when determining the number of factors (Fabrigar, Wegener, MacCallum, & Strahan, 1999) since it tends to result in the retention of too many factors (Nunally & Bernstein, 1994). Even if the K1 is frequently used, it has some limitations; thus it is not recommended to solely rely on the K1 rule (Nunally & Bernstein, 1994). In PCA there is a need to balance between restraining and at the same time ensuring an adequate representation of underlying correlations, so that it is able to differentiate major factors from minor ones (Fabrigar, Wegener, MacCallum, & Strahan, 1999). In the present PCA results, this issue seems evident: four strong factors comprising between 3-6 items along with several small factors were portrayed. The fifth factor (eigenvalue = 1.02) signified a weak construct containing only two items, resulting in a low internal consistency and reliability (α=0.49). Hence, the dimensionality seemed unclear. When looking at the CFA estimates, the analyses suggested a five-dimensional solution

Table 4
Measurement model Cornell's Scale of Depression in Dementia (CSDD).

Items	Parameter	[a]Stata Estimate	t-value	[b]R^2
CSDD Mood-Related Signs				
CSDD1	λx 1,1	0.73	17.68*	0.53
CSDD2	λx 2,1	0.73	17.43*	0.53
CSDD3	λx 3,1	0.65	13.94*	0.42
CSDD Behavioral Disturbance				
CSDD4	λx 4,2	0.66	12.63*	0.44
CSDD5	λx 5,3	0.66	12.41 *	0.44
CSDD7	λx 7,2	0.48	7.86*	0.23
CSDD Physical Signs				
CSDD9	*λx 9,3*	0.87	15.30*	0.75
CSDD10	*λx10,3*	0.68	12.52*	0.46
CSDD11	*λx11,3*	0.48	7.91*	0.23
CSDD Cyclic Functions				
SCDD13	*λx 13,4*	0.78	22.03*	0.60
SCDD14	*λx 14,4*	0.65	17.71*	0.51
CSDD15	*λx 15,4*	0.81	23.67*	0.66
CSDD Ideational Disturbance				
CSDD16	λx *16,5*	0.68	15.71*	0.46
CSDD17	λx *17,5*	0.61	12.93*	0.37
CSDD18	λx *18,5*	0.80	22.43*	0.64
CSDD19	λx *19,5*	0.59	11.92*	0.35
ρ_cMood	[c]ρ_c	0.75		
ρ_cBehavioral	ρ_c	0.63		
ρ_cPhysical	ρ_c	0.72		
ρ_cCyclic	ρ_c	0.80		
ρ_cIdeational	ρ_c	0.77		

Note:
* Significant at the 1 % level.
[a] Completely Standardized Factor Loadings.
[b] Bentler-Raykov squared multiple correlation coefficient = R^2. Listwise, N=245, 16 items included: items 6,12 and 8 are dismissed.
[c] Composite reliability $\rho_C = \frac{(\sum \lambda)^2}{(\sum \lambda)^2 + \sum(\theta)}$.

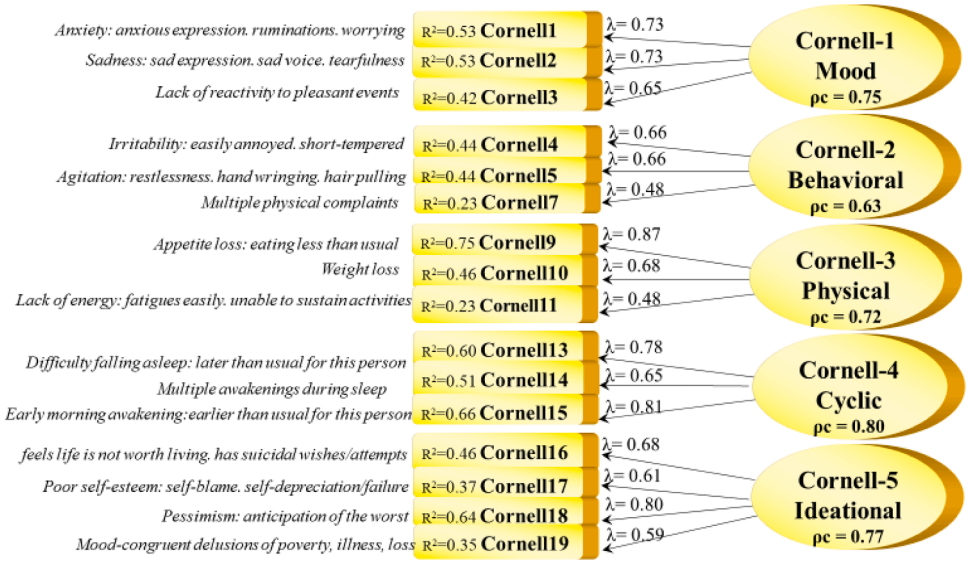

Fig. 1. Measurement model of the Cornell's Scale of Depression in Dementia.
Note: Standardized factor loadings and squared multiple correlations (R^2). ρ_c= composite reliability coefficient. Fit indices: χ2=174.927, df=94, χ2/df=1.86, p=0.0001, RMSEA=0.058, p-value for test of close fit=0.152, CFI=0.94, TLI=0.92, SRMR=0.056. Listwise N=245.

(Table 3). Nevertheless, some items appeared troublesome and indicated misspecifications.

4.2. Reliability

Reliability and construct validity, which point to the suitability of the individual items, indicate that the items perform as good indicators for the CSDD construct in the NH population with and without dementia. Highly significant standardized factor loadings are desired, preferably ≥0.71 (Hair et al., 2010; Netemeyer et al., 2003). The square of a standardized factor loading (R^2), or in other words, the variance extracted of the item, indicates how much variation in an item the latent construct explains (Raykov, 2001). Loadings below 0.71 can still be statistically significant, but then more of the variance in the measure is error variance than explained variance. In the present study, the factor loadings and the R^2-values showed that 14 out of the 16 items revealed good to excellent (≥0.55) loadings, and only two (item 7 and 11) showed a fair loading (≥0.45-0.55) (Fig. 1). Hence, 14 items performed to be reliable indicators of the CSDD construct. Cronbach's alpha (α) (Table 2) and composite reliability (ρ_c) (Table 3) displayed good values, indicating good internal consistency (Hair et al., 2010; Mehmetoglu & Jakobsen, 2017).

4.3. Construct validity

Construct validity implicates if the measured indicators actually reflect the theoretical latent construct the items are designed to measure (Fayers & Machin, 2007). In the present study, significant negative correlations between CSDD and QUALID as well as positive correlations CSDD and MDSDRS (Table 2) indicate adequate convergent construct validity; both hypotheses (H1 and H2) were supported. Interestingly, item 9 (*'Appetite loss; eating less than usual)*, item 15 (*early morning awakening; earlier than usual),* item 18 *(Pessimism: anticipation of the worst)* and item 13 (*difficulties falling asleep)* loaded strongly (λ=.87; .81; .80; .78, respectively), implying to be highly valid indicators of CSDD in this population, strengthening the construct validity. Hence, items concerning the resident's appetite and sleep, both of which are observable by the health care professionals in the NH, were reported as highly valid indicators for depression in this NH population.

Three items performed as invalid indicators of depression and were dismissed; the CSDD-construct hardly explained any variance in items 6 and 12 indicating low validity and reliability. Item 6 *Retardation: slow movement. slow speech or slow reactions* was not perceived to relate with depression in this population. Probably, older adults staying in NHs have all slowed down their movement, reactions and speech; not due to depression but because of illnesses, disabilities and loss of functions. On average, NH residents have 6-7 diagnoses of chronic conditions (Fabbri et al., 2015), which negatively affect their health, functioning, energy and vitality. Furthermore, item12 (*Diurnal variation of mood: symptoms worse in the morning*), did not relate to depression in this study. Due to a painful and stiff body caused by arthrosis, rheumatism, etc. (Fabbri et al., 2015), older NH residents often need much time in the morning to get up, getting dressed and feeling well. Thus, mood variations in the morning may result from other aspects than depression (Wirz-Justice, 2008). Moreover, the analysis disclosed that item8 (*Loss of interest: less involved in usual activities*) loaded on several factors, sharing error variance with many of the other items (1, 9, 10, 11, 17), and thus blurring the dimensionality. This has also been uncovered in previous studies (Barca et al., 2008; Lin & Wang, 2008). It seems logic that less involvement in usual activities might correlate with fatigue, and thereby reduced appetite and sleep problems. Thus, this item shares error variance with several other items and consequently distorts the dimensionality of the measurement model.

Content validity is a sub-form of construct validity. If the wording of items is too similar, the average correlation among items increases, which in effect increases the coefficient alpha, yet without adding substantively to the content validity of the measure (Netemeyer et al., 2003). Consequently, items worded too similar represent a validity problem. In this study, the issue of too close wordings did not occur, which support the construct validity of the CSDD. However, the original structure of the items did not reveal an excellent fit in this Norwegian NH sample; the analyses (both PCA and CFA) indicated that item4 *(Irritability: easily annoyed. short-tempered)* did not belong to the 'mood'--dimension as suggested in the original version of the CSDD. Item4 loaded along with item5 *(Agitation: restlessness. hand wringing. hair pulling)* and item7 *(Multiple physical complaints)* on the 'behavioral disturbance' dimension. Hence, irritability was linked with agitation and physical complaints, and not with the mood dimension containing sadness, anxiety and lack of response/reaction to pleasant happenings. It seems reasonably that irritability is stronger related with agitation and physical complaints than to sadness, anxiety and a kind of apathy in the NH population. These findings are in accordance with previous studies (Knapskog et al., 2013; Ownby et al., 2001; Schreiner & Morimoto, 2002) showing weak loadings for item4 (irritability) and item7 (physical complaints), indicating misspecification.

4.4. Limitations

The CSDD 16-items construct was reinforced by significant factor loadings, several goodness-of-fit indices and expected significant correlations with the selected constructs. Nonetheless, other alternative models might fit equally well with the present data as the identified model (Bollen, 1989).

The effective (listwise) sample size was N=245, which is considered a large sample size. A rate of 10 cases per observed variable is recommended (Brown, 2006; Hair et al., 2010). In this study the tested models included 16 and 19 items; accordingly, the sample of N=245 should be adequate. The present response rate was high (79.3 %; 309/245). This along with almost no missing data is a strength of this study. The excluded residents (n=64, 20.7%) scored lower on cognitive functionality than the total sample. This may limit the generalizability of the study results.

5. Conclusion

This study suggests a five-dimensional solution of the CSDD scale, including 16 of the original 19 items showing highly significant loadings and thus explaining a notable amount of the variation in the CSDD-construct. Each dimension included 3-4 items, and exposed good reliability coefficients (Cronbach's alpha and Composite reliability). Accordingly, reliability and validity were good. Further development and testing of a well-adapted scale assessing depression in the NH population with and without dementia are required.

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CRediT authorship contribution statement

Geir-Tore Stensvik: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Resources, Data curation, Writing - original draft, Writing - review & editing. **Anne-Sofie Helvik:** Conceptualization, Methodology, Validation, Writing - original draft, Writing - review & editing. **Sigrid Nakrem:** Conceptualization, Methodology, Writing - original draft, Writing - review & editing. **Gørill Haugan:** Conceptualization, Methodology, Validation, Formal analysis, Writing - original draft, Writing - review & editing.

Declaration of competing interest

The authors report no conflict of interest.

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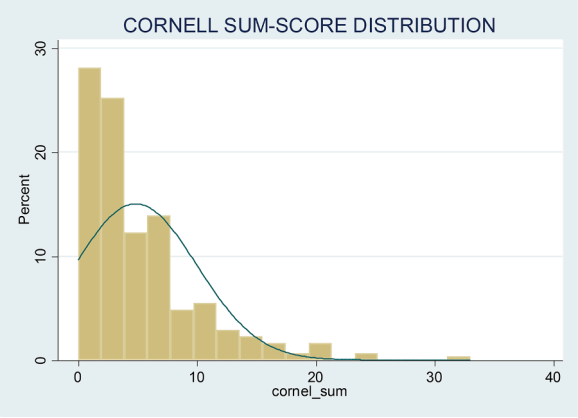
Appendix 1. The distribution of the Cornels depression in dementia sum-score

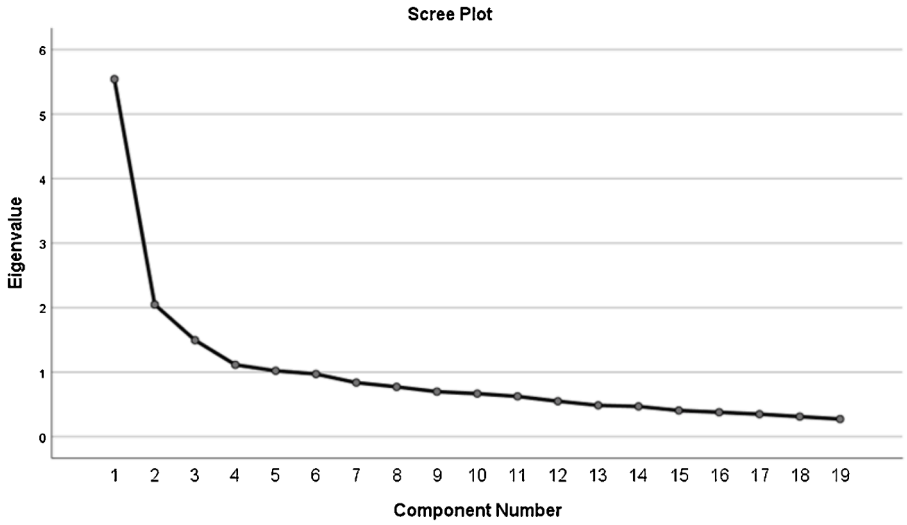


Appendix 2. Principal Component Analysis of the CSDD scale based in eigenvalues ≥1 – Rotated Component Matrix. Estimates for factor loadings, extraction sums of squared loadings and Cronbach's alpha

The PCA suggested 5-factor-solution, 19 items	Component				
	1	2	3	4	5
MOOD-RELATED SIGNS:					
A1 Anxiety: anxious expression. ruminations. worrying	.457				
A2 Sadness: sad expression. sad voice. tearfulness	.528				
A3 Lack of reactivity to pleasant events					.356
A4 Irritability: easily annoyed. short-tempered				.865	
BEHAVIORAL DISTURBANCE:					
B5 Agitation: restlessness. hand wringing. hair pulling				.880	
B6 Retardation: slow movement. slow speech or slow reactions					.816
B7 Multiple physical complaints				.498	
B8 Loss of interest: less involved in usual activities		.643			
PHYSICAL SIGNS:					
C9 Appetite loss: eating less than usual		.817			
C10 Weight loss		.833			
C11 Lack of energy: fatigues easily. unable to sustain activities		.648			
CYCLIC FUNCTIONS:					
D12 Diurnal variation of mood: symptoms worse in the morning				.452	
D13 Difficulty falling asleep: later than usual for this individual			.875		
D14 Multiple awakenings during sleep			.754		
D15 Early morning awakening: earlier than usual for this person			.827		
IDEATIONAL DISTURBANCE:					
E.16 Suicide: feels life is not worth living. has suicidal wishes. makes suicide attempt	.629				
E17 Poor self-esteem: self-blame. self-depreciation. feelings of failure	.871				
E18 Pessimism: anticipation of the worst	.836				
E19 Mood-congruent delusions: delusions of poverty. illness or loss	.446				
Cumulative % of total variance explained	29.17	39.94	47.81	53.67	59.04
Eigenvalues	5.542	2.047	1.495	1.113	1.020
Cronbach's Alpha *(number of items)*	0.79 (6)	0.74 (4)	0.79 (3)	0.66 (4)	0.44 (2)

Note: Extraction Method: Principal Component Analysis. Rotation Method: Promax with Kaiser Normalization. Rotation converged in 5 iterations. Eigenvalue for Factor 6 = 0.971 and 0.837 for Factor 7.

Appendix 3. Scree-plot of the CSDD scale, 19 items. Principal component analysis. N=247



Appendix 4. The Cornell's Depression in Dementia Scale. Original 19-items version

Variable	Scores			Mean	SD
	0	1	2	N=245	
MOOD-RELATED SIGNS:	N	N	N		
1 Anxiety: anxious expression. ruminations. worrying	157	110	11	0.52	0.041
2 Sadness: sad expression. sad voice. tearfulness	199	88	14	0.34	0.035
3 Lack of reactivity to pleasant events	224	61	18	0.26	0.033
4 Irritability: easily annoyed. short-tempered	160	116	30	0.54	0.041
BEHAVIORAL DISTURBANCE:					
5 Agitation: restlessness. hand wringing. hair pulling	257	36	15	0.15	0.028
6 Retardation: slow movement. slow speech or slow reactions	243	46	16	0.20	0.031
7 Multiple physical complaints	217	70	18	0.32	0.036
8 Loss of interest: less involved in usual activities	261	26	2	0.15	0.029
PHYSICAL SIGNS:					
9 Appetite loss: eating less than usual	265	35	8	0.16	0.028
10 Weight loss	265	23	7	0.13	0.025
11 Lack of energy: fatigues easily. unable to sustain activities	255	45	7	0.17	0.028
CYCLIC FUNCTIONS:					
12 Diurnal variation of mood: symptoms worse in the morning	242	44	18	0.23	0.033
13 Difficulty falling asleep: later than usual for this individual	257	35	2	0.21	0.032
14 Multiple awakenings during sleep	217	68	22	0.25	0.039
15 Early morning awakening: earlier than usual for this person	264	31	2	0.17	0.029
IDEATIONAL DISTURBANCE:					
.16 Suicide: feels life is not worth living. has suicidal wishes. makes suicide attempt	269	10	1	0.06	0.018
17 Poor self-esteem: self-blame. self-depreciation. feelings of failure	243	32	6	0.14	0.026
18 Pessimism: anticipation of the worst	217	54	11	0.26	0.032
19 Mood-congruent delusions: delusions of poverty. illness or loss	251	25	12	0.15	0.028

Note: Items 6, 7, 10, 11 and 12 are omitted in the best fitting 8-items measurement model. Listwise N=245. The CSDD is scaled 02, where higher score means higher depression.

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