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Factors in the perceived stress scale differentially associate with mindfulness disposition and executive function among early adolescents

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Abstract

Objectives: The first aim was to test the factor structure and item-loadings of the 10-item Perceived Stress Scale (PSS) when administered to early adolescents. The second aim was to examine associations between PSS factors, mindfulness disposition, and executive function.

Methods: We analyzed data collected from 331 students in grade seven (*M* age=12.4, 48.9% female, 47.1% White, 26.0% Hispanic, 37.8% received free-lunch) classrooms from two ethnically/racially and socio-economically diverse schools. Participants completed paper and pencil self-report measures of stress (PSS), mindfulness disposition (Mindful Awareness Attention Scale, MAAS), and executive function (Behavior Rating Inventory of Executive Function, BRIEF). We tested the statistical association between two factors of the PSS: perceived coping and perceived distress with MAAS and BRIEF.

Results: A two-factor model of the PSS, inclusive of perceived coping and perceived distress, fit the data better than a one-dimensional model. MAAS and BRIEF scores were inversely associated with PSS distress scores ($\beta = -.62$, $p < .0001$ and $\beta = -.66$, $p < .0001$, respectively), but not PSS

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Author Contributions:

AK: designed and executed study analyses; wrote and revised manuscript. DSB: collaborated in manuscript development and revision. NRR: collaborated in writing and editing the manuscript. CMW: collaborated in manuscript development and revision. ARO: collaborated in reviewing the manuscript. CPC: collaborated in statistical analyses development and interpretation. MAP: designed the study, collaborated in path model development, and reviewed manuscript.

Ethics Statement:

All authors complied with ethical standards in the treatment of participants. Authors have full control of all primary data and agree to allow the journal to review upon request. This research was approved by the University of Southern California institutional review board. The submission has not been previously published and is not being considered anywhere else for publication. All authors approved the manuscript and report no competing interests related to the submission of this manuscript.

Informed Consent Statement:

Student participants were required to provide written or verbal assent and their parents were required to provide written or verbal consent.

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Conflict of Interest:

The authors declare no conflicts of interest with this study.

coping scores ($\beta = -.04$, $p = .21$ and $\beta = -.02$, $p = .57$, respectively) in a model adjusted for sex, race, and socio-economic status.

Conclusions: Two factors in the PSS emerged among early adolescents and differentially associated with mindfulness disposition and executive function to similar magnitudes. Findings encourage future assessment of perceived stress in a more refined manner across developmental stages in order to examine trajectories of perceived distress versus perceived coping in relation to mindfulness disposition and executive function.

Keywords

distress; coping; mindfulness disposition; executive function; adolescent

Stress is a multicomponent experience that involves an interplay of psychophysiological systems followed by processes of awareness and action. Individual differences in one's sensitivity and vulnerability to stressors play an important role in how that individual responds (McEwen, 1998). Furthermore, stress can be more detrimental when coping abilities are poor such that effective coping lowers stress reactions (Lazarus, 1990). The Transactional Model of Stress and Coping is a framework for evaluating perception of stress and ability to cope, which involves awareness of the impact a stressful event has on one's cognition (Lazarus & Folkman, 1984). From that awareness one evaluates the threat and controllability of the stressor and then takes action to cope with distress (Lazarus & Folkman, 1984). Therefore, while distress and coping are associated and likely interdependent processes, examining perceived distress and coping as distinct facets measured at the same timepoint may provide insight into perceptual differences in psychological stress.

The Perceived Stress Scale (PSS) is one of the most commonly used tools for measuring psychological stress and was designed to measure "the degree to which individuals appraise situations in their lives as stressful" (Cohen, Kamarck, & Mermelstein, 1983). Previous research has confirmed all versions (14-item, 10-item, and 4-item) of the PSS show better internal reliability when modeled as two distinct factors: perceived coping and perceived distress (also termed perceived self-efficacy and perceived helplessness) (Andreou et al., 2011; Lee, 2012; Tate, Spruijt-Metz, Pickering, & Pentz, 2015); relative to the more commonly used one-factor model, or mean score. However, despite the consensus on the two-factor model, there remains inconclusive psychometric results regarding which items may be most appropriate for different samples such as unhealthy adults versus healthy adolescents.

Early adolescence is a critical developmental period characterized by socioemotional and academic challenges where young people are particularly vulnerable to detrimental consequences of stress. Persistent stress over long periods of time has the potential of long-lasting neurobiological effects that put them at risk for poor psychological and physical health (Schneiderman, Ironson, & Siegel, 2005). However, given the proper resources, early adolescence can simultaneously be a critical period characterized by the development of coping and resiliency skills. Research suggests that mindfulness disposition and executive function are two interrelated capacities that may protect against detrimental consequences of

stress (Black, Semple, Pokhrel, & Grenard, 2011; Short, Mazmanian, Oinonen, & Mushquash, 2016). Therefore, it is important to understand how these interrelated capacities associate with the aforementioned facets of perceived stress during critical developmental stages.

Mindfulness disposition is a trait indicative of the degree that one is attentive to or aware of what is occurring in the present moment (Brown & Ryan, 2003). While research suggests dispositional or trait mindfulness can be enhanced through repeated practice or returning to state mindfulness (Kiken, Garland, Bluth, Palsson, & Gaylord, 2015), we will focus on mindfulness as a disposition, irrespective of mindfulness practice or intervention in this paper. A recent review of the literature found mindfulness disposition appears to be associated with improved emotional factors in adults (i.e., perceived stress and self-regulation) (Tomlinson, Yousaf, Vittersø, & Jones, 2017). One study found mindfulness disposition may explain individual differences in psychological adjustment among adolescents facing life hassles (Marks, Sobanski, & Hine, 2010). All of which is in line with existing theory and research postulating that mindfulness disposition serves as a resilience factor or buffer from developing maladaptive symptoms or behaviors (Bergin, 2016; Black, Milam, Sussman, & Johnson, 2012; Greenberg & Harris, 2012). Given what we know to date, it is likely that mindfulness is an intrapersonal characteristic that alters the degree to which individuals perceive events as threatening.

An interrelated capacity that is similar to, yet distinct from, mindfulness disposition is executive function. Executive function is an umbrella term for neurocognitive sub-processes (i.e., working memory, inhibitory control, cognitive flexibility) that coordinate attention, planning, decision-making, self-regulation, and goal-directed behaviors (Shields, Sazma, & Yonelinas, 2016; Suchy, 2009). Executive function develops with the pre-frontal cortex from birth onward, and accelerates with synaptic pruning during early adolescence (Gogtay et al., 2004). A recent review of the literature found situational stress impacts executive function in complex ways, such that acute stress impairs some sub-processes to a greater magnitude than others (i.e., working memory and cognitive flexibility vs. inhibitory control, respectively) (Shields et al., 2016). The link between executive function and mindfulness disposition remains unclear and continues to be examined through multiple viewpoints (see Black et al., 2011; Quach, Jastrowski Mano, & Alexander, 2016; Short et al., 2016 for more complex associations). In fact, research on mindfulness disposition and executive function has developed somewhat independently and is often assessed separately in the literature (Riggs, Black, & Ritt-Olson, 2015). No previous research has examined how mindfulness disposition and executive function naturally occur in simple associations with multicomponent perceptions of psychological stress among early adolescents.

The current study used cross-sectional data to investigate psychometric properties of the PSS when administered to a sample of early adolescents and examine associations between PSS factors and interrelated capacities of mindfulness disposition and executive function. The analytic aims of the current study were to: (1) test a two-factor structure and item-loadings of the PSS among healthy and early adolescents and (2) test the unique relations of mindfulness disposition and executive function in the best fitting PSS model. Given that mindfulness disposition may be protective against stress through improved resiliency factors

(Black, Milam, et al., 2012; Black et al., 2011; Black, Sussman, Johnson, & Milam, 2012) and chronic stress may impact coping through executive function (Reising et al., 2017), we hypothesized both mindfulness disposition and executive function would be positively associated with perceived coping and negatively associated with perceived distress among a sample of early adolescents.

METHOD

Participants

A cross-sectional study of 7th grade students from two ethnically/racially and socio-economically diverse schools was conducted in Southern California in 2014. Of the total students ($N=496$), 410 (82.7%) assented, had parental consent, and were present during survey administration. Our analytic sample consisted of 331 (80.7%) students, 48.9% female, mean age of 12.4, 26.0% Hispanic, 47.1% White, and 37.8% received free/reduced lunch (low SES) (Table 1).

Procedures

Students completed paper and pencil self-report surveys on mental and behavioral health at one time point. The University of Southern California institutional review board approved all procedures.

Measures

Perceived stress was measured using the 10-item Perceived Stress Scale (PSS), a validated measure among adolescents (Cohen et al., 1983; Siqueira, Rolnitzky, & Rickert, 2001; Tate et al., 2015). Example items include, “I felt good about my ability to handle my problems” (perceived coping factor) and “I felt difficulties were piling up so high that I could not overcome them” (perceived distress factor). Response options for stress experience in the last week ranged from “never” to “often” and mean scores were calculated so a higher score represents higher perceived stress. Internal consistency for the full 10-item scale was moderate (Cronbach’s $\alpha = .70$). When divided into separate factors, the internal consistency of the perceived coping subscale (items 4, 5, 7, 8) decreased to .66 and the perceived distress subscale (items 1, 2, 3, 6, 9, 10) increased to .72.

Mindfulness disposition was measured using the 15-item Mindful Awareness Attention Scale (MAAS) (Brown & Ryan, 2003). MAAS is a validated measure with one item removed or adapted for adolescents (Brown, West, Loverich, & Biegel, 2011; de Bruin, Zijlstra, van de Weijer-Bergsma, & Bogels, 2011). We adapted, “I drive places on ‘automatic pilot’ and then wonder why I went there” to “I walk into a room, and then wonder why I went there.” Additional items include, “I could be experiencing some emotion and not be conscious of it until sometime later” and “I find myself doing things without paying attention.” Response items ranged from “almost never” to “almost always” and mean scores were reversed and summed so a higher score represents higher mindfulness disposition. Internal consistency was high in our sample (Cronbach’s $\alpha = .89$).

Executive function was measured using 4 of 8 clinical subscales on the Behavior Rating Inventory of Executive Function, Self-Report (BRIEF-SR), a validated measure among youth (Egeland & Fallmyr, 2010). A total of 39-items across the 4 subscales were combined for a global executive function score: emotional control (9 of 10 items), inhibitory control (11 of 13 items), working memory (all 12 items), and organization of materials (all 7 items). Example items include, “I do things without thinking first” and “I forget what I’m doing in the middle of things.” Response items ranged from “never” to “often” and mean scores were reversed and summed so higher score represents higher executive function. Internal consistency was high in our sample (Cronbach’s $\alpha = .92$).

Evidence suggests perceived stress, mindfulness, and executive function may differ by sex, race, ethnicity, and socio-economic status (SES) (Bluth, Roberson, & Girdler, 2017; Hackman, Gallop, Evans, & Farah, 2015) and therefore may confound the model tested here. Thus, we measured and controlled for forced-choice items: sex (Male/Female), race (Non-White/White), ethnicity (Non-Hispanic/Hispanic), and recipient of free or reduced-price lunch as a proxy for SES (Yes/No).

Data Analyses

All analyses were conducted in SAS 9.4. Descriptive statistics, frequencies, means and SDs, and bivariate correlations, were first examined. Missing data patterns were assessed to determine the best method of handling (Multiple Imputation vs. Full Information Maximum Likelihood Method [FIML]). Patterns suggested data were missing not at random as the largest proportion of roughly 10% were missing self-report of our proxy for SES, likely because they did not know whether they received free lunch or not. Therefore, to examine the relations of interest in the current sample and avoid listwise deletion, we used FIML as it is the preferred method for structural equation and/or path modeling (Little, Jorgensen, Lang, & Moore, 2014).

Using the CALIS procedure for path analyses, we first assessed a path model for fit based on hypothesized relations using sum scores of MAAS and BRIEF, mean score of PSS, controlling for sex, race, and SES. We then assessed factor loadings of PSS using exploratory factor analysis. Scores were not initially reversed for ease of interpretation of latent constructs (i.e., higher score represented higher perceived coping or higher perceived distress). A threshold of .6 was set for highest item reliability and then patterns were assessed for validity by comparing language. Items below .6 factor loading were considered to have poor reliability and were dropped. Third, a path model was fit based on the hypothesized relations among these factors and measures, controlling for sex, race, and a proxy for SES. We also evaluated a model with ethnicity as a covariate, but due to non-significant impacts on variables of interest in this study it was dropped from the final model. Correlations between error terms were added to the model according to the LM test and justified scale-item overlap. Finally, to test the two factor PSS model versus a one factor PSS model, negative items were reverse coded and loaded to one factor in an otherwise identical model. Absolute and relative goodness of fit statistics were used to assess model fit according to the following cut-offs: GFI = Goodness-of-Fit Index $> .9$; SRMR =

Standardized Root Mean Residual < .05; RMSEA = Root Mean Square Error of Approximation < .05.

RESULTS

Table 2 illustrates descriptive statistics and bivariate correlations between mindfulness disposition, executive function, and perceived stress items. Mindfulness disposition and executive function were highly and positively correlated ($r = .73, p < .001$). Unique patterns of associations emerged within each factor of perceived stress and then between perceived distress, mindfulness disposition, and executive function.

Items 4, 7, and 8 loaded on to perceived coping construct and items 1, 2, 9, and 10 loaded on to perceived distress construct. Due to the a priori threshold of .6 on factor loading, items 3, 5, and 6 were dropped due to poor reliabilities (all < .49). To test the best modeling structure of the PSS with mindfulness disposition and executive function, multiple models were assessed and compared on fit statistics (Table 3). A path model with one factor PSS structure controlling for sex, race and SES was evaluated first and showed unacceptable model fit (Chi-square = 363.08, d.f. = 41, $p < .0001$; GFI = .821; SRMR = .167; RMSEA = .154). Using FIML with the two PSS factors that emerged, the model fit statistics demonstrated substantial improvement (Chi-square = 56.69, d.f. = 35, $p = .01$; GFI = .976; SRMR = .039; RMSEA = .047). Correlated errors were added based on LM test for model fit statistics, but had no impact on the main parameters of interest.

Figure 1 illustrates the path model and standardized estimates of the relations between the two factors of perceived stress, mindfulness disposition, and executive function. Perceived distress factor was inversely associated with mindfulness disposition and executive function ($\beta = -.62, p < .0001$ and $\beta = -.66, p < .0001$, respectively), adjusted for sex, race, and SES. Whereas perceived coping factor showed null associations with mindfulness disposition and executive function ($\beta = -.04, p = .21$ and $\beta = -.02, p = .57$, respectively), which was contrary to our hypotheses.

DISCUSSION

The purpose of this study was to first test the factor structure and item-loadings of the PSS completed by early adolescents and then examine associations between PSS factors, mindfulness disposition, and executive function. While previous work has examined mindfulness disposition and executive function in the same model, no published research has examined the collective association with perceived stress in early adolescents. This study provides insight into three main findings. First, we found that a two-factor model with seven-items from the PSS-10 was superior to a single factor model with all 10-items, which provides insight that stress has distinct multicomponent processes, which are likely developmentally sensitive among our sample of early adolescents; and should be analyzed accordingly. Second, mindfulness disposition and executive function were inversely associated with perceived distress, but not perceived coping. This allows us to identify different relations of perceptions of stress on mindfulness disposition and executive function in early adolescents, which is important for understanding developmental trajectories and

potentially appropriate intervention targets. Third, the similar magnitudes of associations of mindfulness disposition and executive function on factors of perceived stress suggest the possibility of overlapping measures, which adds a new perspective for how these two capacities relate.

From our cross-sectional survey data among early adolescents, a two-factor model of Cohen's PSS provided statistically better fit and conceptually deeper insights. This aligns with previous literature (Andreou et al., 2011; Lee, 2012; Tate et al., 2015; Korten, 2017), yet the majority of publications continue to utilize a single factor sum score (Bao, Xue, & Kong, 2015; Black, Milam, et al., 2012; Chiesa & Serretti, 2009). In addition to confirming a two-factor model fit our data best, we add new knowledge regarding which items on the PSS-10 may be most appropriate among a sample of early adolescents based on psychometric properties. While additional research is needed to replicate low loading threshold for items 3, 5, and 6, we encourage future research using the PSS to test as a two-factor model.

In addition to providing support for a two-factor model of perceived stress, we examined associations of mindfulness disposition and executive function in the same model as stress. As expected, findings suggest those with higher mindfulness disposition and executive function reported lower perceived distress. However, it is unclear why self-reported mindfulness disposition and executive function did not show an association with perceived coping in this study. Based on the moderately low internal consistency reliability for perceived coping items, it is possible that this finding is limited by the measure and additional psychometric evaluation among early adolescent samples is needed. Taking this into consideration, perceived distress items only had a slightly higher Cronbach's alpha (+0.06) than perceived coping items, leading to another plausible explanation regarding adolescent development. That is, there could be a mismatch among these perceptions during this developmental stage such that perceived distress may tap into already developed individual differences or personality characteristics while perceived coping may tap into underdeveloped awareness or ability. Previous research indicates the relation between stress reactivity (i.e., perceived distress) and executive function may be moderated by individual differences (e.g., openness to experience, of the Big Five Personality) (Williams, Suchy, & Rau, 2009). Similarly, mindfulness disposition has also been associated with lower distress and higher openness and curiosity (Keng, Smoski, & Robins, 2011). Yet, less research has focused on mindfulness disposition and executive function with coping, particularly among youth.

We draw from coping and mindfulness theories to expand on the potential interpretation of perceived coping finding. Coping research suggests there are multiple approaches people can take (e.g., problem-focused, emotion-focused, and meaning-focused), but for all of them it is a conscious approach to regulate emotions, cognitions, behavior, and environment in response to stressful events or circumstances (Compas, Connor-Smith, Saltzman, Thomsen, & Wadsworth, 2001). The developmental course of coping is not well understood (Compas et al., 2014) and may explain current findings. That is, null associations between perceived coping with mindfulness disposition and executive function may be explained by a lack of conscious awareness or underdeveloped coping perceptions in our sample of early

adolescents. Garland et al. expands on Lazarus and Folkman stress theory by proposing the mindful coping model, which argues a causal link from mindfulness to positive reappraisal (Garland, Gaylord, & Park, 2009). Such that when someone experiences stress beyond their coping capabilities, mindfulness practices may lead them to initiate an adaptive response of decentering, or attending to the process rather than the content (Garland et al., 2009; Hanley, Garland, & Black, 2014). Together, we may expect mindfulness training to enhance these interrelated capacities in adolescents and therefore facilitate coping competence and awareness of ability to tolerate distress.

These findings suggest that according to self-reports among a sample of seventh grade youth, how one perceives events as stressful associates to a similar magnitude with both mindfulness disposition and executive function. Based on a recent review of the literature, training in mindfulness enhances skills that help youth manage psychological stress early in life, which may support executive function capacities such as self-regulation (Kechter & Black, 2018). Given that mindfulness disposition has been shown to increase with mindfulness meditation practice (i.e., state to trait) (Kiken et al., 2015), it is possible there is a reciprocal relation between mindfulness disposition and executive function among youth. However, that goes beyond the scope of this study and longitudinal research is needed to better understand the individual differences and developmental trajectories of mindfulness disposition and executive function in order to test the degree of overlap and reciprocity of these constructs.

Limitations and Future Directions

The following limitations of the current study should be considered. First, these data are from cross-sectional self-report surveys, which only permit us to examine associations between validated measures without inferring directionality, and such methods are subject to the common method bias. The common method bias often occurs in behavioral research when participants are asked to report on their perceived experiences for multiple constructs in the same survey, which may lead to results confounded by report biases (e.g., response style and/or social desirability) rather than true associations (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). Future studies should consider obtaining measures from different sources (e.g., parent/teacher and adolescent) to reduce possible effects. Second, we only used dichotomous variables for sex, race, and free-lunch as a proxy for SES. More thorough assessments of these sociodemographic and other potentially confounding variables should be examined in future research. Third, Lazarus has argued that while the PSS has its use, it is similar to a personality test with statements about ability or inability to manage demands adequately. Therefore, the PSS may not solely be measuring perceived stress level but psychopathological symptoms that confound stress reactivity (Lazarus, 1990). Future studies should consider controlling for key personality characteristics (e.g., openness) and emotional symptomology (e.g., internalizing symptoms) and test a similar model among different age groups in order to decipher whether perceptions of stress may be confounded by emotional symptomology and/or developmental awareness. Fourth, psychometric research has established mindfulness is a multidimensional construct with five distinct facets: observing, describing, acting with awareness, non-reacting, and non-judging (Baer, Hopkins, Krietemeyer, Smith, & Toney, 2006). However, previous research has highlighted that

MAAS only measures one of those facets: acting with awareness (Coffey & Hartman, 2008), therefore omitting a comprehensive examination of mindfulness and key mechanisms. Future research should consider using an alternative measure of mindfulness, such as the Five-Facet Mindfulness Questionnaire, to examine whether all five facets (and which) may alter findings.

Keeping in mind the aforementioned limitations, the current study provides insight into unique associations of perceived coping and perceived distress with mindfulness disposition and executive function among a sample of 7th grade youth. These capacities merit further investigation to determine which risk and resiliency factors of stress emerge in relation to mindfulness disposition and executive function, why, and in what contexts. There are a number of follow-up studies we suggest based on the current work. First, future research should utilize multiple measures, both self-report and behavioral, to assess potential nuances of coping and distress. Second, it would be important to examine developmental trajectories of distress and coping with mindfulness disposition and executive function across three or more time periods. Third, experimental research should be designed to test the potential reciprocal intervention effects between mindfulness disposition and executive function with perceived stress. While directionality cannot be inferred from this study, developing programs and environments aimed at increasing stress management skills, mindfulness disposition, and executive function may enhance early adolescent's awareness of distress and ability to cope with stress.

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Figure 1.

Associations between PSS Coping and PSS Distress with MAAS and BRIEF among early adolescents ($N=331$)

Note. Path coefficients are standardized estimates and include demographic covariates: sex, race, and SES. * $p < .05$ ** $p < .01$ *** $p < .001$

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Table 1.

Sample demographic characteristics (N=331)

Baseline study covariate	Overall Sample N(%) or M(SD)
Age in years	12.44 (0.52)
Female	162 (48.94%)
Free/reduced Lunch (SES)	125 (37.76%)
Hispanic ethnicity	86 (25.98%)
White	156 (47.13%)

Table 2.Descriptive statistics and bivariate correlations between factors of perceived stress, mindfulness disposition, and executive function ($N=331$)

	<i>M(SD)</i>	1.	2.	3.	4.	5.	6.	7.	8.	9.
Perceived Coping										
1. Handled problems that bothered me	2.21(0.70)	-								
2. Felt that I could handle important things that were happening in my life	2.14(0.70)	.41***	-							
3. Felt good about my ability to handle my problems	2.24(0.68)	.40***	.46***	-						
Perceived Distress										
4. Got upset because of something that happened all of a sudden	1.70(0.65)	.00	.04	-.10	-					
5. Was angry because of things that happened that were outside of my control	1.79(0.72)	.01	.07	-.01	.46***	-				
6. Felt difficulties were piling up so high that I could not overcome them	1.57(0.67)	-.01	.07	-.10	.39***	.40***	-			
7. Felt that I was unable to control the important things in my life	1.60(0.68)	-.06	.01	-.12*	.30***	.42***	.56***	-		
Mindfulness Disposition										
8. Mindfulness Disposition	4.56(0.88)	.03	-.10	.00	-.42***	-.36***	-.40***	-.40***	-	
Executive Function										
9. Executive Function	1.50(0.30)	.00	-.03	.06	-.46***	-.40***	-.40***	-.43***	.73***	-

Note.

* $p < .05$ ** $p < .01$ *** $p < .001$

Table 3.

Sensitivity analyses for modeling perceived stress

MODEL	Chi-square	d.f.	P-value	GFI	SRMR	RMSEA
1. Mean Score PSS	217.17	1	< .0001	.867	.120	.785
2. 1-Factor PSS	363.08	41	< .0001	.821	.167	.154
3. 2-Factor PSS	44.84	35	.12	.978	.038	.029
4. 2-Factor PSS using FIML	56.69	35	.01	.976	.047	.039

Note. PSS=Perceived Stress Scale; d.f. = degrees of freedom; GFI = Goodness-of-Fit Index; SRMR = Standardized Root Mean Residual; RMSEA = Root Mean Square Error of Approximation