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VALIDATION OF CES-D8 AMONG CZECH UNIVERSITY STUDENTS DURING COVID-19 PANDEMIC

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ABSTRACT

Objectives. Due to the rise of depressive symptomatology especially among vulnerable populations such as young adults during the COVID-19 outbreak, a reliable measuring tool is needed. Because of the lack of such studies, the authors decided to validate the 8-item Center for Epidemiologic Studies Depression Scale (CES-D 8) among Czech university students capturing the beginning of lockdown experience.
Statistical analyses. Confirmatory factor analysis was conducted and structural equation modelling with diagonally weighted least squares estimation using lavaan was employed. Different hypotheses about the dimensionality of the CES-D 8 scale were tested. The authors assessed the measurement equivalence of the CES-D 8 scale according to gender using multigroup confirmatory factor analysis. The effect of socio-demographic and COVID-19 issues variables on depression was examined.
Results. One dimensional model with correlated errors showed sufficient validity and therefore, the best fit. Multigroup confirmatory factor analysis results revealed that the factor structure is invariant across gender. Women and those who reported financial distress and academic stress showed a higher level of depressive symptomatology. On the other hand, relationships proved to have a protective effect.
Limitations. The sample came from an online survey, respondents were self-selected. There was a gender imbalance in the sample that cannot be explained by a higher number of women in the Czech university environment.
Conclusions. The CES-D 8 proved to be a useful instrument for measuring depressed mood that opens further possibilities for depression research in the university environment and during pandemic situations.

key words:
C19 ISWS,
university students,
survey data,
measurement of equivalence,
factorial validity,
CES-D 8

klíčová slova:
C19 ISWS,
vysokoškolští studenti,
data z průzkumu,
měření ekvivalence,
faktorová validita,
CES-D 8

1 INTRODUCTION

Public health is at the centre of attention more than ever with the ongoing Covid-19 pandemic. Part of the world population suffers the direct consequences of this disease while the rest is affected by the restrictions responding to the outbreak. One of the unfortunate issues arising from the current situation is the increase of mental health problems such as depression (Salari et al., 2020) which have already had an increasing

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tendency over the last decade (Dine, 2012; James et al., 2018). Hence, it is necessary to have a reliable and verified tool for measuring depressive tendencies at our disposal.

Depressive symptomatology in Social Science is generally assessed via scales used solely for screening, not for diagnosing depression itself which can be done only on an individual basis by a professional. One of the most frequently used is the 8-item Center for Epidemiologic Studies Depression Scale (CES-D). The original version of the measurement tool consists of 20 items (Radloff, 1977) and it was additionally adjusted for use in large-scale surveys such as European Social Survey (ESS) by reducing the number of items to 8. This depression measure is also available in the Czech language and has been previously used in ESS (Median, 2014). For the manuscript, we used the same translation (see Appendix A). Although CES-D 8 has been employed in various studies (Huijts et al., 2013; Missinne & Bracke, 2012; Von Dem Knesebeck et al., 2011), there is on one hand an emphasis on the older population (Akhtarul Islam et al., 2020; Briggs et al., 2018; Ibrahim et al., 2013), and on the other hand a lack of focus on young adults. CES-D 8 was also employed in studies exploring the impact of the Covid-19 pandemic (Busse et al., 2021; Holingue et al., 2020; Zhou et al., 2020), but none of them evaluated the factor structure and psychometric properties of the scale. There is, nonetheless, only a handful of validation studies overall (Karim et al., 2015; Van de Velde et al., 2009) and once again none regarding university students or young adults in general.

Overall, associations between depression and several socio-demographic characteristics have been found; women are more likely to suffer from depression than men (Bebbington, 1996; Bromet et al., 2011; Piccinelli & Wilkinson, 2000; Rai et al., 2013). Also social and economic disadvantages, in general, appear positively correlated to depressive symptomatology (Lorant et al., 2003; Patel et al., 2009) along with the lower level of education (Akhtar-Danesh & Landeen, 2007; Bjelland et al., 2008). Research covering the linkage between age and depression is extensive in numbers, however, the results are unclear; while some studies suggest a higher risk of depression with an age increase (Beekman et al., 1999; Castro-Costa et al., 2007; Mykletun et al., 2001; Stordal et al., 2003), other show quite the opposite (Jorm, 2000; Kessler et al., 2010) or no association at all (Litwin, 2012; Verropoulou & Tsimbos, 2007). In reaction, several studies reflecting upon age as a mediator variable has emerged (Beekman et al., 1999; Buber & Engelhardt, 2011; Verropoulou & Tsimbos, 2007) advising more careful treatment and cautious conclusions. Surprisingly, CES-D 8 has not been employed for depression measurement among university students.

Given the situation we find ourselves in because of Covid-19, these circumstances and their relation to depressive symptoms also need to be reflected upon. Although it is assumed and also shown by recent research efforts, that there are many variables linked to depression that might be either direct or indirect impacts of the current situation, there is only a handful of academic studies pointing them out. Moreover, some are purely theoretical (e.g., Furr et al., 2001) while the less frequent ones are the empirical studies (e.g., Holingue et al., 2020). There are also some more general literature sources providing evidence that social isolation and loneliness harms mental health often aimed at specific populations such as older adults (Adams et al., 2004) or young adults (Matthews et al., 2016). However, there are no validations of CES-D 8 during such a unique situation as the current Covid-19 outbreak.

Students might also be considered a specific population group since the constant preparation for future employment in a form of a load of study and other obligations makes them vulnerable to stress and therefore also depression (Dahlin et al., 2005; Furr et al., 2001; Ibrahim et al., 2013). During the Covid-19 outbreak, a lot changed:

lectures and seminars moved to online platforms significantly lessening time spent socially present. Even though it is still early for steady academic conclusions, there is already some peer-reviewed evidence that home confinement along with the decrease of physical activity and decrease of sleep quality impacted manifested harmfully for students' mental health and their wellbeing overall (Akhtarul Islam et al., 2020; Fawaz & Samaha, 2020; Majumdar et al., 2020).

Czech women previously scored higher on self-reposted depression scale than men (Ciharova et al., 2020). Similar results were confirmed in the Belgian context and gender difference in depression prevalence is a recurrent epidemiological finding (Bracke, 1998, 2000). However, there is still a possibility that the observed difference across gender is partly due to measurement variance. Depression scales are often used to compare depression scores across gender (e.g., Buber & Engelhardt, 2011; Meredith, 1993), if valid comparisons are to be made, we need psychometric properties of the scale to be invariant. This can be tested through statistical procedure concerning the extent to which the same scale items preserve their meaning across groups.

Presented data is a result of research initiative Covid-19 International Student Well-Being Study (C19 ISWS) of the University of Antwerp which consists of 27 countries including the Czech Republic. The aim of this article is a validation of CES-D 8 in the Czech Republic at the beginning of the Covid-19 outbreak on university students since no studies are employing this very measurement tool in such a particular context.

Therefore, as was outlined above, the present study aims to assess psychometric qualities of CES-D 8 in the sample of Czech university students who have already been considered a vulnerable population to develop depressive symptomatology even before the Covid-19 outbreak. First, we examined the factorial structure of the scale using confirmatory factor analysis (CFA). Second, we assessed the measurement equivalence of the scale across gender using multigroup confirmatory factor analysis (MCFA). Third, we tested the measure's ability to exhibit correlations (positively or negatively) with other variables (socio-demographic, Covid-19 issues variables and field of study).

2 MATERIALS AND METHODS

2.1 Data

Analyzed data come from a Czech module of Covid-19 International Student Well-being Study (C19 ISWS). As the name itself indicates, the goal of the study was to map the well-being of students at the beginning of the Covid-19 pandemic (Van de Velde et al., 2021). The data contains answers from 6341 Czech students enrolled in university study in the Czech Republic.

Data were collected through an online survey; questionnaires were distributed by the universities. The online survey included basic demographic information, questions about daily activities (study, paid job, sport, etc.), the CES-D 8, questions about university workload and student services, and a simple true/false test of basic Covid-19 related knowledge. We asked the students to refer to their situation "before the Covid-19 outbreak" (the average situation during the month prior to the moment that the first COVID-19 measures were implemented) and "during the last week" (the week prior to filling out this survey). The data were collected from April 29 to May 19, 2020.

The questionnaire was originally developed in the English language and it was subsequently translated into many languages to correspond to the official language of all participating countries. The Czech version of the questionnaire was provided by the authors of this article who were also responsible for coordinating the Czech branch of

the survey. Where available, already existing Czech translations were applied (such as in the case of CES-D 8).

2.2 Ethical considerations

The research was conducted in compliance with standard ethical considerations. Questionnaires were treated with confidentiality and no personal data were collected to provide the highest possible protection. Participation was voluntary and students were informed about their right to abort the questionnaire at any time. Also, information regarding the aim and scope of the study was provided. Respondents had to actively give consent by marking boxes instructing about ethical considerations. The Czech part of the study was approved by The Research Ethics Committee of the Faculty of Social Sciences at Charles University in Prague.

2.3 Measurement

Our variables of interest were part of the eight-item version of the CES-D scale (see Table 1). Respondents were asked how often within the past week they (a) felt depressed, (b) felt everything they did as effort, (c) had restless sleep, (d) were happy, (e) felt lonely, (f) enjoyed life, (g) felt sad and (h) could not get going. Response categories were four in total: (1) none or almost none of the time, (2) some of the time, (3) most of the time, (4) all or almost all of the time. The two positive items ('was happy' and 'enjoyed life') were reverse coded, which means a higher score indicates more depressive mood.

Table 1 List of CES-D 8 Items in the English Language

Q38. Please indicate how much of the time during the past week …
a. …you felt depressed
b. …you felt that everything you did was an effort
c. ...your sleep was restless
d. ...you were happy (reversed)
e. ...you felt lonely
f. ...you enjoyed life (reversed)
g. ...you felt sad
h. ...you could not get going

Source: C19 ISWS (English version)

Following independent variables were used in the additional analysis: gender, age, relationship, academic stress, financial distress. Gender and being in a relationship are represented by binary variables in our data. Academic stress is measured by a question "The change in teaching methods resulting from the Covid-19 outbreak has caused me significant stress.", the item is rated on a 5-point scale, ranging from "totally disagree" (1) to "totally agree" (5). Financial distress is measured by a question "To what extent do you agree with the following statement? 'I had sufficient financial resources to cover my monthly costs'", response scale ranges from "strongly agree" (1) to "strongly disagree" (5). The field of the study was derived from the faculty at which students were enrolled.

The average age of respondents was almost 24 years, and a higher proportion of the sample was female (73.3%). About half of the respondents reported having a steady relationship (55.6%). Overall, students claimed to be financially secure (mean of finance distress was 2.1) and the data showed an overall moderate level of academic stress (mean was 3.2). Descriptive statistics for age, financial distress, and academic stress can be seen in Table 2.

Table 2 Descriptive Statistics for Independent Variables

	mean	sd	min	25% q.	50% q.	75% q.	max
Age	23.6	4.8	17	21	22	25	59
Finance	2.1	1.2	1	1	2	3	5
Stress	3.2	1.3	1	2	3	4	5

N=6341

Analyzed data consisted predominantly of the student of business, humanities, and natural sciences. Only 2.4 % of the respondents claimed to study technical disciplines. Descriptive statistics for the fields of study can be seen in Table 3.

Table 3 Descriptive Statistics for Fields of Study

	N	%
Agriculture	455	7.2
Business	1082	17.1
Technology	153	2.4
Humanities	1520	24.0
Soc. Science	414	6.5
Law	238	3.8
Medicine	286	4.5
Nat. Sciences	1061	16.7
Education	418	6.6
IT	438	6.9
Physical Edu.	276	4.4

N=6341

2.4 Methods

Confirmatory factor analysis (CFA) was conducted. For estimation, we employed diagonally weighted least squares method (DWLS) using lavaan. This type of estimation is more suitable for ordered categorical data with shorter scales (e.g., data collected using Likert scales) than maximum likelihood (ML) estimation (Mîndrilă, 2010). There is a broad discussion about appropriate estimation techniques for different types of data: ML, MLR, GLS, WLS and robust alternatives to WLS (DWLS, WLSM and WLSMV). Simulation studies compare mostly ML or MLR to WLS or robust alternatives. Studies (Li, 2016; Mîndrilă, 2010; Rhemtulla et al., 2012) confirm better behaviour of robust alternatives of WLS for short ordinal scales (max. to 4 points), these alternative estimation techniques offer better estimation for factor loadings and its standard estimates. These alternatives prove better also in comparison to the robust version of ML (MLR, MLM) (Li, 2016). Since CES-D 8 items have a small number of categories, we decide to apply DWLS. ML estimations can be found in Appendix D for comparison.

We used four specific model fit indicators: chi-square test, Root Mean Squared Error of Approximation (RMSEA), Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI).

No clear guidelines regarding the goodness of fit for ordered categorical data in SEM exist (Xia & Yang, 2019). Conventional cutoff values of goodness of fit for ML estimation are: RMSEA < 0.08, CFI > 0.95, TLI > 0.90 (Hu & Bentler, 1999). These cutoffs do not work when DWLS is applied (Nye & Drasgow, 2011). DWLS is more likely than ML to indicate better model-data fit because it produces smaller RMSEA and larger CFI and TLI than ML (Xia & Yang, 2019). Thus, we were using the goodness of fit indicators as diagnostic tools, without a set of desired values of RMSEA, CFI and TLI.

We also included indicators of discriminant validity – Average Variance Extracted (AVE) and Squared Correlation (SC) (Rönkkö & Cho, 2020). AVE is an indicator of construct validity as how much variance is explained by a given latent variable, squared (factor) correlation quantifies shared variance between latent variables (Farrell, 2010). Discriminant validity is assessed by comparing AVE and SC, the AVE should be greater than the shared variance (SC) (Hair et al., 2006).

Different hypotheses about the dimensionality of the CES-D 8 scale were tested (Reibling et al., 2017; S. Van de Velde et al., 2009). The one-dimensional (1D) model assumes that all eight items load on one common factor. The two-dimensional (2D) model assumes that there are two factors – "depressed affect" (consisting of A, D, E, F, G; see above) and "somatic complaints" (consisting of B, C, H). As already mentioned above, there are two positive items in CES-D 8 (D and F), these two items are somewhat less correlated with the "depressed affect" factor. Because of this, we tested a three-dimensional (3D) model assuming that there are three factors – "positive affect", "depressed affect" and "somatic complaints".

The alternative solution to the inconsistency of positively worded items is models with correlated errors between D and F. Thus, we added 1D and 2D models with correlated errors.

After we choose the best fitting model, we added information about the reliability of the scale. The internal consistency of the scale was assessed by the McDonald's omega. McDonald's omega is a parent measure to more familiar Cronbach's alpha, in contrast with Cronbach's alpha, McDonald's omega does not require "a restrictive assumption that is unlikely to be met in many measurement situations." (Hayes & Coutts, 2020, p. 20) Similar to Cronbach's alpha, McDonald's omega values higher than 0.8 can be interpreted as good internal reliability (Feißt et al., 2019).

Once a baseline model was established, we assessed the measurement equivalence of the CES-D 8 scale according to gender using multigroup confirmatory factor analysis (MCFA). This analysis was employed to test whether the structure of the scale was invariant across gender and therefore had an equal theoretical meaning in men and women. Invariance was tested on four levels of nested multiple group models: configural, weak, strong, and strict invariance models (Byrne, 2010; Cheung & Rensvold, 2009; Meredith, 1993; Widaman & Reise, 1997). In configural invariance, the number of factor loadings is the same across groups and each common factor is associated with identical item sets across groups. No equality constraints are imposed on parameters – factor loadings, intercepts, and unique item variances. In weak invariance, the factor loadings are constrained to be equal across groups. In strong invariance, the factor loadings and intercepts are constrained to be equal across groups. Finally, in a strict measurement invariance model, factor loadings, item intercepts and item residuals (errors) are constrained to equality across groups. These models were compared to determine whether the scale was invariant across gender. We used the CFI<0.01 criterium to determine the invariance of parameters across groups

(Cheung & Rensvold, 2009). If a more constrained model exhibits a critical decrease in model fit as compared to the unconstrained model, the constrained parameters are not considered to be invariant across groups. The decrease in CFI should not be more than 0.01 with each more restrictive model.

Next, the effect of socio-demographic and Covid-19 issues variables on depression was examined. The reason for this is first to test the usability of the selected model, and secondly to analyze gender, relationship status and age differences in depression and association with academic stress and financial distress caused by the Covid-19 pandemic. We hypothesized that academic stress and financial distress caused by the Covid-19 pandemic would have a positive association with depressive mood (more academic stress and financial distress mean more depressive mood).

3 RESULTS

Table 4 presents the summary of goodness-of-fit and discriminant validity of six different models of CES-D 8. These indicators were computed using DWLS estimation, we also produced values using ML estimation for comparison (see Appendix D).

Almost all CFI and TLI values in Table 4 were reaching the ceiling (>0.989) and suggesting an excellent fit. As mentioned before, DWLS produces larger CFI and TLI than ML, standard cutoffs do not work in this case. Still, we can compare individual values for different models. Model named 1D tested the one-factor model – this model has the largest $\chi 2$, which is, however, highly sensitive to sample size, and RMSEA and lowest CFI and TLI values. Also, 2D had relatively high RMSEA and relatively low CFI and TLI. Model 3D provided a better fit than 1D and 2D models, there was a substantial drop in $\chi 2$, RMSEA is lower, and the model has the largest CFI.

The other two models which take the positive items "enjoyed life" and "we're happy" into account (1D with correlated errors and 2D with correlated errors) had acceptable goodness-of-fit values, better than 1D and 2D models. However, a 3D model was technically preferable because of negligibly lower RMSEA and higher CFI and TLI.

In the next step, we examined the discriminant validity of different models. AVE and SC were calculated for latent variables, e.g., in the 2D model there were two AVE numbers for two latent variables and one SC number for the squared correlation between them. SC was higher than AVE for 2D, 2D with correlated errors and 3D. This demonstrates insufficient discriminant validity. As a result, we selected 1D with correlated errors as the most preferred model because low discriminant validity does not apply in this case and the model provides a good fit to the data. This model is also easier to use than models with multiple dimensions.

For comparison, goodness-of-fit indicators using ML estimation (Appendix D) are showing similar results. 1D model had unacceptable values of RMSEA, CFI and TLI (RMSEA < 0.08, CFI > 0.95, TLI > 0.90). 1D with correlated errors was similarly good fitting as 2D with correlated errors and 3D.

Figure 1 presents a 1D model with correlated residuals between two positive items. As we can see, all standardized factors' loading was high, lowest loading of 0.5 was estimated between factor and item C ('had restless sleep'). The reliability of the scale as assessed by the McDonald's omega was well above the acceptable value of 0.8 (0.861).

After deciding the baseline model (1D with correlated errors), we tested measurement invariance across gender through MCFA. Table 5 shows goodness-of-fit indices for four multiple group models: configural, weak, strong, and strict invariance

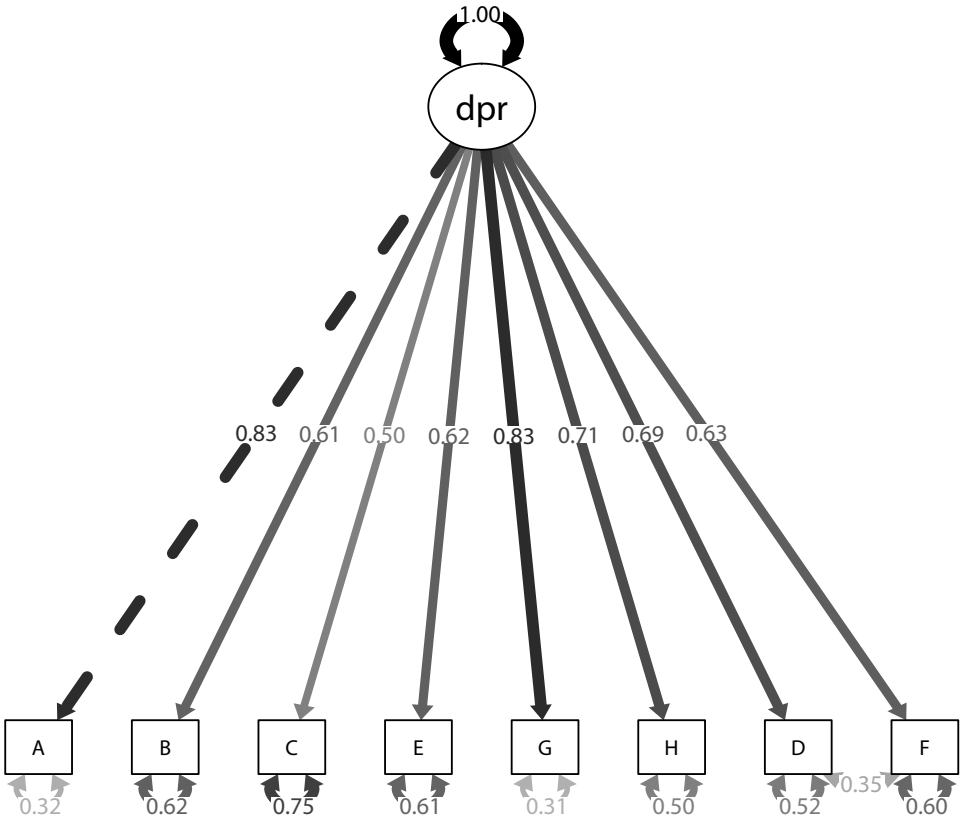

Figure 1 Confirmatory Factor Analysis of the CES-D 8, 1D with Correlated Errors
N=6341

model. Goodness-of-fit indices for the configural model indicated that the model fits well for both males and females, both samples shared the same one-factor pattern. The model with equality constraints imposed on item factor loadings (weak invariant model) had acceptable fit indices. To determine the degree of weak invariance across gender, we compared the CFI value between the configural invariance model and the weak invariance model. CFI decreased but this decrease was less than 0.01 which indicates that item factor loadings were invariant across gender.

The strong invariance model (equality constraints imposed on item factor loadings and intercepts) showed also a more than acceptable fit. The difference in CFI value between strong and weak invariance model was less than 0.01 which indicates that factor intercepts were also invariant across gender (in addition to factor loadings). The strict invariance model (equality constraints imposed on item factor loadings, item intercepts and item residuals) had very low RMSEA and very high CFI and TLI which indicates a good fit. Also, a decrease of CFI was less than 0.01. To summarize, item factor loadings, item intercepts and item residuals were invariant in men and women. According to our results, the scale had the same meaning across gender.

Table 4 Summary of the Goodness-of-Fit and Discriminant Validity Indicators of CES-D Models

Model	$\chi 2$	df	RMSEA	95% CI	CFI	TLI	AVE1	AVE2	AVE3	SC1	SC2	SC3
1D	319.832	20	0.049	0.044-0.053	0.992	0.989	0.477	–	–	–	–	–
1D with correlated errors	166.892	19	0.035	0.030-0.040	0.996	0.994	0.471	–	–	–	–	–
2D	261.834	19	0.045	0.040-0.050	0.993	0.990	0.552	0.414	–	0.820	–	–
2D with correlated errors	124.034	18	0.030	0.026-0.036	0.997	0.996	0.538	0.413	–	0.843	–	–
3D	107.729	17	0.029	0.024-0.034	0.998	0.996	0.617	0.413	0.635	0.791	0.661	0.631

N=6341; SC1 = Squared Correlation depressive affect, somatic complaints; SC2 = Squared Correlation depressive affect, positive affect; SC3 = Squared Correlation positive affect, somatic complaints

Table 5 Multigroup Confirmatory Factor Analysis

Equivalence tests	χ2	df	RMSEA	95% CI	CFI	TLI
configural	168.373	38	0.033	0.028-0.038	0.996	0.995
weak	208.343	45	0.034	0.029-0.039	0.996	0.995
strong	285.544	52	0.038	0.033-0.042	0.994	0.993
strict	310.553	60	0.036	0.032-0.040	0.993	0.994

N=6341

Significant differences across sexes were observed, with females scoring higher than males (2.22 versus 2.29; $p < 0.001$). In Appendix C, the observed means on all items and the total CES-D 8 scale score according to sex are reported.

After measurement equivalence assessment, examination of the effect of socio-demographic and Covid-19 issues variables on depression followed. Five variables, age, sex, relationship status, financial status during Covid-19, academic stress during Covid-19 were added as covariates to the best fitting model. Each covariate was estimated with a direct path to the depression factor. The model with these covariates (estimated using DWLS) had an acceptable fit to the data ($\chi2=876.394$, RMSEA=0.049, CFI=0.981, TLI=0.976). The regression coefficients of the covariates are presented in Table 6. Age proved to be a weak predictor of depression. Gender had a positive effect on depression, women scored on average 0.063 units higher than men. Being in a relationship decreased depression relatively strongly. Financial distress during the Covid-19 pandemic had a negative effect on the depression of university students. Academic stress proved to have a strong negative effect on depression. These five variables explained in total 20.7% of the variance of the depression factor.

Table 6 Parameter Estimates and Statistics for the Covariates of Depression

	Estimate	Std.Err	z-value	p(>|z|)	Std.all
depression ~					
age	-0.001	0.001	-1.152	0.249	-0.010
female	0.063	0.014	4.531	< .001	0.041
relationship	-0.265	0.012	-22.056	< .001	-0.191
finance	0.083	0.006	15.030	< .001	0.139
stress	0.193	0.005	38.022	< .001	0.353

N=6341, R(squared)=0.207

The effect of the field of study was also examined. We added dummy variables as covariates to the 1D model with correlated errors, the referential category was the business and management studies. The model with these covariates had an acceptable fit to the data ($\chi2=254.435$, RMSEA=0.017, CFI=0.996, TLI=0.995). The regression coefficients are presented in Table 7. Students of humanities and law had higher depression symptomatology than students of business, students of the physical education had lower CES-D 8 scores than students of business. Students of agriculture, technology, medicine, and natural sciences had similar CES-D 8 scores in comparison with students of business. The field of the study explained 2.2 % of the variance of the CES-D 8 factor.

Table 7 Parameter Estimates and Statistics for the Covariates of Depression

	Estimate	Std. Err	z-value	p(>|z|)	Std. all
depression ~					
study (ref. Business)					
Agriculture	-0.022	0.033	-0.667	0.505	-0.008
Technology	-0.023	0.041	-0.573	0.567	-0.005
Humanities	0.173	0.029	6.029	< 0.00	0.106
Soc. Science	0.158	0.034	4.676	< 0.00	0.056
Law	0.225	0.039	5.706	< 0.00	0.062
Medicine	0.054	0.035	1.562	0.118	0.016
Nat. Sciences	0.037	0.029	1.263	0.207	0.020
Education	0.132	0.033	3.959	< 0.00	0.047
IT	0.094	0.033	2.819	0.01	0.034
Physical Edu.	-0.247	0.038	-6.422	< 0.00	-0.073

N=6341, R(squared)=0.022

4 DISCUSSION

Even though CES-D 8 was originally intended to cover the general population as well as various subpopulations (Radloff, 1977), it currently has limited psychometric support for use with the university student population. To our knowledge, there have been no studies that would have evaluated CES-D 8 on the university student population or the young adults in general. On the contrary, multiple studies are inquiring about CES-D 8 use in the older population (Briggs et al., 2018; Karim et al., 2015; Missinne & Bracke, 2012). Also, measurement equivalence of the CES-D 8 in the general population in Belgium was examined (Van de Velde et al., 2009). These studies used data from comparative or panel studies (European Social Study, Survey of Health and Retirement in Europe), which have only limited use for inquiring the university student population. This study aimed to utilize data from the Czech module of Covid-19 International Student Well-being Study to evaluate the factor structure and psychometric properties of the CES-D 8 in the university student population.

Moreover, there is not yet a study examining the use of the CES-D 8 during the Covid-19 pandemic. Although CES-D 8 was used in multiple studies concerning the impact of the Covid-19 pandemic (Busse et al., 2021; Holingue et al., 2020; Zhou et al., 2020), none of them evaluated the factor structure and psychometric properties of the scale. CES-D 8 scale use was previously evaluated under normal circumstances, while our data are from the times which saw high levels of stress and anxiety. This argument is supported in Appendix E, where we provide a comparison of depression level means among Czech university students before the Covid-19 outbreak thanks to the use of ESS data and during the first wave. The question is: "Is this scale usable in such a specific context represented by the epidemic?"

The first objective of the present study was to examine the factorial structure of the CES-D 8 in a sample of university students. Hypotheses about the dimensionality of CES-D 8 used in the present study originated in the literature (Reibling et al., 2017; Van de Velde et al., 2009). Three structural forms can be hypothesized: one-dimensional, two-dimensional, and three-dimensional. Three possible factors are named: "positive affect", "depressed affect" and "somatic complaints". We also tested models with correlated errors between positively worded items "felt happy" and "enjoyed life" (namely one dimensional model with correlated errors and two-dimensional models

with correlated errors). The fit of all these models was excellent (CFI and TLI values >0.989). According to goodness-of-fit indicators, the 3D model provided the best fit to the data. However, the discriminant validity of this model was insufficient. As a result, the 1D model with correlated errors proved to be the most preferred.

After the selection of the baseline model, measurement equivalence assessment followed. MCFA with configural, weak, strong, and strict invariance models was conducted. A decrease of CFA of less than 0.01 with each more restrictive model (equality constraints were imposed on item factor loadings, item intercepts and item residuals) provided evidence for measurement invariance at all levels.

In the next step, we examined the effect of socio-demographic and Covid-19 issues variables on depressed mood indicators. According to studies, women report more complaints of depression than men (Van de Velde et al., 2009; Wu et al., 2016). This was also true for our university student sample, women reported more depressed moods than men. Being in a relationship has a strong protective effect against depression. As we hypothesized, financial distress and academic stress caused by the Covid-19 pandemic heightened the depressed mood of the respondents. Our CES-D 8 model proved to be a useful instrument for measuring depressed mood.

5 LIMITATIONS

Although results for psychometric properties of the CES-D 8 are promising, there are some limitations. Our sample came from an online survey, respondents were self-selected. There was a gender imbalance in our sample that cannot be explained by a higher number of women in the Czech university environment. Similarly, age did not prove to have a significant effect, likely due to the small range because the sample consisted of young adults overall. However, web-based studies, in general, can be considered reliable when conducted well (Krantz & Reips, 2017; Turk et al., 2018). Another limitation is that our results do not automatically imply psychometric equivalence outside of the Czech university student context. The expression and experience of depression may vary according to social or cultural factors. Also, it is quite likely the depressive scores means are higher due to the unprecedented occasion such as the currently ongoing Covid-19 pandemic. We reflect this fact in Appendix E where we compare depression levels among students in 2014 and 2020. Further studies outside the Czech context, ideally examining an international sample of university students, are needed.

6 CONCLUSIONS

Our results indicate that CES-D 8 is a promising measurement instrument for depression within the university student context in the Czech Republic during the pandemic situation. One dimensional depression model with correlated errors fits the data best. The scale is invariant across males and females. One dimensional model with correlated errors proved to be useful in analyzing the effect of socio-demographic and Covid-19 issues variables on depression. Female university students reported higher levels of depressed mood than male students. Moreover, financial distress and academic stress caused by the Covid-19 pandemic enhanced depressed mood in respondents overall. The effect of the field of study on depressed mood was weak, according to R-squared. Being in a relationship appeared as a protective trait against depression.

To sum up, CES-D 8 opens further possibilities for depressive symptomatology research in a university environment during pandemic situations. Our analysis shows

the feasibility of using CES-D 8 for university students and accordingly, we intend to continue using it in our future investigations taking place during the ongoing pandemic. Thus, this was not just a theoretical exercise, our article has also practical implications. Beyond that, the advantage of CES-D 8 lies in its considerably short length, and it is, therefore, fit for any questionnaire.

REFERENCES

Adams, K. B., Sanders, S., & Auth, E. A. (2004). Loneliness and depression in independent living retirement communities: Risk and resilience factors. *Aging and Mental Health*, *8*(6), 475-485. https://doi.org/10.1080/13607860410001725054

Akhtar-Danesh, N., & Landeen, J. (2007). Relation between depression and sociodemographic factors. *International Journal of Mental Health Systems*, *1*, 1-9. https://doi.org/10.1186/1752-4458-1-4

Akhtarul Islam, M., Barna, S. D., Raihan, H., Nafiul Alam Khan, M., & Tanvir Hossain, M. (2020). Depression and anxiety among university students during the COVID-19 pandemic in Bangladesh: A web-based cross-sectional survey. *PLoS ONE*, *15*(8 August), 1-12. https://doi.org/10.1371/journal.pone.0238162

Bebbington, P. (1996). The origins of sex differences in depressive disorder: Bridging the gap. *International Review of Psychiatry*, *8*(4), 295-332. https://doi.org/10.3109/09540269609051547

Beekman, A. T. F., Copeland, J. R. M., & Prince, M. J. (1999). Review of community prevalence of depression in later life. *British Journal of Psychiatry*, *174*(APR.), 307-311. https://doi.org/10.1192/bjp.174.4.307

Bjelland, I., Krokstad, S., Mykletun, A., Dahl, A. A., Tell, G. S., & Tambs, K. (2008). Does a higher educational level protect against anxiety and depression? The HUNT study. *Social Science and Medicine*, *66*(6), 1334-1345. https://doi.org/10.1016/j.socscimed.2007.12.019

Bracke, P. (1998). Sex differences in the course of depression: Evidence from a longitudinal study of a representative sample of the Belgian population. *Social Psychiatry and Psychiatric Epidemiology*, *33*(9), 420-429. https://doi.org/10.1007/s001270050075

Bracke, P. (2000). The three-year persistence of depressive symptoms in men and women. *Social Science and Medicine*, *51*(1), 51-64. https://doi.org/10.1016/S0277-9536(99)00432-3

Briggs, R., Carey, D., O'Halloran, A. M., Kenny, R. A., & Kennelly, S. P. (2018). Validation of the 8-item Centre for Epidemiological Studies Depression Scale in a cohort of community-dwelling older people: data from The Irish Longitudinal Study on Ageing (TILDA). *European Geriatric Medicine*, *9*(1), 121-126. https://doi.org/10.1007/s41999-017-0016-0

Bromet, L. H. A., Hwang, I., Sampson, N. A., Alonso, J., de Girolamo, G., de Graaf, R., Demyttenaere, K., Hu, Ch., Iwata, N., Karam, A. N., & Jagdish Kaur, S. K. (2011). Cross-national epidemiology of DSM-IV major depressive episode. *BMC Medicine*, *9*(90). https://doi.org/10.1186/1741-7015-9-90

Buber, I., & Engelhardt, H. (2011). The association between age and depressive symptoms among older men and women in Europe. Findings from SHARE. *Comparative Population Studies*, *36*(1), 103-126. https://doi.org/10.4232/10.CPoS-2011-02en

Busse, H., Buck, C., Stock, C., Zeeb, H., Pischke, C. R., Fialho, P. M. M., Wendt, C., & Helmer, S. M. (2021). Engagement in health risk behaviours before and during the covid-19 pandemic in German university students: Results of a cross-sectional study. In *International Journal of Environmental Research and Public Health* (Vol. 18, Issue 4, pp. 1-16). https://doi.org/10.3390/ijerph18041410

Byrne, B. M. (2010). *Structural equation modeling with Amos: Basic concepts, applications, and programming* (2nd ed.). Routledge/Taylor & Francis Group.

Castro-Costa, E., Dewey, M., Stewart, R., Banerjee, S., Huppert, F., Mendonca-Lima, C., Bula, C., Reisches, F., Wancata, J., Ritchie, K., Tsolaki, M., Mateos, R., & Prince, M. (2007). Prevalence of depressive symptoms and syndromes in later life in ten European countries: The SHARE study. *British Journal of Psychiatry*, *191*(NOV.), 393-401. https://doi.org/10.1192/bjp.bp.107.036772

Cheung, G. W., & Rensvold, R. B. (2009). Structural Equation Modeling : A Evaluating Goodness-of- Fit Indexes for Testing Measurement Invariance. *Structural Equation Modeling: A Multidisciplinary Journal*, *9*(2), 233-255. https://doi.org/https://doi.org/10.1207/S15328007SEM0902_5

Čihařová, M., Cígler, H., Dostálová, V., Šivicová, G., & Bezdíček, O. (2020). Beck depression inventory, second edition, Czech version: demographic correlates, factor structure and comparison with foreign data. *International Journal of Psychiatry in Clinical Practice*,

24(4), 371-379. https://doi.org/10.1080/13651501.2020.1775854
Dahlin, M., Joneborg, N., & Runeson, B. (2005). Stress and depression among medical students: A cross-sectional study. *Medical Education*, *39*(6), 594-604. https://doi.org/10.1111/j.1365-2929.2005.02176.x
Dine, J. (2012). A global crisis? *Companies, International Trade and Human Rights*, 1-40. https://doi.org/10.1017/cbo9780511660139.002
Farrell, A. M. (2010). Insufficient discriminant validity: A comment on Bove, Pervan, Beatty, and Shiu (2009). *Journal of Business Research*, *63*(3), 324-327. https://doi.org/10.1016/j.jbusres.2009.05.003
Fawaz, M., & Samaha, A. (2020). E-learning: Depression, anxiety, and stress symptomatology among Lebanese university students during COVID-19 quarantine. *Nursing Forum*, *October*, 1-6. https://doi.org/10.1111/nuf.12521
Feißt, M., Hennigs, A., Heil, J., Moosbrugger, H., Kelava, A., Stolpner, I., Kieser, M., & Rauch, G. (2019). Refining scores based on patient reported outcomes - Statistical and medical perspectives. *BMC Medical Research Methodology*, *19*(1), 1-9. https://doi.org/10.1186/s12874-019-0806-9
Furr, S. R., McConnell, G. N., Westefeld, J. S., & Jenkins, J. M. (2001). Suicide and depression among college students: A decade later. *Professional Psychology: Research and Practice*, *32*(1), 97-100. https://doi.org/10.1037/0735-7028.32.1.97
Hair, J. F., Black, W. C., Barry, B. J., Anderson, R. E., & Tatham, R. L. (2006). *Multivariate data analysis* (6th ed.). Prentice Hall.
Hayes, A. F., & Coutts, J. J. (2020). Use omega rather than Cronbach's alpha for estimating reliability. But…. *Communication Methods and Measures*, 1-24. https://doi.org/10.1080/19312458.2020.1718629
Holingue, C., Kalb, L. G., Riehm, K. E., Bennett, D., Kapteyn, A., Veldhuis, C. B., Johnson, R. M., Daniele Fallin, M., Kreuter, F., Stuart, E. A., & Thrul, J. (2020). Mental distress in the United States at the beginning of the covid-19 pandemic. *American Journal of Public Health*, *110*(11), 1628-1634. https://doi.org/10.2105/AJPH.2020.305857
Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling*, *6*(1), 1-55. https://doi.org/10.1080/10705519909540118
Huijts, T., Kraaykamp, G., & Subramanian, S. V. (2013). Childlessness and psychological well-being in context: A multilevel study on 24 European Countries. *European Sociological Review*, *29*(1), 32-47. https://doi.org/10.1093/esr/jcr037
Ibrahim, A. K., Kelly, S. J., Adams, C. E., & Glazebrook, C. (2013). A systematic review of studies of depression prevalence in university students. *Journal of Psychiatric Research*, *47*(3), 391-400. https://doi.org/10.1016/j.jpsychires.2012.11.015
James, S. L., Abate, D., Abate, K. H., Abay, S. M., Abbafati, C., Abbasi, N., Abbastabar, H., Abd-Allah, F., Abdela, J., Abdelalim, A., Abdollahpour, I., Abdulkader, R. S., Abebe, Z., Abera, S. F., Abil, O. Z., Abraha, H. N., Abu-Raddad, L. J., Abu-Rmeileh, N. M. E., Accrombessi, M. M. K., … Murray, C. J. L. (2018). Global, regional, and national incidence, prevalence, and years lived with disability for 354 diseases and injuries for 195 countries and territories, 1990-2017: a systematic analysis for the Global Burden of Disease Study 2017. *The Lancet*, *392*(10159), 1789-1858. https://doi.org/10.1016/S0140-6736(18)32279-7
Jorm, A. F. (2000). Does old age reduce the risk of anxiety and depression? A review of epidemiological studies across the adult life span. *Psychological Medicine*, *30*(1), 11-22. https://doi.org/10.1017/S0033291799001452
Karim, J., Weisz, R., Bibi, Z., & ur Rehman, S. (2015). Validation of the eight-item Center for Epidemiologic Studies Depression Scale (CES-D) among older adults. *Current Psychology*, *34*(4), 681-692. https://doi.org/10.1007/s12144-014-9281-y
Kessler, R. C., Birnbaum, H., Bromet, E., Hwang, I., Sampson, N., & Shahly, V. (2010). Age differences in major depression: Results from the national comorbidity survey replication (NCS-R). *Psychological Medicine*, *40*(2), 225-237. https://doi.org/10.1017/S0033291709990213
Krantz, J. H., & Reips, U. D. (2017). The state of web-based research: A survey and call for inclusion in curricula. *Behavior Research Methods*, *49*(5), 1621-1629. https://doi.org/10.3758/s13428-017-0882-x
Li, C. H. (2016). Confirmatory factor analysis with ordinal data: Comparing robust maximum likelihood and diagonally weighted least squares. *Behavior Research Methods*, *48*(3), 936-949. https://doi.org/10.3758/s13428-015-0619-7
Litwin, H. (2012). Physical activity, social network type, and depressive symptoms in late life: An analysis of data from the National Social Life, Health and Aging Project. *Aging and Mental Health*, *16*(5), 608-616. https://doi.org/10.1080/13607863.2011.644264
Lorant, V., Deliège, D., Eaton, W., Robert, A., Philippot, P., & Ansseau, M. (2003).

Socioeconomic inequalities in depression: A meta-analysis. *American Journal of Epidemiology*, *157*(2), 98-112. https://doi.org/10.1093/aje/kwf182

Majumdar, P., Biswas, A., & Sahu, S. (2020). COVID-19 pandemic and lockdown: cause of sleep disruption, depression, somatic pain, and increased screen exposure of office workers and students of India. *Chronobiology International*, *00*(00), 1-10. https://doi.org/10.1080/07420528.2020.1786107

Matthews, T., Danese, A., Wertz, J., Odgers, C. L., Ambler, A., Moffitt, T. E., & Arseneault, L. (2016). Social isolation, loneliness and depression in young adulthood: a behavioural genetic analysis. *Social Psychiatry and Psychiatric Epidemiology*, *51*(3), 339-348. https://doi.org/10.1007/s00127-016-1178-7

Median (2014). *ESS Questionnaire* (p. 48). European Social Survey.

Meredith, W. (1993). Measurement invariance, factor analysis and factorical invariance. *Psychometrika*, *58*(4), 525-543. https://doi.org/https://doi.org/10.1007/BF02294825

Mîndrilă, D. (2010). Maximum Likelihood (ML) and Diagonally Weighted Least Squares (DWLS) estimation procedures: A comparison of estimation bias with ordinal and multivariate non-normal data. *International Journal for Digital Society*, *1*(1), 60-66. https://doi.org/10.20533/ijds.2040.2570.2010.0010

Missinne, S., & Bracke, P. (2012). Depressive symptoms among immigrants and ethnic minorities: A population based study in 23 European countries. *Social Psychiatry and Psychiatric Epidemiology*, *47*(1), 97-109. https://doi.org/10.1007/s00127-010-0321-0

Mykletun, A., Stordal, E., & Dahl, A. A. (2001). Hospital Anxiety and Depression (HAD) scale: Factor structure, item analyses and internal consistency in a large population. *British Journal of Psychiatry*, *179*(DEC.), 540-544. https://doi.org/10.1192/bjp.179.6.540

Nye, C. D., & Drasgow, F. (2011). Assessing goodness of fit: Simple rules of thumb simply do not work. *Organizational Research Methods*, *14*(3), 548-570. https://doi.org/10.1177/1094428110368562

Patel, V., Simon, G., Chowdhary, N., Kaaya, S., & Araya, R. (2009). Packages of care for depression in low- and middle-income countries. *PLoS Medicine*, *6*(10). https://doi.org/10.1371/journal.pmed.1000159

Piccinelli, M., & Wilkinson, G. (2000). Gender differences in depression. *The British Journal of Psychiatry*, *177*, 486-492. https://doi.org/10.1192/bjp.177.6.486

Radloff, L. (1977). The CES-D scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement*, *1*, 385. https://doi.org/10.1063/1.4932809

Rai, D., Lee, B. K., Dalman, C., Golding, J., Lewis, G., & Magnusson, C. (2013). Parental depression, maternal antidepressant use during pregnancy, and risk of autism spectrum disorders: Population based case-control study. *BMJ*, *346*(7907), 1-15. https://doi.org/10.1136/bmj.f2059

Reibling, N., Beckfield, J., Huijts, T., Schmidt-Catran, A., Thomson, K. H., & Wendt, C. (2017). Depressed during the depression: Has the economic crisis affected mental health inequalities in Europe? Findings from the European Social Survey (2014) special module on the determinants of health. *European Journal of Public Health*, *27*, 47-54. https://doi.org/10.1093/eurpub/ckw225

Rhemtulla, M., Brosseau-Liard, P. É., & Savalei, V. (2012). When can categorical variables be treated as continuous? A comparison of robust continuous and categorical SEM estimation methods under suboptimal conditions. *Psychological Methods*, *17*(3), 354-373. https://doi.org/10.1037/a0029315

Rönkkö, M., & Cho, E. (2020). An updated guideline for assessing discriminant validity. *Organizational Research Methods*, *25*(1),6-14. https://doi.org/10.1177/1094428120968614

Salari, N., Hosseinian-Far, A., Jalali, R., Vaisi-Raygani, A., Rasoulpoor, S., Mohammadi, M., Rasoulpoor, S., & Khaledi-Paveh, B. (2020). Prevalence of stress, anxiety, depression among the general population during the COVID-19 pandemic: A systematic review and meta-analysis. *Globalization and Health*, *16*(1), 1-11. https://doi.org/10.1186/s12992-020-00589-w

Stordal, E., Mykletun, A., & Dahl, A. A. (2003). The association between age and depression in the general population: A multivariate examination. *Acta Psychiatrica Scandinavica*, *107*(2), 132-141. https://doi.org/10.1034/j.1600-0447.2003.02056.x

Turk, T., Elhady, M. T., Rashed, S., Abdelkhalek, M., Nasef, S. A., Khallaf, A. M., Mohammed, A. T., Attia, A. W., Adhikari, P., Amin, M. A., Hirayama, K., & Huy, N. T. (2018). Quality of reporting web-based and non-web-based survey studies: What authors, reviewers and consumers should consider. *PLoS ONE*, *13*(6), 1-15. https://doi.org/10.1371/journal.pone.0194239

Van de Velde, S., Levecque, K., & Bracke, P. (2009). Measurement equivalence of the CES-D 8 in the general population in Belgium: A gender perspective. *Archives of Public Health*, *67*(1), 15-29. https://doi.org/10.1186/0778-7367-67-1-15

Van de Velde, S., Buffel, V., Bracke, P., Van Hal, G., Somogyi, N. M., Willems, B., & Wouters, E. (2021). The COVID-19 International Student Well-being Study. *Scandinavian Journal of Public Health*, *49*(1), 114-122. https://doi.org/10.1177/1403494820981186

Verropoulou, G., & Tsimbos, C. (2007). Socio-demographic and health-related factors affecting depression of the Greek population in later life: An analysis using SHARE data. *European Journal of Ageing*, *4*(3), 171-181. https://doi.org/10.1007/s10433-007-0060-6

Von Dem Knesebeck, O., Pattyn, E., & Bracke, P. (2011). Education and depressive symptoms in 22 European countries. *International Journal of Public Health*, *56*(1), 107-110. https://doi.org/10.1007/s00038-010-0202-z

Widaman, K. F., & Reise, S. P. (1997). Exploring the measurement invariance of psychological instruments: Applications in the substance use domain. In K. J. Bryant, M. Windle, & S. G. West (Eds.), *The science of prevention: Methodological advances from alcohol and substance abuse research* (pp. 281-324). American Psychological Association. https://doi.org/https://doi.org/10.1037/10222-009

Wu, Q., Erbas, Y., Brose, A., Kuppens, P., & Janssen, R. (2016). The factor structure, predictors, and percentile norms of the Center for Epidemiologic Studies Depression (CES-D) Scale in the Dutch-speaking adult population of Belgium. *Psychologica Belgica*, *56*(1), 1-12. https://doi.org/10.5334/pb.261

Xia, Y., & Yang, Y. (2019). RMSEA, CFI, and TLI in structural equation modeling with ordered categorical data: The story they tell depends on the estimation methods. *Behavior Research Methods*, *51*(1), 409-428. https://doi.org/10.3758/s13428-018-1055-2

Zhou, J., Yuan, X., Qi, H., Liu, R., Li, Y., Huang, H., Chen, X., & Wang, G. (2020). Prevalence of depression and its correlative factors among female adolescents in China during the coronavirus disease 2019 outbreak. *Globalization and Health*, *16*(1), 1-6. https://doi.org/10.1186/s12992-020-00601-3

SOUHRN

Validizace CES-D 8 na českých vysokoškolských studentech během pandemie covid-19

Cíle. Vzhledem k nárůstu depresivní symptomatologie během pandemie covid-19 zejména u zranitelných skupin, jako jsou mladí dospělí, narostla potřebnost spolehlivého nástroje na měření depresivity. Z důvodu chybějící validizace se autoři rozhodli ověřit osmipoložkovou škálu Center for Epidemiologic Studies Depression Scale (CES-D 8) u českých vysokoškolských studentů v době samého počátku pandemie.
Statistické analýzy. Byla provedena konfirmační faktorová analýza za použití strukturního modelování metodou DWLS (diagonally weighted least squares) pomocí balíku laavan. Byly testovány různé hypotézy o dimenzionalitě škály CES-D 8. Pomocí MCFA (multigroup confirmatory factor analysis) autoři posuzovali ekvivalenci měření škály CES-D 8 podle pohlaví. Byl zkoumán vliv sociodemografických proměnných a proměnných týkajících se problematiky covid-19 na depresivní symptomatologii.
Výsledky. Jednodimenzionální model s korelovanými reziduálními rozptyly u dvou položek prokázal dostatečnou validitu a nejlépe odpovídal datům. Výsledky MCFA ukázaly, že faktorová struktura zvoleného modelu byla invariantní vzhledem k pohlaví. Ženy a osoby, které byly ve finanční nouzi nebo prožívaly zvýšený stres ze studia, vykazovaly vyšší úroveň depresivní symptomatologie. Naopak partnerský vztah se ukázal mít protektivní efekt.
Limity práce. Vzorek pochází z online průzkumu, respondenti byli vybráni samovýběrem. Nadreprezentaci žen-studentek v datech nelze zdůvodnit vyšším podílem žen na českých univerzitách.
Závěr. CES-D 8 se ukázal být užitečným nástrojem pro měření depresivity, jenž otevírá další možnosti pro výzkum deprese v univerzitním prostředí a během pandemických situací.

Appendix A

Table 8 List of CES-D 8 Items in the Czech Language

Q38. Prosím zaznačte, kolikrát během posledního týdne…
a. ... jste se cítil(a) sklesle
b. ... jste cítil(a), že všechno děláte s vypětím sil
c. ... jste spal(a) neklidně
d. ... jste byl(a) šťastná(ý)
e. ... jste se cítil(a) osaměle
f. ... jste si užíval(a) života
g. ... jste se cítil(a) smutný(á)
h. ... jste pociťoval(a) nedostatek elánu

Answer options: vůbec nebo téměř vůbec (1), menšinu času (2), většinu času (3), stále nebo téměř stále (4)
Source: C19 ISWS

Appendix B

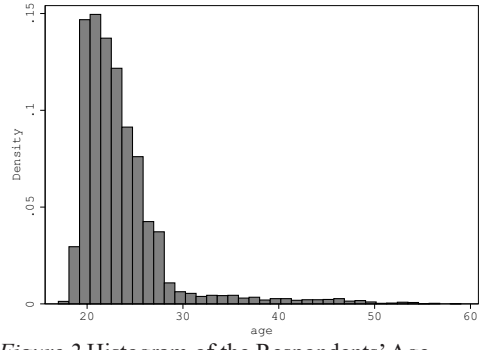

Figure 2 Histogram of the Respondents' Age

Appendix C

Table 9 The Observed Means and Estimated CES-D 8 Factor Score

	Means		
	Male	Female	p
Depressed	2.10	2.27	< 0.001
Everything an effort	2.07	2.20	< 0.001
Restless sleep	1.98	2.07	< 0.001
Happy	2.52	2.59	0,001
Lonely	2.04	2.01	0,347
Enjoyed life	2.63	2.65	0,535
Sad	2.07	2.20	< 0.001
Could not get going	2.40	2.51	< 0.001
Mean total score	2.22	2.29	< 0.001
Estimated score	2.22	2.29	< 0.001

Appendix D

Table 10 Summary of the Goodness-of-Fit of CES-D Models Using ML Estimation

Model	χ2	df	RMSEA	95% CI	CFI	TLI
1D	1333.516	20	0.102	0.097-0.106	0.940	0.916
1D with correlated errors	614.328	19	0.070	0.066-0.075	0.973	0.960
2D	1186.062	19	0.098	0.094-0.104	0.947	0.922
2D with correlated errors	468.711	18	0.063	0.058-0.068	0.980	0.968
3D	414.185	17	0.061	0.056-0.066	0.982	0.970

N=6341

Appendix E

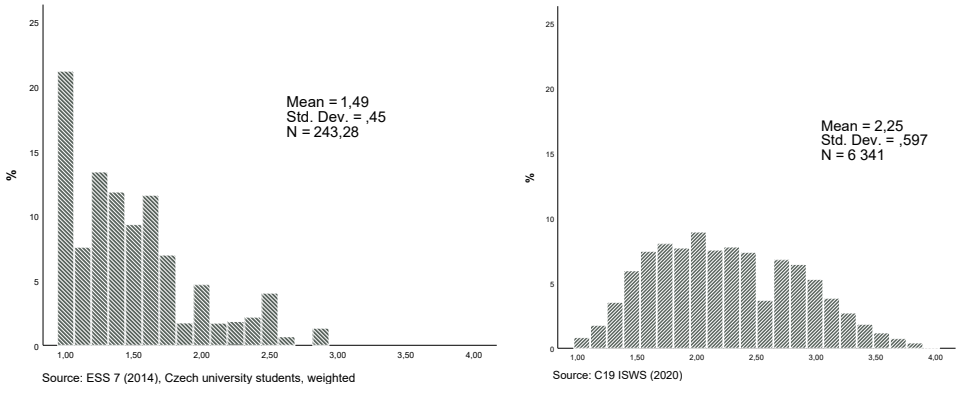

Figure 3 Comparison of Depressive Symptomatology (CES-D 8) among University Students between 2014 and 2020