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Validity of Center for Epidemiologic Studies Depression (CES-D) Scale in Eritrean Refugees Living in Ethiopia

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Validity of CES-D Scale in Eritrean Refugees Living in Ethiopia

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Berhanie Getnet,[1*] M.A., Girmay Medhin,[2] M.Sc., Ph.D., Atalay Alem,[1] M.D., Ph.D

[1]College of Health Sciences, Department of Psychiatry, Addis Ababa University; Addis Ababa, Ethiopia

[2]Aklilu Lemma Institute of pathobiology, Addis Ababa University, Addis Ababa, Ethiopia

Corresponding Author: Berhanie Getnet,; College of Health Sciences, Department of Psychiatry, Addis Ababa University; Addis Ababa, Ethiopia; email address: berhanie.getnet.bg@gmail.com ; Cell phone: +251911336295

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Abstract

Objectives: This study aimed at identifying the factor structure and construct validity of Center for Epidemiologic Studies Depression (CES-D) Scale in Eritrean refugees living in Ethiopia.

Setting: This study was carried out in Mai Aini refugee camp, situated in Northern Ethiopia , which is serving as a temporary shelter for more than 10,000 Eritrean refugees.

Participants: In a cross-sectional survey, 562 adults aged eighteen years old and above were randomly selected from Eritrean refugee community of which 304(54.1%) were females.

Measures: Primary outcome of the present study were measured by Center for Epidemiologic Studies Depression Scale (CES-D). The secondary outcome measures used for the purpose of validation, namely: Primary Care PTSD screener (PC-PTSD), Pre and Post-Migration Living Difficulties checklist, Oslo Social Support Scale (OSS-3), Sense of Coherence Scale (SoC-13), Coping Style scale and Fast Alcohol Screening Test (FAST) were administered concurrently. Confirmatory Factor Analysis (CFA) was employed to test pre-specified factor structures of CES-D.

Result: Two factors with second order common factor structure of CES-D (correlated error terms) yielded the best fit to the data [CFI= 0.975; RMSEA=0.040 (90%CI=0.032, 0.047)]. The 16 items defining depressive affect were internally consistent (Cronbach's alpha = 0.932) and internal consistency of the four items defining Positive Affect was medium (Cronbach's alpha = 0.703). Two factors with second-order common factor model of CES-D (uncorrelated error terms) has demonstrated configural, metric, scalar, error variance, and structural co-variance invariance (p>0.05) for both males and females.

Conclusions: Unlike previous findings among Eritreans living in the United States, second-order two factors structure of CES-D best fitted data for Eritrean refugees living in Ethiopia, implying importance of addressing culture for assessment and intervention of depression.

Key words: Depression, epidemiology, measurement, CES-D, validity, Factor structure, Eritrean refugees

Strengths and Limitations of the study

- Adaptation of measures into Tigrigna version following rigorous procedures of adaptation can be taken as the strength of the study in the face of paucity of research output which focused on adaptation of measures in African humanitarian settings.

- Ratings of each item of CES-D items for content relevance by expert before using them in the main study was another strength of the present study

- For this particular paper, however, optimal estimate of sample size would have been achieved if we had calculated our sample size based on statistical criteria. Sample size calculation for the current study was based on average prevalence estimate of PTSD in refugee camps of East Africa, because this particular paper was extracted from the larger study involving psycho-trauma of Eritrean refugees.

- This study would have been profitable if we have concurrently administered structured interviews like Schedule for Clinical Assessment in Neuropsychiatry (SCAN) and Composite International Diagnostic Interview (CIDI) or any of gold standard measure of depression to estimate criterion and predictive validity of the adapted Tigrigna version of CES-D.

Study Background

By the year 2020, depression is projected to be the second leading cause of Disability Adjusted Life Years (DALYs) and the fourth leading contributor to burden of disease (1, 2). Center for Epidemiologic Studies Depression Scale (CES-D) is one of the most common instruments used to measure depression in non-clinical populations (3). Despite the fact that there are several studies on detection of depression in the community using different measures, the latent factor structure for most measures of depression in many low income countries particularly in almost all African countries is not well understood. Mere reliance on total score of depression measures without understanding their latent factor structure is not sounding for reasons associated with possible threats to validity. In addition, symptom presentations for depression vary across cultures, implying the likelihood of incompatibility of existing measures of depression with local concepts of distress (4).

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CES-D is one of the widely used depression scales, which was originally designed to measure clinical depression in the general population (3). Four factors structure of CES-D was previously fitted to the data from elderly population of Spain and Mexico; samples of the Netherlands and China; African Americans living in the United States (5-7).

Studies suggest that the factor structures of CES-D can vary across different cultures (7-9). Alternative model of four latent factors with Sheehan's item allocation was tested as a variant for four factors structural model and demonstrated better fit to the data in many studies on samples from different cultures (10). In addition, evidence for two and three factor solutions of CES-D put the universality of the four factor dimensions of CES-D questionable (8,11). Therefore, its original four latent factor structure indicated is not consistently demonstrated across cultures (12). For example, in a Turkish sample, the psychometric properties (i.e. fit indices) of the four factor structures of CES-D were found to be weak (13). Besides its application to general population, CES-D was employed in different group of vulnerable populations, including prisoners in Nepal (14), genocide survivors in Rwanda (15), Eritrean refugees in United States (16), and Bosnian refugees (17). It was also used to measure depression among Korean immigrants in Canada (18). The instrument is translated into many languages, employed in different ethnic groups, used for wider age groups, and utilized to study depression from various groups of patients (13).

For example, the four factor structure demonstrated the best fitting model among black women in United States with or without history of cancer (20) and Eritrean refugees in the United States (16). It was reported that the two factor model, which combines all the negative items on one separate factor, and the remaining positive items on the second factor demonstrated superior fit (11). For example, the two factors model, negative affect (16-items) and wellbeing (4-items) best fits data from samples of elderly Mexicans in United

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States (9), Puerto Ricans (21), and in studies from South Africa (19) and Rwanda (15). The rational of the present study lies in the assumption that the factor structure of CES-D may vary across groups of Eritrean refugees living in Ethiopia compared to those Eritrean refugees living in United States for difference in their current culture.

Being informed by the findings of validation study of Tigrigna version of CES-D among Eritrean refugees in the United States (16) as a starting point, the general aim of the current study was to further the factor structure and construct validity of CES-D in Eritrean refugee community living in Ethiopia. The specific objectives of this study is to identify divergent, convergent and discriminant validities of the translated Tigrigna version of CES-D scale. For this purpose, Eritrean refugee population living in a camp in Ethiopia was used for the study.

Methods

Study setting: This study was carried out in Mai-Aini refugee camp, situated at 1,116 km North of Addis Ababa, the capital of Ethiopia. This is one of the largest refugee camps in Northern Ethiopia, and was established in 2008 by the support from the United Nations Higher Commissioner for Refugees (UNHCR) (22). As of 2013, this camp alone hosts about 17,825 Eritrean refugees (23) during the time of the study.

Study design: The findings in this study were extracted from an extensive cross-sectional survey that examined psychological trauma among Eritrean refugees in Ethiopia.

Sample size and sampling procedures

Since this study in large involves the psycho-trauma of Eritrean refugees, sample size was estimated based on average PTSD prevalence of 30.73% among refugees in East African camps (24-26) with 4% precision, 95% confidence and 90% response. This resulted in a

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minimum sample size of 562. Census data with complete information was not available, and we conducted census and coding of houses from December 2015 to January, 2016. In this census, a total of 2055 houses were registered out of which 100 houses were filtered out because they were units for unaccompanied minors (children below the age of 18 living without their parents or guardians). The remaining 1955 units of houses were taken as a sampling frame. From 1955 houses, 562 houses were selected using simple random sampling method. A single participant aged at least 18 years of age was selected from each of the selected house using a lottery method. Inclusion criteria include: those who had Eritrean nationality before migrating to Ethiopia, currently having a refugee status and those who were not admitted in the health center for treatment during the time of survey. Twenty two of the selected households were replaced from neighboring households (i.e. from those that preceded or followed the selected household numbers) because household members were not found upon three visits by data collectors. Data collection took place from January to March, 2016.

Adaptation procedures of measures

Except for CES-D, all the instruments were adapted following standard adaptation procedures of instruments for trans-cultural study. First, instruments were translated from the source language (English) into the target language (Tigrigna) by two bilingual experts, and then masked back translation was done by other two independent bilingual translators who had no knowledge about the original version. The translations as well as the back translations were given to experts for comments, and hence two consensus meetings were held to merge the translations.

Besides, cognitive interviews were done with six refugees from the target community and minor revisions were made based on their feedbacks. All the instruments were pilot tested before using them in the main study.

Patient and public involvement

Since refugees are special vulnerable people, care was taken during recruitment of participants. Each refugee participant was provided with sufficient information about the purpose of the study, expectations of participants, and potential outcomes of the study. Being vulnerable refugees, in order to avoid unnecessary fears of participants associated with the consequence of participation, they were shown official permission letter obtained from higher refugee government authority called Administration of Refugees and Returnees Affairs (ARRA). Involving counselors and psychiatrist , having years of work experience with Eritrean refugees in the process of adaptation of measures was helpful to ease of accommodating the interest and priorities of refugees in framing research questions as well as adapting measures to the best cultural understanding Eritrean refugees. Indeed, there was a direct involvement of some members of refugee community(especially local Eritreans who are members of health staff) and district level stakeholder organizations (i.e. CVT, International organization for Migration (IOM), United Nations Higher Commissionaire for the Refugees (UNHCR), and ARRA). These organizations collaborated our study by rendering some material support as well as equipping us with information during the adaptation study. Although those refugee who scored higher on PTSD were encouraged to visit counselors in Center for Victims of Trauma(CVT) and ARRA health center through Eritrean health staff members, arrangement of workshops and briefing sessions will be made to communicate on the outcome of the study directly to the participants of the study.

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Measures

Depression was measured using *Center for Epidemiologic Studies Depression Scale (CES-D)* (27). The translated Tigrigna version of CES-D is a brief 20 item scale with four alternative response options, which ranges from 'None of the time' to be scored 0 to 'Most of the time' to be scored 3, and this instrument is designed to measure depressive symptomatology in the general population (27). Four items (i.e.items-4, 8, 12 and 16) measuring feelings of positive affect were reverse coded (27).   CES-D was translated and validated into Tigrigna for Tigrigna speaking Eritrean refugees in the United States, and the author found alpha value of 0.86   for internal consistency and 0.91 for test re-test reliability (16).

Traumatic events for refugees were measured using *Pre and Post Migration Living Difficulties Checklist* (28). This brief 14-items checklist has a five point response format (i.e. strongly disagree scored 1; disagree = 2; neutral = 3; agree = 4, and strongly agree = 5) (28). In the present study, the internal consistency alpha values for pre-migration and post-migration living difficulties are 0.88 and 0.85 respectively (n=562).

 PTSD was measured using *Primary Care PTSD Screener* (*PC-PTSD)* (29). This is a four item brief PTSD screening instrument, having two option response level to be responded as 'Yes' or 'No' (29). In the present study, the internal consistency alpha value was found to be 0.68 for pilot study (n=50) and 0.64 for the main study (n=562).

 Coping strategies were measured using a *Coping Style Scale* (30), which is brief consisting of a list of 10 items.   The items have dichotomous response options, which require participants to respond as "this is not like me" or "this is like me" (30). In the present study, the internal consistency alpha value was found to be   0.61 in the pilot study (n=50) and 0.48 in the main study (n=562).

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Resilience was measured using Sense *of Coherence Scale (SoC-13)* (31). This is a 13-item semantic differential scale adapted to Eritrean culture in the form of a 5-point Likert scale from the original 7-point scale to reduce complexity of understanding (32). In the present study, the internal consistency alpha value was found to be 0.67 for pilot study (n=52) and 0.74 for main study (n= 562).

Social support was measured using *Oslo Social Support Scale (OSS-3)* (33). In the present study, the internal consistency Cronbach's alpha value of OSS-3 is 0.39 in the pilot study (n=52), while it is 0.58 for the main study (n=562).

Alcohol use was measured using *Fast Alcohol Screening Test (FAST*) (34). FAST is a brief four items tool meant to measure alcohol use, which was derived by taking few items from Alcohol Use Disorder Identification Test (AUDIT) (34,). Each item is scored from 0 to 4, whose total score was considered FAST positive for total scores of at least three (34). In the present study, item-total correlation ranges from 0.711 to 0.876 for pilot study (n=52) and from 0.723 to 0.905 in main study (n=562). Chronbach's alpha value for pilot and main study were 0.73 and 0.86 respectively.

Statistical analysis

Before running Confirmatory Factor Analysis (CFA), CES-D items were evaluated on the basis of minimum requirement criteria for assumptions of factor analysis. CFA was employed to generate 'etic' knowledge using IBM SPSS Amos, version, 21. More specifically, Confirmatory Factor Analysis (CFA) was employed to test theoretically relevant pre-specified factor structures of CES-D.

Cut-off values of fit indices for accepting a model was determined based on standard cut-off minimum criteria: values of chi-square to degrees of freedom (x^2/df) should be less than or equal to 3; values should be greater than or equal to 0.95 for Comparative Fit Index (CFI);

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greater than or equal to 0.95 for Tucker Lewis Index (TLI); less than or equal to 0.06 to 0.08 for Root Mean Square Error of Approximation (RMSEA), and less than or equal to 0.08 for Standardized Root Mean Square Residual (SRMR) (36).

Convergent validity was assessed by examining the extent to which the indicators loaded onto the expected factors, divergent or discriminate validity was judged using the correlation between the latent factors (38). Discriminant validity is considered adequate when this correlation is less than or equal to 0.80 or 0.85 (37).

Results

Socio demographic characteristics of participants

From among 562 participants, 304(54.1%) were females. The mean age of participants was 29.63 years, which ranged from 18 to 74 years (SD=10.18). The vast majority was literate; the average duration of stay in the refugee camp was 3.71 years, and high proportion of participants (92%) belonged to the Tigriya ethnic group. Only 8% of participants constitute other ethnic groups: Saho, Bilen, Tigre and Jabelty ethnic groups of Eritrea constituting 8% of altogether. 84% are followers of Coptic Orthodox Christianity. The study participants had diverse profile of occupation before coming to Ethiopia and most of them (71%) constituted students, military and farmers (see Table-1).

Table-1: The demographic characteristics of participants

Characteristics		Number (%)
Sex	Male	258(45.9)
	Female	304(54.1)
Age	Mean(SD)	29.6(10.2)
	18-24	205 (36.5)
	25-34	219(39.0)
	35-44	89(15.8)
	45-54	29(5.2)
	55-64	15(2.5)
	65-74	5 (0.9)
Educational	Non-literate	67(11.9)
Background	Elementary school	232(41.3)
	Secondary school	238(42.3)
	College graduate or above	25(4.5)
Marital status	Single	189(33.6)
	Married	327(58.2)
	Divorced	29(5.2)
	Widowed	17(3.0)
Religion	Orthodox	477(84.9)
	Protestant	17(3.0)
	Catholic	23(4.1)
	Muslim	44(7.8)
	Jehovah witness	1(0.2)
Past occupation in	Student	201 (35.8)
Eritrea	Military	111 (19.8)
	Farmer	89 (15.8)
	Home maid	66 (11.7)
	Educator	23 (4.1)
	Daily laborers	15 (2.7)
	Others	57(10.1)

Confirmatory Factor Analysis

Preliminary test for assumption of factor analysis for CES-D items indicates that Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.939. Bartlett's Test of sphericity was significant (x^2= 5258.70; df=190, P < 0.001). The minimum sample size needed (i.e. n > 200) for running factor analysis was also met (n=562).

In the present study, Single Group confirmatory factor Analysis (SGCFA) results for total sample (n=562) indicated that the four factors solution of CES-D model, which was identified by the original scale developer (Radloff), hasn't achieved a minimum of adequate fit because of negative definitiveness across the variance matrix within the factors. Further investigations of the alternative models of CES-D factor structures were made and the findings are shown in Table-2.

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Table-2: Comparison of data fit to computing factor structures of CES-D

Proposed Model of CES-D		x^2(df)	CFI	x^2/df	GFI	TLI	SRMR	RMSEA	P-value
1. Four correlated factors model (Sheehan's item allocation)	Correlated error terms	588.62(158)	0.916	3.725	0.903	0.899	0.0475	0.070	p<0.001
	Uncorrelated error terms	704.346(164)	0.895	4.295	0.882	0.878	0.0504	0.077	p<0.001
2. Four correlated factors second order model (Sheehan's item allocation)	Correlated error terms	619.63(161)	0.911	3.819	0.897	0.895	0.0480	0.071	p<0.001
	Uncorrelated error terms	709.251(166)	0.894	4.273	0.881	0.879	0.0508	0.076	p<0.001
3. Two correlated factors, second-order structure	Correlated error terms	271.65(144)	0.975	1.886	0.955	0.967	0.0378	0.040	p<0.001
	Uncorrelated error terms	725.929(169)	0.892	4.295	0.879	0.878	0.0512	0.077	p<0.001
4. Two correlated factors structure	Correlated error terms	271.65(144)	0.975	1.886	0.955	0.967	0.0378	0.040	p<0.001
	Uncorrelated error terms	725.929 (169)	0.892	4.295	0.879	0.878	0.0512	0.077	p<0.001
5. Three correlated factors structure based on PCA	Correlated error terms	337.45(155)	0.965	2.177	0.944	0.956	0.0480	0.046	p<0.001
	Uncorrelated error terms	520.45(167)	0.931	3.116	0.914	0.922	0.0480	0.061	p<0.001

Legend: X2/df=Chi-square to degree of freedom; CFA=Comparative Fit index; GFI=Goodness of Fit Index; TLI=Tucker Lewis Index; SRMR=Standardized Root Mean Residual; RMSEA=Root Mean Error of Approximation

Further modifications on this model based on Modification Indix (MI), after allowing error terms to correlate, suggested a reasonable fit of the data: x^2 =588.62; df= 158; CFI= 0.916; RMSEA= 0.070; SRMR= 0.0475. The four factors with second-order common factor model of CES-D, Sheehan's item allocation (uncorrelated error terms) demonstrated poor fit to the present data with fit indices of CFI < 0.90 and RMSEA > 0.05 (see figure-1). In addition, the four correlated factors structure of CES-D (Sheehan's item allocation with uncorrelated error terms) also demonstrated poor fit to the present data(see Figure-3).

Figure-1: Four factors with second order common factor structure of CES-D model (Sheehan's item allocation, uncorrelated error terms)

However, examination of the three correlated factors of CES-D (see Table-2: model-5), after allowing error terms to correlate, yielded excellent fit (CFI > 0.95, RMSEA<0.05). Of all the models tested, the second-order two factor structure of CES-D (Figure-2), after allowing error

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terms to correlate, demonstrated the best fit. The first factor, Negative Affect (16-items) has excellent internal consistency (Cronbach's alpha value of 0.932) whereas the second factor, Positive Affect (4 items), has demonstrated medium level of internal consistency (Cronbach's alpha value of 0.703). The internal consistency for all the 20 items of CES-D in the current study was 0.91.

The two correlated factors model of CES-D yielded a similar estimate of item loadings as well as the same fit indices with the second order two correlated factors model. Thus, modifications of the model after allowing error terms to correlate based on MI suggests that this model best fits data from this study population better than all models tested : x^2 =271.65; df=144; CFI= 0.975; SRMR= 0.0378; RMSEA= 0.040 (90%CI=0.032, 0.047).

Figure-2: Two factors with second order common factor model of CESD(uncorrelated error tems)

Divergent Validity

 CES-D showed negatively and significantly associated with Sense of Coherence Scale (SoC-13) r= -0.597, p<0.001, and Oslo Social Support Scale (OSS-3) (r= -0.319, p<0.001).

Convergent validity

The bi-variate Pearson's correlation coefficient (r) of CES-D with pre-migration living difficulties checklist (r= 0.545, p<.001), post migration living migration checklist (r= 0.47, p<0.001); PC-PTSD (r= 0.538, p<0.001); FAST (r=0.197, p<0.001) indicates a significant positive relationship. The internal consistency among the 20 items demonstrated excellent Cronbach's alpha of 0.91. The item-total correlation for the 16 items (defining negative affect) demonstrated strong correlation(r≥0.53), while for the remaining 4 items (defining positive affect), the item total correlation showed relatively weaker(r≤0.43).(see Table-1 in online supplement).

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In addition, the first-order two latent factors were adequately loaded onto a single dimension, and all the 20 indicator items have demonstrated sufficient loading onto their respective latent factors. More specifically, 57% of variance in the single second order factor ' depression' is explained by first-order latent factor, positive affect(4 items), while another 57% of variance of this single common construct 'depression' is explained by first-order latent factor, negative affect (16–items). In the same model, all the sixteen items sufficiently loaded onto the first factor (negative affect) ranging from 0.51 to 0.76, while four items sufficiently loaded onto the second factor (positive affect) ranging from 0.46 to 0.75.

Multi Group Confirmatory Factor Analysis (MGCFA) for males and females was performed on the two factors with second-order one common factor structure of CES-D (uncorrelated error terms) (see Table-3). Findings showed that there is evidence of measurement invariance such that chi-square differences for the two groups with respect to measurement weight, measurement intercept, structural co-variance and measurement residuals were not significant (p> 0.05).

Table-3: Comparison of unconstrained and constrained second order two factors CES-D model (with uncorrelated error terms) for males and females

Model	DF	x^2	P	NFI Delta-1	IFI Delta-2	RFI rho-1	TLI rho2
Measurement weights	18	13.965	0.731	0.003	0.003	-0.007	-0.007
Measurement intercepts	38	49.601	0.099	0.009	0.009	-0.010	-0.011
Structural covariances	41	55.456	0.065	0.010	0.011	-0.010	-0.011
Measurement residuals	61	76.714	0.085	0.014	0.015	-0.016	-0.017

Note:DF= Degree of Freedom; x^2 =chi-square; NFI=Normed Fit Index; IFI= Incremental Fit Index; RFI=Relative Fit Index; TLI= Tucker Lewis Index

Discriminant Validity

Evidence from the present study with respect to discriminant validity among four latent correlated factors (Sheehan's item allocation) demonstrates that there is strong co-variance

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between the three factors of depressive affect, somatic vegetative and interpersonal problems (r > 0.94, p< 0.001), which is greater than the threshold of value for a factor to be significant for discriminant validity. There is a satisfactory discriminant validity below the threshold cut-of point (r <0.80) demonstrated between positive affect with each of the three latent factor structures (i.e. depressive affect, somatic vegetative and interpersonal problems) with standardized co-variance of 0.37, 0.29 and 0.31, respectively (see Figure-3).

Figure-3: Four factors model of CES-D (Sheehan's item allocation, uncorrelated error terms)

Discussion

In this study, which was aimed at identifying factor structure and structural invariance of CES-D from among in Eritrean refugees currently living in Ethiopia, two correlated factors structure and two factors with second-order single factor structure of CES-D had reasonable fit to the data with all the twenty items sufficiently loading onto their respective latent factors. After allowing error terms to correlate, there is a substantial improvement in the fit indices in the two models. Since there is a second-order common 'depression factor' that represents the two related factors (i.e. depressive affect and positive affect) , we chose the two factors with second-order single common factor model to explain and meaningfully interpret data in the present study.

The present finding regarding the fit of our data with two factors structure supported previous findings in the African contexts, such as South Africa (19), and from the sample of genocide survivors in Rwanda (15). The present findings also supported previous evidence from the two factors structure of CES-D among non-institutionalized civilian Puerto Ricans living on the Islands (21), and in elderly Mexicans in the United States (9). It can be inferred that depression, as measured by CES-D, is best presented in terms of two factors instead of four factor structure proposed by the original scale developer (27) as well as demonstrated in

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Eritrean refugees in United States (16). Our finding come up with a contrasting finding regarding factor structure of depression for the same people who are living in different geographical and social environment, which underlines culture as more determinant for symptom expression of depression than ethnicity. Unlike the evidence from Puerto Ricans, which indicates two factors structure of CES-D was non-invariant between males and female (21), the current finding demonstrated measurement invariance of the two factors beteen males and females

The alpha value of 0.91 obtained for the whole scale as a measure of internal consistency in the present study is comparable with previous findings in African settings, such as 0.86 in Rwanda, and 0.90 in South Africa (35). Item-8 (*I felt hopeful about the future*), and item-4 *(I felt that I was just as good as other people*) showed the lower item-total correlation both in the pilot and in the main studies. This weaker correlation of item-4 in the present study supported previous evidence reported in cross cultural studies in Latin America, Spain and Mexico (5). The association between CES-D and other measures of adverse conditions in the current study including PC-PTSD, pre and post-migration living difficulties checklist, and FAST indicate a significant positive relationship. This implies that there is acceptable convergent validity between CES-D and measures of theoretically related constructs.

Test for discriminant validity in the present study between four latent correlated factors, in light of the proposed Sheehan's item allocation (10), demonstrated that there is strong co-variance among the three factors of depressive affect, somatic vegetative and interpersonal problems ($r \geq 0.95$, $p < 0.001$). This correlation is greater than 0.85 which is the maximum threshold value for a factor to be significant for discriminant validity (37). This may imply that the factors may stand to measure similar or the same construct. However, there is a satisfactory discriminant validity below the threshold cut-off point ($r < 0.80$) demonstrated

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between positive affect and each of the three latent factors (i.e. depressive affect, somatic vegetative and interpersonal problems) with standardized co-variance of 0.37, 0.29 and 0.31, respectively (see Figure-3). This indicates that the coefficients for the three former highly correlated factors indicate above the maximum threshold of discriminant validity. This may imply that the three correlated sub-scale factors (i.e. depressive affect, somatic vegetative and interpersonal problem) measure similar or same factor, while the later absence of positive affect may represent the second distinct factor for depression construct.

Conclusions

There is variation in symptom presentation of depression for people with the same ethnic background, but who are living in different socio-cultural and geographical settings. Although findings in the present study provided an additional evidence on the utility of CES-D as psychometrically sound instrument to measure depression among Eritreans in humanitarian settings, caution should be taken while interpreting the dimensionality of CES-D in light of the western Diagnostic Statistical Manual (DSM) framework in the assessment and diagnosis of depressive symptoms as well as planning an intervention for Eritrean refugee community living in Ethiopia.

Implications of the study to clinical practice

▪ Evidence of two factor structure of CES-D in Eritrean refugees in Ethiopia, in contrast to the common four factors structure, may be helpful for health care providers and researchers in the assessment and diagnosis of symptom presentation for depression in this community.

▪ Identification of factor structure for CES-D basically provides insight into how Eritrean community present symptom of depression, which is so vital to ease patient-vis-à-vis health provider communication, and facilitating conditions to plan for intervention.

▪ The current findings regarding the validity of CES-D as psychometrically sounding instrument as a measure depression in Eritrean community provides a supporting evidence of prior validity study made on Eritrean refugees in United States.

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Figure-1: Four factors structures of CES-D model, Sheehan's item allocation
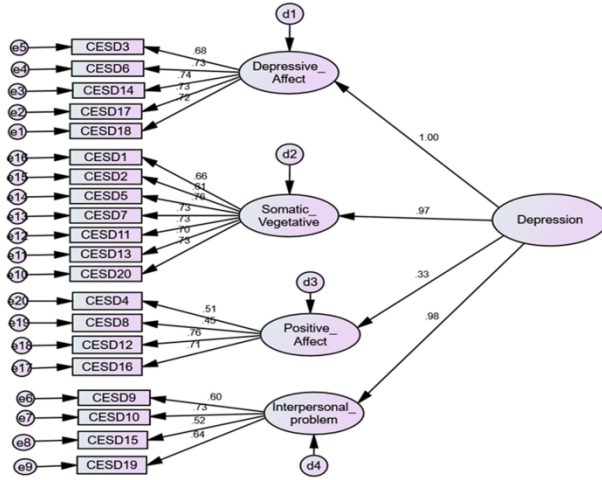
Legend: Rectangles represent indicator items; ovals represent latent factors; single headed arrows along with standardized weights represent factor loadings; circles represent error terms for each item (e), and disturbance terms of each latent factor (d).

Figure-1: Four factors structures of CES-D model, Sheehan's item allocation

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Figure-2: Two factors with second order common factor model of CESD (uncorrelated error tems)
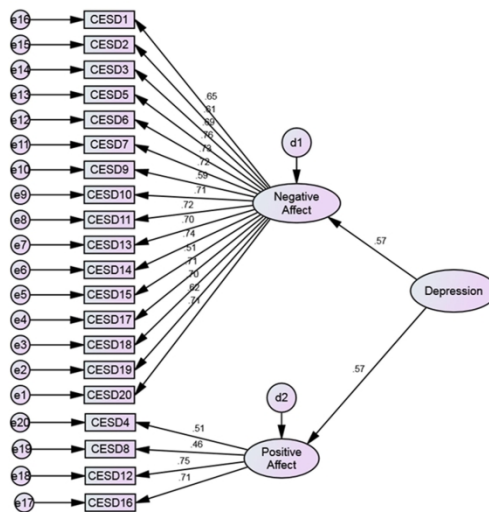
Legend: Rectangles represent indicator items; ovals represent latent factors; single headed arrows along with standardized weights represent factor loadings; circles represent error terms for each item (e), and disturbance terms of each latent factors (d).
Model fit: x^2=725.929; df=169; x^2/df= 4.295 ; CFI= 0.892; TLI= 0.878; RMSEA= 0.077; SRMR= .0512

Figure-2: Two factors with second order common factor model of CESD (uncorrelated error tems)

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Figure-3: Four factors model of CES-D (Sheehan's item allocation, uncorrelated error terms)
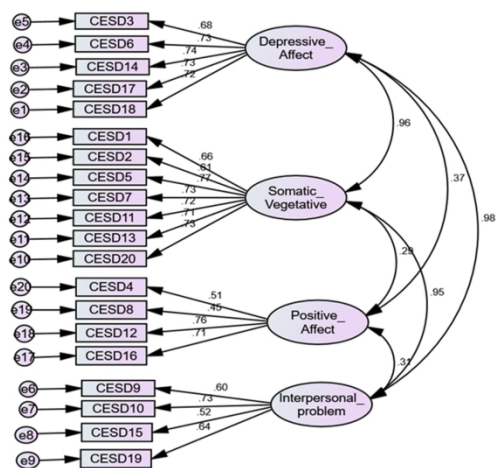
Legend: Rectangles represent indicator items; ovals represent latent factors; single headed arrows along with standardized weights represent factor loadings; double-headed arrows represent co-variances between factors; circles represent error terms for each item (e).
Model fit: x^2=704.346; df= 164; x2/df= 4.295; CFI= 0.895; TLI= 0.878; RMSEA= 0.077; SRMR= 0.0504

Figure-3: Four factors model of CES-D (Sheehan's item allocation, uncorrelated error terms)

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Validity of Center for Epidemiologic Studies Depression (CES-D) Scale in Eritrean Refugees Living in Ethiopia

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1,2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-5
Objectives	3	State specific objectives, including any pre specified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5,6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7-9
Bias	9	Describe any efforts to address potential sources of bias	2,6,9
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9
		(*b*) Describe any methods used to examine subgroups and interactions	9

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		(c) Explain how missing data were addressed	5
		(d) If applicable, describe analytical methods taking account of sampling strategy	5
		(e) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	NA
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	10
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	NA
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	NA
		(b) Report category boundaries when continuous variables were categorized	NA
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	14-15
Discussion			
Key results	18	Summarise key results with reference to study objectives	16,18
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16-18
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	2,16,17
Generalisability	21	Discuss the generalisability (external validity) of the study results	2,17-18
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	19

NA-Not Applicable

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Validity of Center for Epidemiologic Studies Depression (CES-D) Scale in Eritrean Refugees Living in Ethiopia

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Validity of CES-D Scale in Eritrean refugees living in Ethiopia

Validity of Center for Epidemiologic Studies Depression (CES-D) Scale in Eritrean Refugees Living in Ethiopia

Berhanie Getnet,[1,2*] M.A.,Atalay Alem,[1,3] M.D., Ph.D

[1] Addis Ababa University, College of Health Sciences, Faculty of Medicine, Department of Psychiatry, Addis Ababa, Ethiopia

[2]University of Gondar, Department of Psychology, P.O...Box: 196, Gondar, Ethiopia

[3]Amanuel Hospital, Addis Ababa, Ethiopia, P.O.Box 9086, Ethiopia

Corresponding Author: Berhanie Getnet, PhD candidate in Mental Health Epidemiology, College of Health Sciences, Faculty of Medicine, Department of Psychiatry, Addis Ababa University; Addis Ababa, Ethiopia;; email address: berhanie.getnet.bg@gmail.com ; Cell phone: +251911336295

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Validity of CES-D Scale in Eritrean refugees living in Ethiopia

Abstract

Background: Depression is among top priority mental health problems with high contribution to global burden of disease. This study aimed at identifying the latent factor structure and construct validity of Center for Epidemiologic Studies Depression (CES-D) Scale.

Participants and setting: In a cross-sectional survey, 562 adults aged eighteen years and above were randomly selected from Eritrean refugee community living in Mai Aini refugee camp, Ethiopia.

Measures: Center for Epidemiologic Studies Depression Scale (CES-D), Primary Care PTSD screener (PC-PTSD), Pre and Post-Migration Living Difficulties checklist, Oslo Social Support Scale (OSS-3), Sense of Coherence Scale (SoC-13), Coping Style scale and Fast Alcohol Screening Test (FAST) were administered concurrently. Confirmatory Factor Analysis (CFA) was employed to test pre-specified factor structures of CES-D.

Result: First-order two factors with second-order common factor structure of CES-D (correlated error terms) yielded the best fit to the data [CFI= 0.975; RMSEA=0.040 (90%CI=0.032, 0.047)]. The 16 items defining depressive affect were internally consistent (Cronbach's alpha = 0.932) and internal consistency of the four items defining Positive Affect was relatively weak (Crombach's alpha = 0.703). These two latent factors have weaker standardized co-variance estimate of 33% (24% for females and 40% for males), demonstrating evidence of discriminant validity. CES-D is significantly associated with measures of adversities, specifically, pre-migration living difficulties (r= 0.545, p<0.001) and post-migration living difficulties (r= 0.47, p<0.001), PC-PTSD (r= 0.538, p<0.001), FAST (r=0.197, p<0.001), and emotion-oriented coping (r=0.096, p<0.05) providing evidence of its convergent validity. It also demonstrated inverse association with measures of resilience factors, specifically, SoC-13 (r= -0.597, p<0.001) and OSS-3 (r= -0.319, p<0.001). The two correlated factors model of CES-D demonstrated configural, metric, scalar, error variance, and structural co-variance invariances (p>0.05) for both males and females.

Conclusions: Unlike previous findings among Eritreans living in the USA, second-order two factors structure of CES-D best fitted the data for Eritrean refugees living in Ethiopia, implying importance of addressing culture for assessment and intervention of depression.

Key words: Depression, Center for Epidemiological Depression Scale, Symptom presentation, Factor structure, Validity, Eritrean refugees, Ethiopia

Strengths and Limitations of the study

- Adaptation of measures into Tigrigna version following rigorous procedures of adaptation can be taken as the strength of the study, because it fills the pressing need for adaptation of depression measures in humanitarian settings of Africa.

- Rating of all the CES-D items by the experts for their content relevance is also the strength of the present study before using them in the main study.

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Validity of CES-D Scale in Eritrean refugees living in Ethiopia

- Comparison of factor structure of CES-D observed between males and females shades light for our limited understandings regarding the contrast of symptom presentation for males and females in African humanitarian context.

- This study would have been profitable if we have concurrently administered structured interviews like Schedule for Clinical Assessment in Neuropsychiatry (SCAN) and Composite International Diagnostic Interview (CIDI) to estimate predictive validity.

- Had the present study based on multiple groups of samples, it would have been increased the external validity of our findings. However, our sample was derived from a single population.

Study Background

By the year 2020, depression is projected to be the second leading cause of Disability Adjusted Life Years (DALYs) and the fourth leading contributor to burden of disease [1, 2]. Center for Epidemiologic Studies Depression Scale (CES-D) is one of the most common instruments used to measure depression in non-clinical populations [3]. Despite the fact that there are several studies to detect depression in the community using different measures, the latent factor structure for most measures of depression in many low income countries, particularly in almost all African countries, is not well understood. Mere reliance on total score of depression measures without understanding their latent factor structure is not sounding for reasons associated with validity. In this respect, cross cultural study recommended for the need to ensure measurement equivalence (measurement invariance) of CES-D before using this measure in a given culture [4]. Although most symptoms of depression are universal, problems related to validity and reliability of depression in African settings should be understood in light of ethnocentric conceptualizations [5, 6]. Symptoms of depression vary across a culture, which implies the possibility of incompatibility between existing measures of depression and local concepts of distress [5].

CES-D is one of the depression scales, which was originally designed to measure clinical depression in the general population (3). It was developed based on Beck's four-factor model of depression constituting four dimensions: positive affect, negative affect, somatic symptoms and retarded activity, and interpersonal difficulties [6]. Four factor structure of CES-D was previously fitted to the data from elderly population of Spain and Mexico, the Netherlands,

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China, African Americans and Caucasians living in the United States, and Hispanic older adults [7-10].

Studies suggest that factor structures of CES-D can vary across different cultures [9, 11, 12]. Alternative model of four latent factors proposed by Sheehan's item allocation was tested as a variant for the four factors structural model and demonstrated better fit to the data in many studies on study populations from different cultures [13]. In addition, evidence for two and three factor solutions of CES-D put the universality of the four factor dimensions of CES-D questionable [11,14]. Therefore, its original four latent factor structure indicated in previous studies, including by the original scale developer Radloff (1977) [15] is not consistently seen across cultures. For example, in a Turkish sample, the psychometric properties (i.e. fit indices) of the four factor structures of CES-D were found to be weak [16]. Besides its application to general population, CES-D was employed in different group of vulnerable populations, including prisoners in Nepal [17], genocide survivors in Rwanda [18], Eritrean refugees in United States [19], and Bosnian refugees [20]. It was also used to measure depression among Korean immigrants in Canada [21]. The instrument is translated into many languages, employed in different ethnic groups, various groups of patients and wider age groups to study depression [16]. Differences in the factor structures of CES-D have been reported in those studies.

Besides variation in culture and types of population, difference in age is also accountable for the difference in factor structure CES-D scale [22]. There are contrasting findings which state that CES-D is having stable factor structure and is reliable such that age, and other demographic variables and physical health factors do not significantly affect the factor structure as well as factor scores [10]. For example, the four factor structure demonstrated the best fitting model among black women in United States with or without history of cancer [23]. However, a report from South Korea stated that the 14 items of CES-D fits into three factor structures: anhedonia, negative affect and somatic symptoms [24]. CFA analysis in women selected from a Middle Eastern country of Jordan resulted in three factor solution, namely, negative affect, somatic symptoms and positive affect [25].

It was reported that the two factor model, which combines all the negative items on one separate factor, and the remaining positive items on the second factor demonstrated superior fit [14]. For example, the two factors model, negative affect (16-items) and wellbeing (4-items) best

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fits data in studies of elderly Mexicans in United States [12], Puerto Ricans [26], and in studies from South Africa [22] and Rwanda [18].

These variations in factor structure of CES-D measure seen across cultures, as reported in preceding paragraphs, necessitated the need to conduct further empirical study on the validity of this measure in sample of Eritrean refugees in the present study, because previous studies recommended the need to test the validity of measurement equivalence [4, 9, 11, 12, 13]. Being informed by the findings of validation study of Tigrigna version of CES-D among Eritrean refugees in the United States [19] as a starting point, the current study was designed to further understand the construct validity, factor structure and other psychometric properties of the Tigrigna version of CES-D scale. For this purpose, an Eritrean refugee population living in a camp in Ethiopia was used for the study.

Methods

Study setting: This study was carried out in Mai-Aini refugee camp, situated 1,116 km North of Addis Ababa, the capital of Ethiopia. This is one of the largest refugee camps in Northern Ethiopia, and was established in 2008 by the support from the United Nations Higher Commissioner for Refugees (UNHCR) [27]. As of 2013, this camp alone hosts about 17,825 Eritrean refugees [28]. In the camp there are three churches for Orthodox, Protestant and Catholic religion followers and one Mosque. The camp provides employment opportunities; health and education support to the local Ethiopians as well as the Eritreans [27]. Two humanitarian institutions, namely Administration of Refugees and Returnees Affairs (ARRA) and Center for Victims of Trauma (CVT) offer counseling and other forms of mental health care in the camp. In addition, Norwegian Refugee Council (NRC), International Rescue Committee (IRC) and Jesuit Refugee Service (JRS) are providing services such as education, psychosocial care and logistic support [29]. Together with other partner organizations, a coordinated delivery of protection and assistance was jointly run by ARRA of Ethiopian government and UNHCR [30].

Study design: In this paper we report a portion of findings from cross-sectional survey data, which is part of the larger study on the psycho-trauma of Eritrean refugees living in Ethiopia during the survey period.

Sample size and sampling procedures

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Validity of CES-D Scale in Eritrean refugees living in Ethiopia

This report was extracted from the larger study on psycho-trauma of Eritrean refugees. Sample size was estimated based on average prevalence estimate of PTSD of 30.73% among refugees and forced migrants in East African camps [31-33] with 4% precision, 95% confidence interval and 90% response. This resulted in a minimum sample size of 562. In order to determine a sampling frame, a census of refugees' document by UNHCR from the office of ARRA was used as the starting point. According to the census, there were a total of 10,006 registered refugees living in Mai Aini camp in January 2016, of which 4,257 were females. Since we found that the census data were not complete, especially for new arrivals, we conducted census of households from December 2015 to January, 2016. In this census, a total of 2055 households were registered out of which 100 houses were filtered out because they were units for unaccompanied minors (children below the age of 18 living without their parents or guardians). The remaining 1955 units of households were taken as a sampling frame. From this, 562 households were selected using simple random sampling method. One participant aged at least 18 years of age was selected from each of the selected households using a lottery method. Inclusion criteria included: those who had Eritrean nationality before migrating to Ethiopia, currently having a refugee status, and those who were not admitted in the health center for treatment during the time of the survey. Twenty two of the selected households were replaced from neighboring households (i.e. from those that preceded or followed the selected household numbers), because household members were not found upon three visits by data collectors. Data collection took place from January to March, 2016.

Adaptation procedures of measures

Except for CES-D, all the instruments were adapted following adaptation procedures of instruments for trans-cultural study [34]. First, instruments were translated from the source language (English) into the target language (Tigrigna) by two bilingual experts, and then masked back translation was done by other two independent bilingual translators who had no knowledge about the original version. Translations and the back translations were given to experts for comments, and hence two consensus meetings were held by the experts in Addis Ababa and Mekele Universities. Having input from feedbacks from the experts, other two consensus meetings were held to merge the translations.

Translations were then rated using a 4-point rating scale for their content relevance by seven experts to obtain content validity index [35, 36]. Besides, cognitive interviews were done with six refugees from the target community and minor revisions were made based on their feedbacks. All the instruments were pilot tested before using them in the main study.

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Patient and public involvement

Validation of measures employed in the present study was informed by the situational analysis study carried out one year prior to the current study (Getnet B. Personal communication, 2015). Specifically, validation of measures involved refugee counselors and a psychiatrist, who had years of work experience with Eritrean refugees. In doing this, the interest and priorities of refugees were accommodated in framing research questions as well as adapting measures to fit to the understanding of Eritrean refugees. There was a direct involvement of some members of the refugee community (especially Eritreans who were members of the health staff) and district level stakeholder organizations, such as CVT, International organization for Migration (IOM), United Nations Higher Commissionaire for the Refugees (UNHCR), and ARRA. These organizations supported the study by providing us with some materials support giving us the necessary information during the adaptation study. Although those refugees who scored higher on PTSD and depression were already encouraged to visit counselors in Center for Victims of Trauma (CVT) and ARRA through Eritrean healthcare staff, findings of the study will be communicated directly to the study participants as well as primary refugee stakeholder organizations, such as IOM, UNHCR, ARRA, CVT and JRS in the form of seminars and poster presentations.

Measures

Depression was measured using *Center for Epidemiologic Studies Depression Scale (CES-D)* [37]. The English version of CES-D is a brief 20 item scale with four alternative response options, which ranges from 'None of the time' to be scored 0 to 'Most of the time' to be scored 3, and this instrument is designed to measure depressive symptomatology in the general population [37]. Four items (i.e. items-4, 8, 12 and 16) measuring feelings of positive affect were reverse coded [37]. CES-D was translated and validated into Tigrigna for Tigrigna speaking Eritrean refugees in the United States, and the author found alpha value of 0.86 for internal consistency and 0.91 for test re-test reliability [19].

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Traumatic events for refugees were measured using *Pre and Post Migration Living Difficulties Checklist* [38]. This brief 14-item checklist has a five point response format (i.e. strongly disagree; disagree; neutral; agree, and strongly agree to be scored from 0 to 5) [38]. It was developed and employed to measure traumatic events of Zimbabwean refugees in South Africa in pre and post-migration periods [38, 39]. In order to differentiate those who had encountered trauma from those who hadn't, the authors re-coded original scores 1 to 3 to 0 and scores 4 & 5 to 1 [39].

PTSD was measured using *Primary Care PTSD Screener* (*PC-PTSD)* [40]. This is a four item a PTSD screening instrument, having two options as 'Yes' or 'No' [40]. Test re-test reliability for this measure was found to be 0.83 [41] with sensitivity and specificity of 0.78 and 0.87, respectively [40]. This scale was used in different population groups such as soldier returnees of the US from combat and refugees in the US from different countries to detect PTSD [41, 42, 43, 44]

Coping strategies were measured using a *Coping Style Scale* [45], which is consisting of a list of 10 items. The items require participants to respond as "this is not like me" or "this is like me" [45]. This instrument was cross-culturally validated by Trans-cultural Psychosocial Organization (TPO), and later used to study displaced Ethiopians from Eritrea [45]. This scale roughly captured three coping strategies, including: task-oriented, avoidance-oriented and emotion-oriented coping strategies [45].

Resilience was measured using Sense *of Coherence Scale (SoC-13)* [46]. This is a 13-item semantic differential scale adapted to Eritrean culture in the form of a 5-point Likert scale from the original 7-point scale to reduce complexity of understanding [47]. The instrument was reported to have proved measure of resilience in an Eritrean population [47].

Social support was measured using *Oslo Social Support Scale (OSS-3)* [48]. This is a scale consisting of three items in which sum scores range from 3-14 [49]. In a validation study of OSS-3 in Nigeria, the internal consistency Cronbach's alpha value was found to be 0.5 [49].

Alcohol use was measured using *Fast Alcohol Screening Test (FAST)* [50]. FAST is a four items tool meant to measure alcohol use, which was extracted from Alcohol Use Disorder Identification Test (AUDIT) [50, 51]. Each item is scored from 0 to 4, whose total score was considered as either FAST positive or negative. Mean score of three or more would be considered FAST positive [50]. Test-retest reliability of the total score for inter-rater agreement

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was 0.83, demonstrating excellent agreement [51]. It was employed to study alcohol use in the settings of East Africa, including Ethiopia [52]. FAST demonstrated overall sensitivity of 91% and specificity 93% [50], and it is assumed to be used in busy medical settings [51].

Statistical analysis

Before running Confirmatory Factor Analysis (CFA), CES-D items were evaluated on the basis of minimum requirement criteria for assumptions of factor analysis. CFA was employed to generate 'etic' knowledge using IBM SPSS Amos, version, 21. Single Group Confirmatory Factor Analysis (SGCFA) was employed to test theoretically relevant pre-specified factor structures for a single group of the total sample (n=562). Multi Group Confirmatory Factor Analysis (MGCFA**)** was used to test for measurement invariance between males and females on the four dimensions. Specifically, metric invariance (invariance of factor loadings) was performed upon confirmation of configural invariance between two groups [53]; scalar invariance (intercept invariance), which indicates equivalence for latent scores and observed scores; error variance invariance, which indicates presence of measurement error of each in the two groups; factor covariance invariance, indicating the stability in the relationship of factors between groups [54].

Cut-off values of fit indices for accepting a model was determined based on standard cut-off minimum criteria: values of chi-square to degrees of freedom (x^2/df) should be less than or equal to 3; values should be greater than or equal to 0.95 for Comparative Fit Index (CFI); greater than or equal to 0.95 for Tuker Lewis Index (TLI); less than or equal to 0.06 to 0.08 for Root Mean Square Error of Approximation (RMSEA), and less than or equal to 0.08 for Standardized Root Mean Square Residual (SRMR) [55].

Convergent validity was assessed by examining the extent to which the indicators loaded onto the expected factors and divergent or discriminate validity was judged using the correlation between the latent factors [56]. Discriminant validity is considered adequate when this correlation is less than or equal to 0.80 or 0.85 [56]. Content validity was analyzed by Content Validity Index (CVI), which estimates for item level content validity index (I-CVI) and scale level content validity index (S-CVI) for content relevance [35,57,58]. The proportion of agreement on the relevance of each item (I-CVI) should be at least 0.78 [35, 36].

Results

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Validity of CES-D Scale in Eritrean refugees living in Ethiopia

Socio demographic characteristics of participants

Characteristics	Number (%)

Of the 562 participants, 304(54.1%) were females. The mean age of participants was 29.63 years, which ranged from 18 to 74 years (SD=10.18). The vast majority was literate; the average duration of stay in the refugee camp was 3.71 years, and high proportion of participants (92%) belonged to the Tigriya ethnic group. Only 8% of participants constituted other ethnic groups: Saho, Bilen, Tigre and Jabelty ethnic groups In terms religion, 84% are followers of Coptic Orthodox Christianity. The study participants had diverse profile of occupation before coming to Ethiopia and most of them (71%) constituted students, military and farmers (see Table-1)

Table-1: The demographic characteristics of participants

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Validity of CES-D Scale in Eritrean refugees living in Ethiopia

Sex	Male	258(45.9)
	Female	304(54.1)
Age	Mean(SD)	29.6(10.2)
	18-24	205 (36.5)
	25-34	219(39.0)
	35-44	89(15.8)
	45-54	29(5.2)
	55-64	15(2.5)
	65-75	5 (0.9)
Educational	Non-literate	67(11.9)
Background	Elementary school	232(41.3)
	Secondary school	238(42.3)
	College graduate or above	25(4.5)
Marital status	Single	189(33.6)
	Married	327(58.2)
	Divorced	29(5.2)
	Widowed	17(3.0)
Religion	Orthodox	477(84.9)
	Protestant	17(3.0)
	Catholic	23(4.1)
	Muslim	44(7.8)
	Jehovah witness	1(0.2)
Past occupation	Student	201 (35.8)
in Eritrea	Military	111 (19.8)
	Farmer	89 (15.8)
	Home maid	66 (11.7)
	Educator	23 (4.1)
	Daily laborers	15 (2.7)
	Others	57(10.1)

Mean score and internal consistency of CES-D

The mean value of CES-D for the total sample (n=562) is 26.87 with standard deviation of 12.86. Specifically, females have a mean CES-D score of 26.83 on with standard deviation of 13.07, whereas males have a mean CES-D score of 26.91 with standard deviation of 13.76. The Cronbach's alpha value as a measure of internal consistency for items of CES-D was 0.917 in the pilot study (n=50) and 0.913 in the main study (n=562). The Gutman's split half reliability of this instrument was 0.905 (n=562). The item-total correlation ranged from 0.22 to 0.85 in the pilot study (n=50) and from 0.21 to 0.74 in the main study (n=562). Four items, which measure absence of positive wellbeing (item-4, item-8, item-12 and item-16), have consistently demonstrated lower item-total correlation both in the pilot and in the main study. The internal consistency is substantially reduced to less than or equals to 0.75 if any of the items is deleted compared to 0.91 alpha value for the total items (Table-2).

Content Validity

The Item-level Content Validity Index (I-CVI) values for the 20 items ranged from 0.71 to 1, and Average Scale Level Content Validity Index (S-CVI/ Ave) for the total scale was 0.92 (see Table-2).

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Validity of CES-D Scale in Eritrean refugees living in Ethiopia

Table-2: Summary of item-total correlation, internal consistency and content validity of CES-D

*Cronbach's alpha value for the total scale =0.91

Legend: I-CVI (Item level Content Validity Index); S-CVI/Ave (Scale level Content Validity Index, Average method) = 0.92

Single Group Confirmatory Factor Analysis (SGCFA)

CES-D items	Item-total correlation Main study (n=562)	Cronbach's Alpha if Item deleted (n=562)	I-CVI (n=562)
1: I was bothered by things that usually don't bother me.	0.670	0.740	1
2: I did not feel like eating; my appetite was poor	0.623	0.742	1
3: I felt that I could not shake off the blues even with help from my family.	0.687	0.738	0.86
4: I felt that I was just as good as other people.	0.284	0.750	1
5: I had trouble keeping my mind on what I was doing.	0.735	0.739	1
6: I felt depressed.	0.721	0.738	0.86
7: I felt that everything I did was an effort.	0.70	0.738	0.86
8: I felt hopeful about the future.	0.210	0.752	1
9: I thought my life had been a failure.	0.601	0.741	1
10: I felt fearful.	0.712	0.739	1
11: My sleep was restless.	0.732	0.739	0.86
12: I was happy.	0.425	0.747	1
13: I talked less than usual.	0.698	0.740	1
14: I felt lonely.	0.742	0.737	1
15: People were unfriendly.	0.525	0.744	0.86
16: I enjoyed life.	0.386	0.747	1
17: I had crying spells.	0.738	0.738	0.71
18: I felt sad.	0.706	0.739	1
19: I felt that people disliked me.	0.662	0.740	1
20: I could not "get going."	0.707	0.739	1

Preliminary test for assumption of factor analysis for CES-D items indicates that Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was 0.939. Bartlett's Test of sphericity was significant (x^2= 5258.70; df=190, P < 0.001). The minimum sample size needed (i.e. n > 200) for running factor analysis was also met (n=562).

In the present study, CFA results for the total sample (n=562) indicates that the four factor solution of CES-D model, which was identified by the original scale developer, Radloff (1977), hasn't achieved a minimum of adequate fit because of negative definitiveness across the variance matrix within the factors. Further investigations of the alternative models of CES-D factor structures were made and the findings are shown in Table-3.

Validity of CES-D Scale in Eritrean refugees living in Ethiopia

Table-3: Comparison of fit indices to the computing factor structures of CES-D to Eritrean refugee sample

Proposed model of CES-D		Sample	χ^2(df)	CFI	χ^2/df	GFI	TLI	SRMR	RMSEA	P-value
1. Four correlated factors model (Sheehan's item allocation)	Correlated error terms	Total sample (n=562)	588.62(158)	0.916	3.725	0.903	0.899	0.0475	0.070	p<0.001
	Uncorrelated error terms	Total sample (n=562)	704.346(164)	0.895	4.295	0.882	0.878	0.0504	0.077	p<0.001
2. First-order four factors with second order model (Sheehan's item allocation)	Correlated error terms	Total sample (n=562)	619.63(161)	0.911	3.819	0.897	0.895	0.0480	0.071	p<0.001
	Uncorrelated error terms	Total sample (n=562)	709.251(166)	0.894	4.273	0.881	0.879	0.0508	0.076	p<0.001
3. Two correlated factors structure	Correlated error terms	Total sample (n=562)	302.801(150)	0.970	2.019	0.950	0.962	0.0391	0.043	p<0.001
4. First-order twofactors, second-order common factor	Correlated error terms	Total sample (n=562)	271.65(144)	0.975	1.886	0.955	0.967	0.0378	0.040	p<0.001
	Correlated error terms	Female (n=304)	239.495	0.965	1.5886	0.929	0.956	0.0484	0.044	p<0.001
	Correlated error terms	Male (n=258)	284.592	0.952	1.801	0.901	0.943	0.0479	0.056	p<0.001

Legend: χ^2/df=Chi-square to degree of freedom; CFA=Comparative Fit index; GFI=Goodness of Fit Index; TLI=Tucker Lewis Index; SRMR=Standardized Root Mean Residual; RMSEA=Root Mean Error of Approximation

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Validity of CES-D Scale in Eritrean refugees living in Ethiopia

Examination of the four correlated factor structure of CES-D, Sheehan's item allocation, (figure-1) demonstrated poor fit to the present data with CFI < 0.90 and RMSEA > 0.05.

Figure-1: Four correlated factors model of CES-D model (Sheehan's item allocation, uncorrelated error terms)

Further modifications on this model based on Modification Index (MI), after allowing error terms of some items to correlate, this model showed a reasonable fit of the current data: χ^2 =588.62; df= 158; CFI= 0.916; RMSEA= 0.070; SRMR= 0.0475 (Table-3). Additional CFA test for the second-order four factors model of CES-D (Sheehan's item allocation) (figure-2) yielded more or less similar results with fit indices for the four correlated factors structure of CES-D with very slight differences (Table-3: model 1 and 2).

Figure-2: Four factors with second-order single common factor model of CES-D (Sheehan's item allocation, uncorrelated error terms)

CFA test for the two models, specifically for the two correlated factors model of CES-D (figure-3) and the first-order two factors with second-order common factor structure of CES-D (figure-4) yielded a similar estimate of item loadings and fit indices, which is below the acceptance level (CFI<0.95; RMSEA>0.06). The second-order common factor with first-order two factor structure was tested in order to further understand if the current data supported evidence of a single common latent factor 'depression', thinking that it can explain the two related factors.

Figure-3: Two correlated factor structure of CES-D, uncorrelated error terms

Further modifications of the model was made after allowing error terms of some items to correlate based on MI, and constraining one additional second-order path into 1 (see supplemental Figure-1). This resulted in excellent fit to the current data in sample of Eritrean refugees better than all models tested: x^2 =271.65; df=144; CFI= 0.975; SRMR= 0.0378; RMSEA= 0.040 (90%CI=0.032, 0.047) (see Figure-4).

The first factor, Negative Affect (16 Items) has excellent internal consistency (Cronbach's alpha value of 0.932) whereas the second factor, positive Affect (4 items), has good level of internal consistency (Cronbach's alpha value of 0.703).

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Figure-4: The first-order two factors with second-order common factor structure of CES-D, uncorrelated error terms.

In addition, the first-order two latent factors were adequately loaded onto a single dimension, and all the 20 indicator items have demonstrated sufficient loading onto their respective latent factors. In the hierarchical model of CES-D with first-order two factors model (correlated error terms), 57% of variance in the single second- order factor ' depression' is explained by first-order latent factor, positive affect (4 items), while 61% of variance of this second-order common construct 'depression' is explained by another first-order latent factor, negative affect (16–items) (see Figure-1 in supplement). In the first-order two factors with second-order common factor structure of CES-D, all the sixteen items sufficiently loaded onto the first factor (negative affect) ranging from 0.51 to 0.76, while four items sufficiently loaded onto the second factor (positive affect) ranging from 0.46 to 0.75 (Figure-4) for total sample. Similar trend of item loadings with smaller variation is observed between female (n=304) and male (n=258) sub-samples (see figure-5). In the second order single common factor model with first-order four factors model of CES-D (Sheehan's item allocation), all the 20 items of CES-D sufficiently loaded onto the expected four separate latent factors ranging from 0.45 to 0.76 (see Figure-2).

Multi Group Confirmatory Factor Analysis (MGCFA)

Multi Group Confirmatory Factor Analysis (MGCFA) was performed for males and females on the two correlated factors structure of CES-D (uncorrelated error terms), which resulted in a close fit to the data ($\chi^2 = 938$, df= 338, p<0.001; CFI= 0.884, TLI= 0.870, RMSEA=0.056 [90%CI=0.052, 0.061] , SRMR= 0.0538). Separate analysis for each group indicates that the fit indices for males (n=258) were $\chi^2 =432$, df=169, p<0.001; CFI=0.901, TLI=0.888, SRMR= 0.0538; RMSEA=0.078 (90%CI=0.069, 0.087), and the fit indices for females (n=304) were $\chi^2 = 505.571$, DF=169; CFI=0.867, TLI= 0.851, SRMR=0.0602, RMSEA= 0.081(90%CI=0.073, 0.089).

Thus, configural invariance was supported since this model demonstrated close fit, but not within acceptable range, to the current data for both males and females. Further analysis for measurement weight, measurement intercept, structural co-variance and measurement residuals indicate that chi-square differences were not significant (p> 0.05) (see Table-4).

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Validity of CES-D Scale in Eritrean refugees living in Ethiopia

Overall, the two correlated factors model is invariant between males and females. Thus, the findings demonstrate configural invariance, metric invariance, scalar invariance and structural co-variance invariance.

Table-4: Comparison of two correlated factors model of CES-D (with uncorrelated error terms) for males and female sub-samples of Eritrean refugees

Model	DF	χ^2	P	NFI Delta-1	IFI Delta-2	RFI rho-1	TLI rho2
Measurement weights	1 8	13.965	0.731	0.003	0.003	-0.007	-0.007
Measurement intercepts	3 8	49.601	0.099	0.009	0.009	-0.010	-0.011
Structural covariance	4 1	55.456	0.065	0.010	0.011	-0.010	-0.011
Measurement residuals	6 1	76.714	0.085	0.014	0.015	-0.016	-0.017

Note: DF= Degree of Freedom; χ^2=chi-square; NFI= Normed Fit Index; IFI= Incremental Fit Index;

RFI=Relative Fit Index; TLI= Tucker Lewis Index

In addition, an estimate for the standardized co-variance estimate for the two second-order depression latent factors calculated for male and female samples (figure-5), after constraining second order paths to 1 yielded modest relationship demonstrated significant relationship (standardized co-variance=0.28, p=0<0.05).

Figure-5: Co-variance between second-order depression latent factors for male (n=258) and female (n=304) sub-samples of Eritrean refugees

Discriminant Validity

Evidence from the present study with respect to discriminant validity among four latent correlated factors (Sheehan's item allocation) (Figure-1) demonstrated that there is strong co-variance between the three factors of depressive affect, somatic vegetative and interpersonal problems (standardized co-variance ≥ 0.95, p< 0.001), which is greater than the threshold of value for a factor to be significant for discriminant validity. There is a satisfactory discriminant validity below the threshold cut-off point (standardized co-variance < 0.80) demonstrated between positive affect with each of the three latent factor structures (i.e. depressive affect, somatic vegetative and interpersonal problems) with standardized co-variance of 0.37, 0.31 and 0.32, respectively. For women sub-sample(n=304), the covariance between positive affect with each of the sub-scales(i.e. depressive affect, somatic vegetative and interpersonal problems) with standardized co-variance of 0.34, 0.18 and 0.20, respectively. For male sub-sample (n=258) there is a standardized co-variance between positive affect with depressive

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affect, somatic vegetative and interpersonal problems is 0.39, 0.40, 0.40 respectively. The co-variance demonstrated in females and males is consistently lower (standardized co-variance ≤ 0.40) between positive affect and the other three latent factors. However, the co-variance seen in the three factors are very high both females and males (standardized co-variance estimate ≥0.91 for males and ≥0.96 for females) (see Table-5).

Table-5: Comparison in the co-variance between latent factors of CES-D for male and female sub-samples of Eritrean refugees

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Validity of CES-D Scale in Eritrean refugees living in Ethiopia

Four factors model of CES-D	sample	Fit statistics	Latent factors	Positive affect	Depressive affect	Somatic vegetative	Interpersonal problem
	Total (n=562)	CFI=0.895; RMSEA=0.077 (90%CI=0.71, 0.83)	Positive affect	1			
			Depressive affect	0.37	1		
			Somatic vegetative	0.29	0.96	1	
			Interpersonal problem	0.31	0.98	0.95	1
	Male (258)	CFI=0.906; RMSEA=0.077 (90%CI=0.68, 0.86)	Positive affect	1			
			Depressive affect	0.39	1		
			Somatic vegetative	0.40	0.96	1	
			Interpersonal problems	0.40	0.96	0.91	1
	Female (304)	CFI=0.872; RMSEA=0.081 (90%CI=0.73, 0.89)	Positive affect	1			
			Depressive affect	0.34	1		
			Somatic vegitative	0.18	0.96	1	
			Interpersonal problem	0.20	0.98	0.98	1
				Negative Affect			
Two factors model CES-D	Total (n=562)	CFI=0.892; RMSEA=0.077 (90%CI=0.71, 0.82)	Positive affect	0.33			
	Male (258)	CFI=0.901; RMSEA=0.078 (90%CI=0.69, 0.87)	Positive affect	0.40			
	Female (304)	CFI=0.867; RMSEA=0.081 (90%CI=0.73, 0.89)	Positive affect	0.24			

Note: CFI= Comparative Fit Index; RMSEA= Root Mean Square Error of Approximation

The bi-variate Pearson's correlation analysis indicated that CES-D showed negatively and significantly associated with Sense of Coherence Scale (SoC-13) r= -0.597, p<0.001, and Oslo Social Support Scale (OSS-3) (r= -0.319, p<0.001). The higher discriminant validity with estimates of co-variance ≤0.40) in the four factors model (Sheehan's item allocation) is

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Validity of CES-D Scale in Eritrean refugees living in Ethiopia

consistently demonstrated in female (n=304) and male (n=258) samples. In the two factors model, there is 33% of covariance between latent factors of 'positive affect' and 'negative affect'. Sub-sample CFA analysis by gender for this two factor model of CES-D demonstrated that there is some variation in factor co-variance (Table-4) and item loadings (Figure-5). The covariance between the two factors for females, males and total sample is 24%, 40% and 33% respectively. MGCFA showed that chi-square differences with respect to these factor co-variance and item loadings are not statistically significant (p>0.05), indicating factor co-variance invariance and metric invariance of this model for both males and females.

Convergent validity

Analysis of the bi-variate Pearson's correlation coefficient (r) of CES-D with measures of other constructs has showed a significant positive relationship with pre-migration living difficulties checklist (r= 0.545, p<.001), post migration living difficulties checklist (r= 0.47, p<0.001); PC-PTSD (r= 0.538, p<0.001); FAST (r=0.197, p<0.001) and emotion-oriented coping (r=0.096, p<0.05).

Comparison of the factor structure of present study with samples from western culture

In order to clearly understand the contrast in the factor structure of the present finding with findings of previous studies done in Europe, United States and Canada is summarized on table-6

Table-6: Comparison of the factor structure of the Tigrigna version of CES-D previous studies in sample of United States, Canada and Europe

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Validity of CES-D Scale in Eritrean refugees living in Ethiopia

Author	Study context	Sample	Best fitting Factor structure of CES-D
Present study	Eritreans in Ethiopia	Eritrean refugees living in Mai Aini refugee camp, Ethiopia	First- order two factors model, with second-order common factor (correlated error terms) CFI=0.975; RMSEA=0.040(90%CI==0.032, 0.047)
Wu, Q. et al.(2016)	Belgium	Dutch speaking Belgians (n=837)	First- order four factors model, with second-order common factor (correlated error terms) CFI=0.982, RMSEA=0.036(90%CI=0.031,0.041)
McCauley SR, et al. (2006)	United States	-340 participants who had brain injury, -Based on 3 years prospective data.	Four factors model of CES-D has a reasonable fit to the data CFI=0.99; RMSEA=0.023(90%CI=0.00,0.035)
Carleton, et al (2013)	Canada and United States	Multiple samples drawn from Canada and United States: -Undergraduate students (n=948); -Community sample (n=254); -Rehabilitation sample (n=522); -Clinical sample (n=84) -National Health and Nutrition Examination Survey (NHANES) (n=2814)	Three factor solutions CES-D best fitted to: -Undergraduate sample CFI=0.96;RMSEA=0.06(90%CI=0.05,0.06) -Community sample CFI=0.96;RMSEA=0.06(90%CI=0.05,0.08) -Rehabilitation sample CFI=0.97;RMSEA=0.05(90%CI=0.04,0.06) -Clinical sample CFI= 0.96;RMSEA=0.05(90%CI =0.01,0.08) -NHANES sample CFI=0.96;RMSEA=0.05(90%CI=0.04,.08)
Morin A.J.S, et al(2011)	France	French sample(n=461) Clinical sample(n=163) Non-clinical sample(n=298)	Four first-order factors and second-order factor (CFI= 0.993,RMSEA=0.04(90%CI=0.036,0.051)
Asari et al. (2016)	United States	-Comparative study based on two samples-based study: n=891= non-Hispanic whites; n=3570 black Africans	-The three factor model demonstrated optimum solutions to whites and blacks CFI=0.96; RMSEA=0.03 -Lack of invariance of item loadings between the two racial groups
Tatar and Saltukoglu	Turkey	1143 sample aged 17 to 85 selected from from student and adult population	Four factor structure of CES-D has demonstrated better fit to the data GFI=0.84; RMSEA=0.10

Note: GFI= Goodness of Fit Index; CFI= Comparative Fit Index; RMSEA= Root Mean Square Error of Approximation.

Discussion

In the present study, which was mainly aimed at identifying construct validity and factor structure and structural invariance of CES-D in Eritrean refugees who were living in Ethiopia during the study period, the two factors with higher-order single factor model of CES-D (with correlated error terms) showed best fit to the present data, with all the twenty items sufficiently loading onto their respective latent factors.

The present finding regarding the fit of our data with two factors structure seems to be in line with previous findings from South Africa [22], and from genocide survivors sample in Rwanda

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[18]. The present finding is also in agreement with studies from non-institutionalized civilian Puerto Ricans living on the Islands and in elderly Mexicans in the United States [12, 26]. It can be inferred that depression, as measured by CES-D, is best presented in terms of two factors instead of four factor structure proposed by the original scale developer, Radloff (1977) [37] as well as findings of previous study in Eritrean refugees in United States [19]. Our finding came up with a contrasting finding regarding factor structure of depression for Eritrean refugees living in different geographical and social environments, which would make it difficult to explain. The question remains whether the difference in current living circumstances of refugees can explain the difference in symptom expression of depression in people who originated from the same geographical and social environment.

Unlike the evidence from Puerto Ricans, which indicates two factor structure of CES-D was non-invariant between males and female [26], the current finding showed measurement invariance of the two factors between males and females. The overall two correlated factors model of CES-D (uncorrelated error terms) is invariant between male and female Eritrean refugees in this study since chi-square differences for measurement weight, measurement intercept, structural covariance and measurement residuals were not statistically significant (p> 0.05). This implies the stability of a two factor structure of depression in males and females as measured by CES-D where gender cannot confound the validity of this model in Eritrean refugee sample.

The alpha value of 0.91 obtained for the whole scale as a measure of internal consistency in the present study is comparable with previous findings in African settings, such as 0.86 in Rwanda, and 0.90 in South Africa as was indicated in a systematic review report [53]. The implications of a substantial reduction in internal consistency to less than or equals to 0.75 if any of the item is deleted compared to 0.91 alpha value for the total items (Table-2) is that all items of CES-D proposed by Radloff (1977) are so valid in Eritrean culture to measure the depression construct. The alpha value of 0.91 obtained for the whole scale as a measure of internal consistency in the present study is comparable with previous findings in African settings, such as 0.86 in Rwanda, and 0.90 in South Africa [35]. Item-8 (*I felt hopeful about the future*), and item-4 (*I felt that I was just as good as other people*) showed the lower item-

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total correlation both in the pilot and in the main studies. This weaker correlation of item-4 in the present study supports a report from cross cultural studies in Latin America, Spain and Mexico [7]. The association between CES-D and other measures of adverse conditions in the current study including PC-PTSD, pre and post-migration living difficulties checklist, and FAST indicate a significant positive relationship. This implies that there is acceptable convergent validity between CES-D and other scales, which measure adversities to psychological wellbeing. Of all measures used in the current study, CES-D is highly correlated with PC-PTSD, although the direction of relationship cannot be inferred from the current cross-sectional study design [57]. On the other hand, acceptable and the expected significant inverse association was demonstrated between sense of coherence scale (SoC-13) and CES-D on the same sample of Eritrean refugees, reported in a recent publication [58]. This means CES-D as measure of depression in Eritrean community did not positively relate to measures of resilience and wellbeing (sense of coherence), implying its acceptable divergent validity.

Test for discriminant validity in the present study between four latent correlated factors, in light of the proposed Sheehan's item allocation [13], demonstrated that there is strong co-variance among the three factors of depressive affect, somatic vegetative and interpersonal problems (r ≥ 0.95, p< 0.001). This correlation is greater than 0.85 which is the maximum threshold value for a factor to be significant for discriminant validity [56]. This may imply that the factors may stand to measure similar or the same construct. However, there is a satisfactory discriminant validity below the threshold cut-off point (r< 0.80) shown between positive affect and each of the three latent factors (i.e. depressive affect, somatic vegetative and interpersonal problems) with standardized co-variance of 0.37, 0.29 and 0.31, respectively (see Figure-1). This indicates that the coefficients for the three former highly correlated factors indicate above the maximum cut-off point in factor co-variance, implying absence of discriminant validity between the three related sub-scales. This may imply that the three correlated sub-scale factors measure similar things or same factor, while the later absence of positive affect may represent the second distinct factor for depression construct. The present findings support those previous research findings, which reported that the two factor structure of CES-D is more reasonable in the non-western sample studied [12,18,22,26], which is different from an acceptable four factor structure of the scale reported in samples reviewed in United States and Europe [59-64]. Our evidence strengthens the view that cultural variation in symptom presentation of depression is crucial [65], arguing that depression is not a mere product of the in balance in brain chemicals,

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but depression can may be a   socially constructed, whereby specific symptoms and pattern of symptomatology are differently emphasized across cultures. Our findings is in line with a contemporary theory of depression called social constructivist paradigm, which contends that depression can be resulted from individual's living environment and some other factors different from neural functioning [66]. In this paradigm, it is argued that depression should not be regarded as universal emotion; rather it is a condition lived out in a given socio-cultural condition [66]. A pillar of this paradigm known as *symbolic interactionism* contends that people construct the meaning of their depression in their daily life [66]. The dimensions of CES-D seen in terms of three/four   factors structures in samples drawn from samples of Europe, United States and Canada [59-64] contrasts the two factor structure of this scale in samples of non- western cultural settings [12,18,22,26]. In this regard, our findings lend a supportive evidence to the previous findings seen in samples of the latter group of studies done in non-western cultural contexts that   strengthens the social constructivism paradigm of depression [66].

Clinical implications of findings for refugees' health care

The findings of this study imply that there is variation in symptom presentation of depression for people with the same ethnic background, but who are living in different socio-cultural and geographical settings. Therefore, in the present sample, inter-correlated separate symptoms of depression, depressive affect, somatic complaints and social problem are loading onto a single common factor, implying that these three interrelated symptoms are being manifested as one mix of symptoms. Absence of positive affect was the second presenting symptom for depression. The diminished factor loadings from the first three separate latent factors (which is dominant factor structure of CES-D in many western settings) to one merged latent factor from among the two factors in the present sample may be helpful for health care providers and researchers to understand   and   explain the reason why most Eritreans may express their depressive feelings associated with social relationship and depressed mood through somatic symptoms.

Conclusions

Unlike Eritrean refugees in United States whose data fitted well with four correlated first order factor structure of CES-D, second-order one factor with two first order factors of CES-D fitted

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well to the current data generated from Eritrean refugees living in Ethiopia. Although findings in the present study provided an additional evidence on the utility of CES-D as psychometrically sound instrument to measure depression among Eritreans in humanitarian settings, caution should be taken while interpreting the dimensionality of CES-D in light of the western Diagnostic Statistical Manual (DSM) framework in the assessment of symptoms as well as planning an intervention for Eritrean refugee community living in Ethiopia.

List of Abbreviations: CES-D (Center for Epidemiologic Studies Scale); PC-PTSD (Primary Care PTSD Screener); OSS-3 (Oslo Social Support Scale,3- Items); SoC-13 (Sense of Coherence Scale,13-Items); ARRA (Administration of Refugee and Returnees Affairs); CVT (Center for Victims of Trauma); NRC (Norwegian Refugee Council); IRC (International Rescue Committee); JRS (Jesuit Refugee Service); UNHCR (United Nations Higher Commissioner for Refugees); DSM (Diagnostic Statistical Manual); I-CVI (Item-Level Content Validity Index); S-CVI/Ave (Scale-Level Content Validity Index, Average method); CFI (Comparative Fit Index); TLI (Tuker Lewis Index); RMSEA (Root Mean Square Error of Approximation); SRMR (Standardized Root Mean Square Residual); MGCFA (Multi Group Confirmatory Factor Analysis); Multi Group Confirmatory Factor Analysis (MGCFA); AAU (Addis Ababa University); USA (United States of America); MS (Manuscript).

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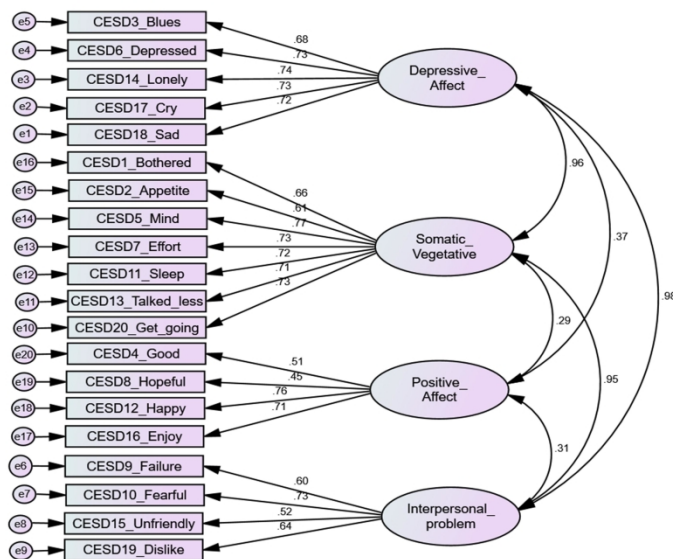
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Figure-3: Four factors model of CES-D (Sheehan's item allocation, uncorrelated error terms)

Legend: Rectangles represent indicator items; ovals represent latent factors; single headed arrows along with standardized weights represent factor loadings; double-headed arrows represent co-variances between factors; circles represent error terms for each item (e).
Model fit: x^2=704.346; df= 164; x2/df= 4.295; CFI= 0.895; TLI= 0.878; RMSEA= 0.077; SRMR= 0.0504

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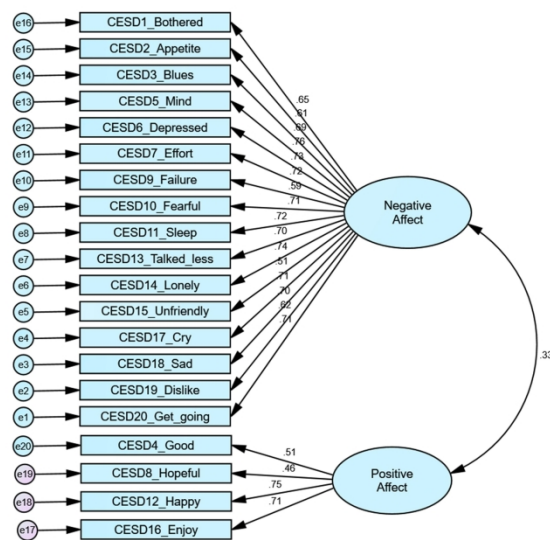
Figure-2:First-order four factors with second-order common factor structure of CES-D model, (Sheehan's
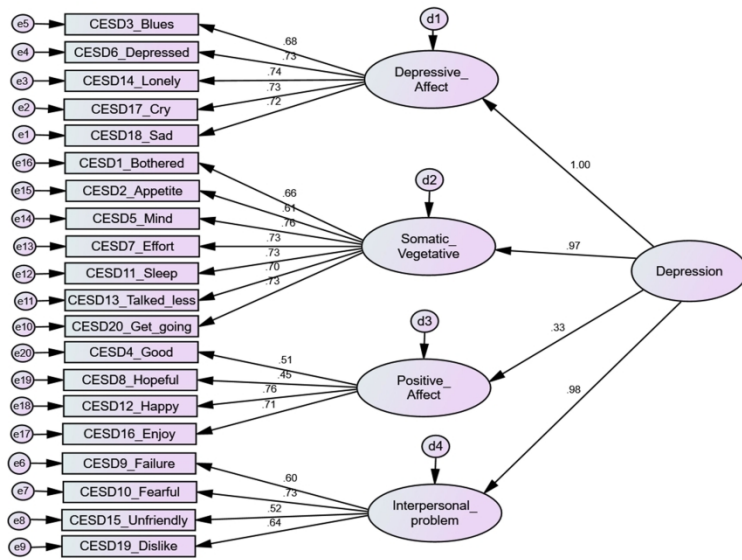
Legend: Rectangles represent indicator items; ovals represent latent factors; single headed arrows along with standardized weights represent factor loadings; circles represent error terms for each item (e), and disturbance terms of each latent factor (d). Model fit: $x2=709.251$; df= 166 ; $x^2/df=$ 4.273 ; CFI= 0.894 ; TLI= 0.879 ; RMSEA= 0.076 ; SRMR= 0.0508
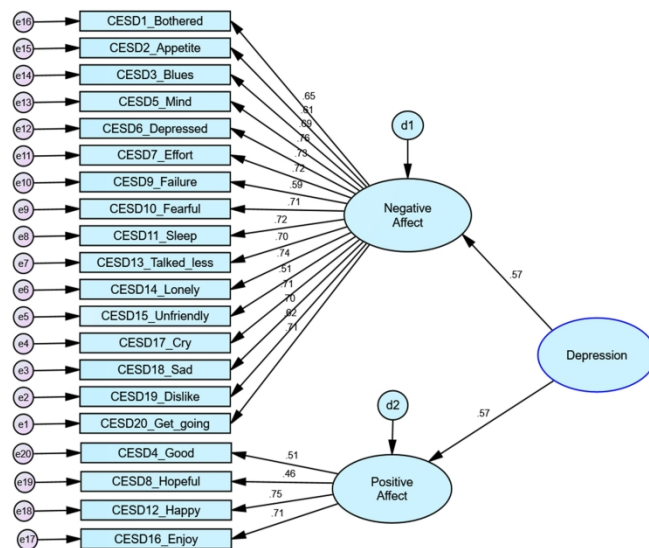
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Figure-2: Two correlated factors model of CESD (uncorrelated error terms)

Legend: Rectangles represent indicator items; ovals represent latent factors; single headed arrows along with standardized weights represent factor loadings; circles represent error terms for each item (e), and disturbance terms of each latent factors (d). Model fit: x^2=725.929; df=169; x^2/df= 4.295 ; CFI= 0.892; TLI= 0.878; RMSEA= 0.077;SRMR= .0512

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Figure-2: Two factors with second order common factor model of CESD (uncorrelated error terms)

Legend: Rectangles represent indicator items; ovals represent latent factors; single headed arrows along with standardized weights represent factor loadings; circles represent error terms for each item (e), and disturbance terms of each latent factors (d). Model fit: x^2=725.929; df=169; x^2/df= 4.295 ; CFI= 0.892; TLI= 0.878; RMSEA= 0.077;SRMR= .0512

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Figure-5: Covariance between second-order depression latent factors for male (n=258) and female (n=304) sub-samples of Eritrean refugees
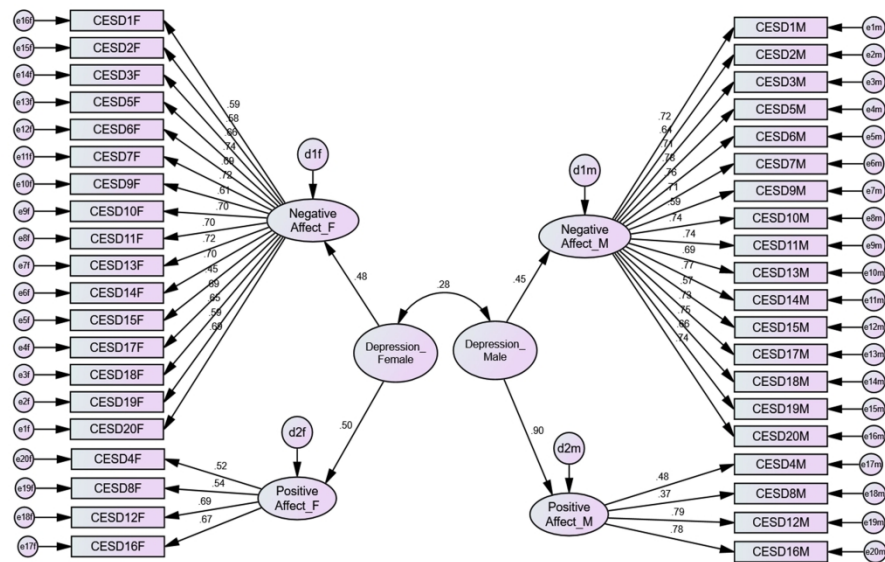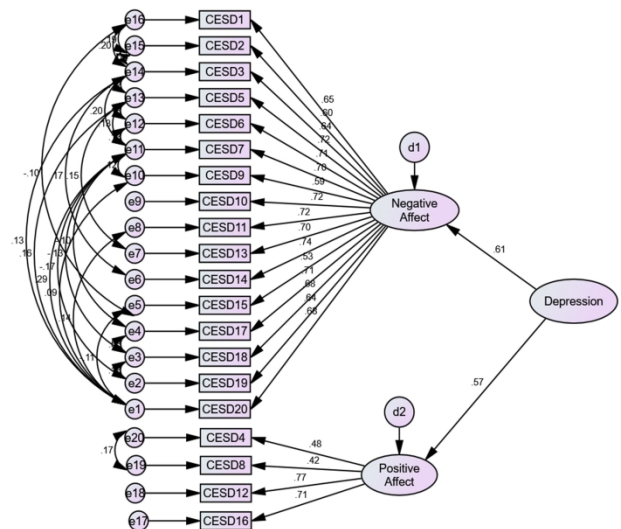
Legend: Rectangles represent indicator items; ovals represent latent factors; single headed arrows along with standardized weights represent factor loadings; circles represent error terms for each item (e), and disturbance terms of each latent factor (d). Model fit: $x2=71478.854$; df= 737; x^2/df= 2.007; CFI= 0.860 ; TLI= 0.844; RMSEA= 0.042(90% CI=0.039,0.045) .

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Figure-2: Two factors with second order common factor model of CESD

Legend: Rectangles represent indicator items; ovals represent latent factors; single headed arrows along with standardized weights represent factor loadings; circles represent error terms for each item (e), and disturbance terms of each latent factors (d).
Model fit: x^2=271.65 df=144; x^2/df= 1.886 ; CFI= 0.0.975 TLI= 0.967 ; RMSEA= 0.040 SRMR= .0.0378

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Validity of Center for Epidemiologic Studies Depression (CES-D) Scale in Eritrean Refugees Living in Ethiopia

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cross-sectional studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1,2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3-5
Objectives	3	State specific objectives, including any pre specified hypotheses	5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	5,6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7-9
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	7-9
Bias	9	Describe any efforts to address potential sources of bias	2,6,9
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	9
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	9
		(*b*) Describe any methods used to examine subgroups and interactions	9

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		(*c*) Explain how missing data were addressed		5
		(*d*) If applicable, describe analytical methods taking account of sampling strategy		5
		(*e*) Describe any sensitivity analyses		
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed		NA
		(b) Give reasons for non-participation at each stage		NA
		(c) Consider use of a flow diagram		
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders		10
		(b) Indicate number of participants with missing data for each variable of interest		NA
Outcome data	15*	Report numbers of outcome events or summary measures		NA
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included		NA
		(*b*) Report category boundaries when continuous variables were categorized		NA
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period		NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses		14-15
Discussion				
Key results	18	Summarise key results with reference to study objectives		16,18
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias		16-18
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence		2,16,17
Generalisability	21	Discuss the generalisability (external validity) of the study results		2,17-18
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based		19

NA-Not Applicable

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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