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A Validation Study of the Mini-IPIP Five-Factor Personality Scale in Adults With Cancer

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ABSTRACT

The Mini International Personality Item Pool (Mini-IPIP) is a brief measure of the Five-Factor Model of personality with documented validity in healthy samples of adults and could be useful for assessing personality in patient populations such as individuals with cancer. The purpose of this study was to examine the psychometric properties of the Mini-IPIP in 2 samples of adults with cancer. A sample of 369 (Sample 1) and a sample of 459 (Sample 2) adults with cancer completed an online survey including the Mini-IPIP. To assess criterion validity, Sample 2 completed measures of emotional distress. Analyses included internal consistency (Samples 1 and 2), confirmatory factor analyses (CFAs; Samples 1 and 2), and correlations and a structural regression model to examine the associations between the 5 personality factors and emotional distress (Sample 2 only). Results showed that the Mini-IPIP demonstrated levels of internal consistency and CFA model fit that were similar to previous validation studies conducted in the general population. Consistent with prior research and theory, this study also found that personality factors measured by the Mini-IPIP were associated with measures of emotional distress in Sample 2. These findings suggest the potential utility of the Mini-IPIP in both research and clinical settings involving individuals with cancer.

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Cancer is emotionally burdensome, and a growing body of research suggests that information about patients' personality characteristics could contribute to effective management of emotional distress in this population. Across differing measurement methods and samples, it is estimated that anywhere from 15% to 50% of individuals with cancer experience emotional distress at some point, including symptoms of depression, anxiety, and anger (Batty, Russ, Stamatakis, & Kivimäki, 2017; Jacobsen & Andrykowski, 2015; Mehnert et al., 2018; Mitchell et al., 2011). Although important in its own right, emotional distress might also decrease treatment efficacy through nonadherence behavior and could lead to decreased survival rates (Berry, Blonquist, Hong, Halpenny, & Partridge, 2015; Mathes, Pieper, Antoine, & Eikermann, 2014; Mitchell et al., 2011). Therefore, a major priority in cancer care is to reduce the emotional burden of cancer, with efforts recently including routinely screening for emotional distress symptoms throughout the course of the illness (National Comprehensive Cancer Network [NCCN], 2018). Although assessment for current emotional distress symptoms is necessary for referring people to immediately needed psychological services, personality assessments could provide additional information for future or longer term patient outcomes. However, cancer care teams have not incorporated personality assessment into routine practice. As a first step toward achieving this goal, this study sought to psychometrically validate a personality measure in a sample of adults with cancer.

Personality characteristics comprising the Five-Factor Model (FFM) have been shown to be associated with emotional distress outcomes in cancer. The FFM is a comprehensive, widely used, and empirically supported taxonomy of normal personality variation that includes five broad dimensions: neuroticism (tendency to be emotionally unstable, impulsive, and experience negative emotions), extraversion (tendency to be socially outgoing, active, and experience positive emotions), openness to experience (tendency to be creative, intellectual, and prefer novelty), conscientiousness (tendency to be organized, self-disciplined, and reliable), and agreeableness (tendency to be warm, altruistic, and modest; Hengartner, Graf, & Schreiber, 2017; John, Naumann, & Soto, 2008). Most consistently, neuroticism is typically associated with worse anxiety and depression symptoms in samples with heterogenous cancer (Hulbert-Williams, Neal, Morrison, Hood, & Wilkinson, 2012; Morgan et al., 2017), breast cancer (Hinnen et al., 2008; Van Esch, Roukema, Ernst, Nieuwenhuijzen, & De Vries, 2012), and prostate cancer (Perry, Hoerger, Silberstein, Sartor, & Duberstein, 2018; van den Bergh et al., 2009). Additionally, extraversion and the closely related concept of optimism tend to be associated with less depression and anxiety in mixed cancer (Morgan et al., 2017), breast cancer (Chang et al., 2014), and prostate cancer samples (Orom, Nelson, Underwood, Homish, & Kapoor, 2015; Perry et al., 2018). In addition to predisposing an individual

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to experience negative (neuroticism) versus positive (extraversion) emotions (Hengartner et al., 2017), these two personality characteristics can also be associated with emotional regulation strategies used during stressful life events. For example, individuals higher on neuroticism tend to engage in avoidance or substance use, whereas individuals higher on extraversion tend to seek out social support (Carver & Connor-Smith, 2010). Longitudinal data show that personality characteristics are relatively stable across the life course (Wagner, Lüdtke, & Robitzsch, 2019). Therefore, assessing personality might be helpful for identifying patients who could benefit from supportive intervention to address current emotional distress as well as prevent the possibility of future negative outcomes.

However, distress management guidelines in oncology care do not currently recommend attending to patients' personality. In fact, personality assessment in health care settings has largely been confined to presurgical evaluations for elective procedures, especially bariatric surgery (Block, Marek, Ben-Porath, & Kukal, 2017; Marek et al., 2013; Sogg, Lauretti, & West-Smith, 2016). Here, psychologists conduct in-depth psychological evaluations that usually include the Minnesota Multiphasic Personality Inventory (MMPI) or the Personality Assessment Inventory (PAI), which provide broad-level information about personality and psychopathology. The results are used to identify patients who might be at risk for poor postsurgical outcomes and for whom supportive interventions might be beneficial (Marek et al., 2013; Walfish, Vance, & Fabricatore, 2007). However, these personality assessments tend to focus on personality psychopathology rather than assessments of less extreme personality characteristics that might be more relevant to a broader group of individuals. Personality assessments using the FFM framework are rare in health care settings. Two studies (Chapman, Roberts, Lyness, & Duberstein, 2013; Israel et al., 2014) have successfully assessed the FFM in a primary care setting, and results underscored the potential utility of personality information for predicting future physical health outcomes and informing preventative care. In this study, we argue that personality measures from the FFM could be especially useful to include in cancer care because of patients' heightened risk for emotional distress and because personality characteristics such as neuroticism and extraversion are prospectively associated with distress outcomes (Chang et al., 2014; Hinnen et al., 2008; Hulbert-Williams et al., 2012; Van Esch et al., 2012). However, there is a need for more research evaluating the psychometric properties of commonly used measures of personality in cancer samples.

This study focused on psychometrically evaluating a commonly used measure of the FFM—the Mini International Personality Item Pool (Mini-IPIP; Donnellan, Oswald, Baird, & Lucas, 2006)—in adults with cancer. The Mini-IPIP has been widely used in studies involving healthy samples of adults, having been cited more than 1,300 times. It assesses each of the five personality factors using only four items, is well-validated in general population samples, and is freely available to the public (Donnellan et al., 2006). In college and community samples, the Mini-IPIP has demonstrated sufficient internal consistency reliability despite its short length, and has been shown to predict other validated measures of the FFM as well as important criterion validity outcomes such as psychopathology symptoms, positive and negative affect, life satisfaction, and informant reports of personality from close family and friends (Baldasaro, Shanahan, & Bauer, 2013; Cooper, Smillie, & Corr, 2010; Donnellan et al., 2006; Laverdiere, Morin, & St-Hilaire, 2013). Past research has examined the FFM with the NEO Five-Factor Inventory (McCrae & Costa, 2004) in cancer samples (e.g., Hoerger, Chapman, Mohile, & Duberstein, 2016; Hulbert-Williams et al., 2012; Van Esch et al., 2012) and, given its generally positive psychometric performance in healthy samples of adults, recent studies have also begun to use the Mini-IPIP (Lattie et al., 2016; Perry et al., 2018; Rochefort, Hoerger, Turiano, & Duberstein, 2018).

This study examined the psychometric properties of the Mini-IPIP in two separate samples of adults with cancer. The first aim of this study was to evaluate the evidence of the measure's reliability and five-factor structure in both samples. The second aim of this study was to examine the criterion-related validity of the Mini-IPIP with emotional distress outcomes in the second sample of adults with cancer. Based on previous research (Hinnen et al., 2008; Hulbert-Williams et al., 2012; Orom et al., 2015; Perry et al., 2018; van den Bergh et al., 2009; Van Esch et al., 2012), neuroticism was hypothesized to be associated with increased emotional distress, whereas extraversion was hypothesized to be associated with decreased emotional distress.

Methods

Participants and procedures

Both samples included data from two separate online surveys of psychosocial issues in cancer patients that employed similar procedures. Sample 1 data were collected in 2013 via Qualtrics as a part of a broader study (Hoerger, Chapman, et al., 2016), and as a follow-up study, Sample 2 data were collected in 2017 via REDCap. Participants were required to be at least 18 years old, be able to read and understand English, and have a current or past cancer diagnosis. They were recruited mainly using the National Institutes of Health (NIH)–sponsored ResearchMatch recruitment tool, which is an online database that matches patient volunteers with researchers at more than 100 institutions in the United States (Harris et al., 2012). The survey link was also posted with administrator permission on several cancer education Web sites, online support groups, listservs, or social media where participants could also access the study.

Demographic and personality measures (Samples 1 and 2)

Demographic and health measures

Participants self-reported on sociodemographic information including age, gender, race and ethnicity, marital status, and

education. They also responded to several measures of health status that included cancer history, cancer site (e.g., prostate, breast, lung, colorectal), cancer stage (local vs. distant metastases), and how long ago they were diagnosed with cancer.

Mini International Personality Item Pool

Participants completed the open-source Mini-IPIP measure of the FFM (Donnellan et al., 2006). Each of the five factors (neuroticism, extraversion, openness, agreeableness, and conscientiousness) was assessed with four items, comprising a total scale that included 20 items. Each item was written as a statement, and participants rated how well it described them on a scale from 1 (*very inaccurate*) to 5 (*very accurate*). Sample items include "Get upset easily" (neuroticism), "Am the life of the party" (extraversion), "Have a vivid imagination" (openness to experience), "Sympathize with others' feelings" (agreeableness), and "Get chores done right away" (conscientiousness).

Criterion validity measures (Sample 2 only)

Emotional distress

Participants in Sample 2 additionally completed measures of emotional distress, including depression, anxiety, and anger symptom severity. Each symptom was assessed using a short-form measure from the Patient-Reported Outcomes Information System (PROMIS; Cella & Stone, 2015; Pilkonis et al., 2011; Schalet et al., 2016), an NIH initiative to create an inventory of standardized measures spanning multiple domains relevant to a patient's quality of life. Symptom severity was assessed using a four-item (depression and anxiety) or five-item (anger) scale that asked participants to report how often they experienced a given symptom in the past 7 days, with response options ranging from 1 (*never*) to 5 (*always*). Sample items included "I felt hopeless" (depression), "my worries overwhelmed me" (anxiety), and "I was irritated more than people knew" (anger). These measures of emotional distress have been well-validated in samples with cancer and other chronic medical conditions (Pilkonis et al., 2011; Schalet et al., 2016), and displayed excellent internal consistency reliability in this sample: depression ($\alpha = .92$), anxiety ($\alpha = .92$), and anger ($\alpha = .92$). Responses to each item of a given scale (depression, anxiety, anger) were summed to form an overall score for each indicator of emotional distress.

Analyses

Data screening

Before analyses were undertaken, data were screened for missing values, outliers (univariate and multivariate), and normality in SPSS Statistics Version 25. Univariate outliers were determined if a score was greater than 3.3 *SD* from the variable's mean. These scores were replaced with the next-most extreme nonoutlying value on that variable (a method commonly known as *winsorizing*). To screen for multivariate outliers, each personality or emotional distress item was entered simultaneously into a regression analysis to obtain a Mahalanobis distance value for each participant in the data set. A multivariate outlier was determined if its Mahalanobis distance value was associated with a p value $\leq .001$ under the chi-square distribution and was subsequently deleted from the data set. Data were screened for normality by examining skewness and kurtosis statistics, with skewness values within the range of ±2 and kurtosis values within the range of ±7 indicating that normality assumptions had been met (Cooper et al., 2010; Kline, 2015).

Descriptive statistics

In SPSS Statistics Version 25, we gathered descriptive statistics for key demographic and health variables to define the sample. Next, means and standard deviations for each item of the Mini-IPIP scale were examined and the Cronbach's alpha value for each personality factor and emotional distress indicator (depression, anxiety, anger) was evaluated. Total scale scores for each personality factor and emotional distress indicator were calculated by summing each item included in a given scale, and descriptive statistics as well as interscale correlations were assessed for each total score.

Confirmatory factor analysis

We aimed to validate the factor structure of the Mini-IPIP through a confirmatory factor analysis (CFA) in both samples, which was conducted in the lavaan package available for R statistical software Version 3.4.4 (Rosseel, 2012). Given that the data were continuous and normally distributed (see "Results"), the maximum likelihood estimation method was selected. Because the chi-square test of exact fit is prone to Type I errors in sufficiently large samples ($>$ 200 participants), we instead used the comparative fit index (CFI), Tucker–Lewis index (TLI), root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR; Schermelleh-Engel, Moosbrugger, & Müller, 2003). These indexes have been used in prior research examining the factor structure of the Mini-IPIP, and together they provide estimates of model fit that are reasonably robust to biases based on sample size, distribution of scores, and model complexity (Baldasaro et al., 2013; Cooper et al., 2010; Laverdiere et al., 2013). Adequate model fit was determined with criteria used in previous research that conducted CFAs on the Mini-IPIP: CFI and TLI values of $\geq .90$, RMSEA values $\leq .08$, and SRMR values $\leq .10$ (Baldasaro et al., 2013; Cooper et al., 2010; Laverdiere et al., 2013).

In Sample 1, we began by evaluating a simple five-factor model, where each item loaded on its respective personality factor, errors were not allowed to covary, and factors covaried. If this initial model did not fit adequately, modification indexes were inspected and a respecified model that included only theoretically justified modifications was tested. A chi-square difference test was then performed to examine whether the respecified model achieved significantly better model fit than the initial model. For confirmatory purposes, data from Sample 2 were used to replicate the CFA testing

the accepted model from Sample 1 in a second sample of individuals with cancer. As a post-hoc analysis, we examined a configural invariance model where the number of factors and corresponding items were fixed to be equivalent across Sample 1 and Sample 2, testing the hypothesis that our retained five-factor model fit equally well in both samples. This analysis was conducted using a multigroup CFA in the SemTools package of R statistical software and was evaluated using the same model fit criteria as the single-sample CFAs (CFI $\geq$ .90 and RMSEA $\leq$ .08).

Criterion validity

In Sample 2, we extended on our analyses in Sample 1 by examining associations between the Mini-IPIP personality factors and emotional distress. This was first assessed in SPSS Statistics Version 25 by examining correlations between summated scores for each personality factor and each indicator of emotional distress (depression, anxiety, and anger). Next, we examined a multiple indicators, multiple causes (MIMIC) structural regression model using the lavaan package for R statistical software Version 3.4.4 (Jöreskog & Goldberger, 1975). The MIMIC model examined whether the five personality factors (latent independent variables) were associated with an overall emotional distress factor (latent dependent variable), while controlling for key demographic and health covariates (observed independent variables). The overall emotional distress factor was a latent variable indicated by the summated scale scores of depression, anxiety, and anger symptom severity. Personality factors were represented using the same measurement model that was retained from the CFAs conducted earlier in this study.

The covariates in the MIMIC model were included on a theoretical basis because they have been shown in prior research to be related to emotional distress in cancer (Hoerger, Chapman, et al., 2016; Hoerger, Perry, Gramling, Epstein, & Duberstein, 2017). They included age, gender (dummy-coded: female = 1, male = 0), marital status (dummy-coded: married = 1, unmarried = 0), education (dummy-coded: bachelor's degree present = 1, absent = 0), race and ethnicity (dummy-coded: at least one diverse racial or ethnic identity present = 1, absent = 0), cancer stage (dummy-coded: metastases present = 1, absent = 0), comorbidities (dummy-coded: at least one noncancer physical health condition present = 1, absent = 0) and time since diagnosis (years). Model fit indexes and parameters were estimated using maximum likelihood estimation, which is a valid estimation method in MIMIC models that include both continuous and categorical covariates (Jöreskog & Goldberger, 1975). Adequate model fit was determined using the same criteria as for the CFA model: CFI and TLI values of $\geq$ .90, RMSEA values $\leq$ .08, and SRMR values $\leq$ .10.

Results

Data screening

Sample 1 initially contained a total of 376 individuals with cancer with no missing values (Hoerger, Chapman, et al., 2016). Eight univariate outliers were identified: four on Item 12, "Do not have a good imagination," and four on Item 16, "Am not really interested in others." In all cases the outlying value was a value of 1 (*very inaccurate*). All outlying values were replaced with a value of 2 (*moderately inaccurate*), which was the next-most extreme nonoutlying value. Seven multivariate outliers were identified and deleted, yielding a final sample size of 369. The data met assumptions for normality as determined by skewness and kurtosis statistics (skewness from −0.91–0.80; kurtosis from −1.10–0.79).

In Sample 2, a total of 492 records were downloaded from REDCap, where the survey responses were recorded. Cases were deleted if they were missing values on five or more variables in the data set ($n = 4$), had reported not having a history of cancer ($n = 11$), or reported not completing the survey carefully or honestly ($n = 11$) or having previously completed the survey ($n = 11$). This yielded a sample size of 462 cases with 37 participants (8%) missing values on fewer than five variables. In these cases, missing values were imputed using basic techniques appropriate for this small degree of missingness. If the variable was part of a multi-item scale, the missing value was imputed with the participant's mean on all other items belonging to that scale. In other cases, missing values were imputed with the sample mean (single-item continuous variable), sample median (single-item ordinal variable), or sample mode (categorical variable). A total of 21 univariate outliers were identified across four variables: depression symptom severity ($n = 2$), anger symptom severity ($n = 3$), Item 13 on the mini-IPIP ("Sympathize with others' feelings," $n = 11$), and Item 16 on the Mini-IPIP ("Am not really interested in others," $n = 5$), which were subsequently winsorized in the same manner as in Sample 1 data. Three instances of multivariate outliers were identified and subsequently deleted, resulting in a final analytic sample size of 459 for Sample 2. All variables met assumptions for normality based on their skewness and kurtosis statistics (skewness from −0.97–0.80; kurtosis from −1.10–0.79).

Sample characteristics

Across both samples, participants were an average of 58 years old and tended to be mostly non-Latino/a White (Sample 1, 94.0%; Sample 2, 92.2%) and college-educated (Sample 1, 67.8%; Sample 2, 66.7%). However, there were some notable differences in participant characteristics across samples (see Table 1). In Sample 1, participants were more likely to be men (67.2%) and have prostate cancer (59.3%), whereas Sample 2 participants were more likely to be women (75.6%) and have breast (29.4%), colorectal (28.1%), or lung (16.3%) cancers. Additionally, a larger portion of Sample 1 (31.2%) had metastatic cancer compared to Sample 2 (23.3%), and Sample 1 participants were diagnosed more recently ($M = 2.45$ vs. 6.27 years, $p < .001$).

Descriptive statistics

Item-level descriptive statistics and scale-level descriptive statistics are displayed in Tables 2 through 4. Table 4

Table 1. Participant characteristics.

Characteristic	Sample 1 ($N = 369$)	Sample 2 ($N = 459$)	p value
Age	58.30 (10.41)	58.20 (12.04)	.896
Gender, female	121 (32.8%)	347 (75.6%)	< .001
White, non-Latino/a	347 (94.0%)	423 (92.2%)	.292
Education, bachelor's degree or higher	250 (67.8%)	306 (66.7%)	.741
Marital status, married	289 (78.3%)	302 (65.8%)	< .001
Cancer diagnosis			
Prostate	219 (59.3%)	51 (11.1%)	< .001
Breast	59 (16.0%)	135 (29.4%)	< .001
Lung	6 (1.6%)	75 (16.3%)	< .001
Colorectal	49 (13.3%)	129 (28.1%)	< .001
Other	76 (20.6%)	156 (34.0%)	< .001
Metastases, present	115 (31.2%)	107 (23.3%)	.011
Time since diagnosis, years	2.45 (2.79)	6.27 (6.64)	< .001

Note. Values indicate *M* (*SD*) for continuous variables or *n* (%) for categorical variables. *p* values were obtained from independent sample *t* tests (continuous participant variable) or chi-square tests of independence (categorical participant characteristic).

Table 2. Item-level statistics for the Mini-IPIP in Sample 1.

Item	*M*	*SD*	Skewness	Kurtosis	Factor loading (Model 1)[a]	Factor loading (Model 2)[b]
Neuroticism						
1. Have frequent mood swings	2.65	1.17	0.13	−0.94	.79	.79
2. Am relaxed most of the time (R)	2.63	1.07	0.29	−0.80	.65	.64
3. Get upset easily	2.75	1.18	0.80	−0.96	.72	.72
4. Seldom feel blue (R)	2.96	1.20	−0.08	−0.98	.58	.58
Extraversion						
5. Am the life of the party	2.73	1.11	0.02	−0.81	.76	.76
6. Don't talk a lot (R)	3.19	1.20	−0.04	−0.99	.60	.60
7. Talk to a lot of different people at parties	3.05	1.26	−0.13	−1.10	.81	.81
8. Keep in the background (R)	3.15	1.19	−0.05	−1.05	.75	.75
Openness						
9. Have a vivid imagination	3.73	0.94	−0.42	−0.26	.45	.54
10. Am not interested in abstract ideas (R)	3.84	1.05	−0.67	−0.21	.68	.53
11. Have difficulty understanding abstract ideas (R)	4.01	0.96	−0.85	0.30	.68	.49
12. Do not have a good imagination (R)	4.18	0.88	−0.89	0.08	.58	.78
Agreeableness						
13. Sympathize with others' feelings	4.25	0.73	−0.86	0.79	.75	.26
14. Am not interested in other people's problems (R)	3.96	1.01	−0.97	0.50	.49	.51
15. Feel others' emotions	3.90	0.87	−0.87	065	.71	.67
16. Am not really interested in others (R)	4.14	0.89	−0.90	0.16	.58	.53
Conscientiousness						
17. Get chores done right away	3.36	1.13	−0.17	−0.97	.60	.59
18. Often forget to put things back in their proper place (R)	3.81	1.23	−0.16	−1.00	.60	.60
19. Like order	3.86	0.97	−0.77	0.16	.45	.44
20. Make a mess of things (R)	3.99	1.01	−0.74	−0.21	.57	.58

Note. $N = 369$. (R) indicates that an item was reverse-coded for analyses. Factor loading = standardized factor loading obtained from a five-factor confirmatory factor analysis (CFA) model (see Table 5 for fit indexes).
[a]Model 1 = simple five-factor CFA model with uncorrelated error terms.
[b]Model 2 = respecified five-factor CFA model where the following items' error terms were allowed to correlate due to overlapping content: Items 9 and 12, 10 and 11, 13 and 15, and 14 and 16 (see Table 5 for fit indexes).

additionally displays internal consistency and interscale correlations in both samples, which shows that the alpha values met levels of acceptability for all personality factors across samples ($\alpha = .70–.82$), except for openness and conscientiousness in Sample 2, which only showed fair internal consistency ($\alpha = .64–.69$).

Confirmatory factor analysis

Table 5 provides fit indexes for the CFA models tested in Samples 1 and 2. The initial model tested in Sample 1 was a simple five-factor model where each item loaded on its respective factor, item error terms were not allowed to covary, and factors correlated. Results for model fit were mixed, with the RMSEA (.08) and SRMR (.07) within acceptable range, but the CFI (.80) and TLI (.83) values indicating poor fit. The CFAs summarized all of the potential modification indexes for improving the model fit; we accepted only a small number of theoretically meaningful modifications. Specifically, we conducted a respecified model with the following correlated error terms: Item 9, "Have a vivid imagination," with Item 12, "Do not have a good imagination"; Item 10, "Am not interested in abstract ideas," with Item 11, "Have difficulty understanding abstract ideas"; Item 13, "Sympathize with others' feelings," with Item 15, "Feel others' emotions"; and Item 14, "Am not interested in other peoples' problems," with Item 16, "Am not really interested in others." Only these modifications were made because they were determined to be the only item pairs that had enough unique overlapping content to justify freeing their correlations. These same modifications have also been suggested in previous research examining the factor structure of the Mini-IPIP (Laverdiere et al., 2013) and longer measures of the FFM (Marsh et al., 2010).

Table 3. Item-level statistics for the Mini-IPIP in Sample 2.

Item	*M*	*SD*	Skewness	Kurtosis	Factor loading
Neuroticism					
1. Have frequent mood swings	2.00	1.16	0.13	−0.94	.77
2. Am relaxed most of the time (R)	2.63	1.21	0.29	−0.80	.61
3. Get upset easily	2.28	1.13	0.80	−0.96	.68
4. Seldom feel blue (R)	3.06	1.35	−0.08	−0.98	.39
Extraversion					
5. Am the life of the party	2.35	1.11	0.02	−0.81	.64
6. Don't talk a lot (R)	3.33	1.18	−0.04	−0.99	.66
7. Talk to a lot of different people at parties	2.85	1.29	−0.13	−1.10	.81
8. Keep in the background (R)	2.98	1.23	−0.05	−1.05	.82
Openness					
9. Have a vivid imagination	3.57	1.08	−0.42	−0.26	.49
10. Am not interested in abstract ideas (R)	3.86	1.08	−0.67	−0.21	.63
11. Have difficulty understanding abstract ideas (R)	3.92	1.09	−0.85	0.30	.46
12. Do not have a good imagination (R)	4.01	1.10	−0.89	0.08	.83
Agreeableness					
13. Sympathize with others' feelings	4.30	0.82	−0.86	0.79	.43
14. Am not interested in other people's problems (R)	4.19	0.99	−0.97	0.50	.60
15. Feel others' emotions	3.89	1.01	−0.87	0.65	.72
16. Am not really interested in others (R)	4.36	0.83	−0.90	0.16	.68
Conscientiousness					
17. Get chores done right away	3.03	1.20	−0.17	−0.97	.60
18. Often forget to put things back in their proper place (R)	3.41	1.25	−0.16	−1.00	.65
19. Like order	3.99	0.91	−0.77	0.16	.44
20. Make a mess of things (R)	3.74	1.16	−0.74	−0.21	.76

Note. $N = 459$. (R) indicates that an item was reverse-coded for analyses. Factor loading = standardized factor loading obtained from a five-factor confirmatory factor analysis, which allowed the following error terms to correlate due to overlapping content: Items 9 and 12, 10 and 11, 13 and 15, and 14 and 16 (see Table 5 for fit indexes).

Table 4. Scale-level statistics: Means, standard deviations, alphas, and correlations.

Scale	*M*	*SD*	1	2	3	4	5	6	7	8
Sample 1 ($N = 369$)										
1. Neuroticism	10.99	3.57	(.77)					—	—	—
2. Extraversion	12.11	3.83	−.21***	(.82)				—	—	—
3. Openness	15.76	2.78	−.25***	−.13*	(.69)			—	—	—
4. Agreeableness	16.24	2.60	−.15**	.30***	.22***	(.72)		—	—	—
5. Conscientiousness	14.53	3.02	−.21***	.20***	.09	.06	(.64)	—	—	—
Sample 2 ($N = 459$)										
1. Neuroticism	9.97	3.53	(.70)							
2. Extraversion	11.52	3.88	−.19***	(.82)						
3. Openness	13.53	2.05	.03	.06	(.75)					
4. Agreeableness	16.71	2.77	−.10*	.20***	.10*	(.74)				
5. Conscientiousness	14.18	3.31	−.26***	.06	.02	.09*	(.70)			
6. Depression	6.97	3.59	.62***	−.19***	−.02	−.07	−.23***	(.92)		
7. Anxiety	7.85	3.72	.60***	−.18***	−.01	−.01	−.28***	.76***	(.92)	
8. Anger	10.49	4.29	.60***	−.18***	.05	−.07	−.16***	.69***	.67***	(.92)

Note. Values in parentheses indicate Cronbach's alphas for each scale. Correlations are reported on the off-diagonals, which were computed in SPSS using summated scale scores for personality dimensions and measures of emotional distress. In both samples, personality was assessed using the Mini-IPIP (Donnellan et al., 2006). In Sample 2, depression, anxiety, and anger symptom severity were assessed using the PROMIS four-item short forms for these indicators of emotional distress (Pilkonis et al., 2011).
*$p < .05$. **$p < .01$. ***$p < .001$.

The second model displayed in Table 5 shows the fit indexes for this respecified model in Sample 1. Although an improvement from Model 1, $\Delta\chi^2(\Delta df) = 97.25(4)$, $p < .001$, the results were still mixed. Fit was adequate when examining RMSEA (.07) and SRMR (.07) values but was poor when examining CFI (.88) and TLI (.85) values. Table 2 displays standardized factor loadings for each item. Except for Item 13, "Sympathize with others' feelings" (loading = .26), each item in the respecified model was a strong indicator of its respective factor (loadings ≥ .44) in Sample 1. A replication of this respecified model in Sample 2 (Table 5, Model 3) indicated that it achieved acceptable model fit (CFI = .92, TLI = .90, RMSEA = .05, SRMR = .05), with standardized factor loadings indicating that each item was a strong indicator of its respective factor (loadings ≥ .43; see Table 3). A post-hoc multigroup CFA showed that the cross-sample configural invariance model achieved adequate fit to the data (CFI = .90, RMSEA = .06), indicating that the underlying factor structure of the respecified model was similar in both samples. Therefore, this respecified measurement model was retained.

Criterion validity

Table 4 shows that personality was correlated with emotional distress in Sample 2. Specifically, neuroticism was strongly associated with increased emotional distress on each indicator: depression ($r = .62$, $p < .001$), anxiety ($r = .60$, $p < .001$), and anger ($r = .60$, $p < .001$). Conscientiousness and extraversion were moderately

Table 5. Fit indexes from confirmatory factor analyses testing the model fit of the Mini-IPIP in Samples 1 and 2.

Model	CFI	TLI	RMSEA	SRMR	$\Delta\chi^2$ (Δdf)	p value
Sample 1 ($N = 369$)						
1. Simple five-factor	.83	.80	.08	.07	—	—
2. Respecified	.88	.85	.07	.07	97.25 (4)	< .001
Sample 2 ($N = 459$)						
3. Respecified[a]	.92	.90	.05	.05	—	—

Note. Model 1 = an initial simple five-factor model with uncorrelated error terms. Model 2 = a respecified five-factor model that allowed the following items' error terms to correlate: Items 9 and 12, 10 and 11, 13 and 15, and 14 and 16. Model 3 = identical to Model 2, except that one variance term was fixed due to a Heywood case. CFI = comparative fit index; TLI = Tucker–Lewis index (also known as the non-normed fit index); RMSEA = root mean square error of approximation; SRMR = standardized root mean square residual. $\Delta\chi^2$ (Δdf) and p value = chi-square difference test between Model 1 and Model 2 in Sample 1.

[a]During estimation of this model, the statistical software detected a Heywood case: A negative variance was estimated for Item 16, "Am not really interested in others" (variance = –0.22, 95% CI [–.82 to 0.38]). We proceeded by verifying that the model was identified, properly specified, and that there were no outliers in the data. Furthermore, given that the 95% CI of the estimated variance term contained 0, we determined that the Heywood case might have been due to random sampling fluctuation and was not a concern. Therefore, the model was respecified in a manner that fixed the variance for that item to be equal to the absolute value of its original value (Kline, 2015; Kolenikov & Bollen, 2012).

associated with decreased emotional distress on each indicator: depression ($rs = -.19$ to $-.23$, $ps < .001$), anxiety ($rs = -.18$ to $-.28$, $ps < .001$), anger ($rs = -.16$ to $-.18$, $ps < .001$). Openness and agreeableness were not associated with emotional distress.

Next, a MIMIC structural regression model predicting a latent emotional distress factor (comprised of the three symptom scales) from the five personality factors and key covariates was examined (see Figure 1). The model achieved adequate model fit based on prespecified guidelines (CFI = .91, TLI = .90, RMSEA = .04, SRMR = .06). Neuroticism remained associated with increased emotional distress in this multivariate analysis ($\beta = 0.81$, $p < .001$). Agreeableness also emerged in these analyses as significantly associated with decreased emotional distress ($\beta = -.10$, $p = .039$), although this finding should be interpreted cautiously because univariate correlations between agreeableness and emotional distress were not significant (see Table 4). Among covariates included in the model, participants who had at least a bachelor's-level education ($\beta = -.09$, $p = .009$), were married ($\beta = -.12$, $p = .001$), and were older ($\beta = -.15$,

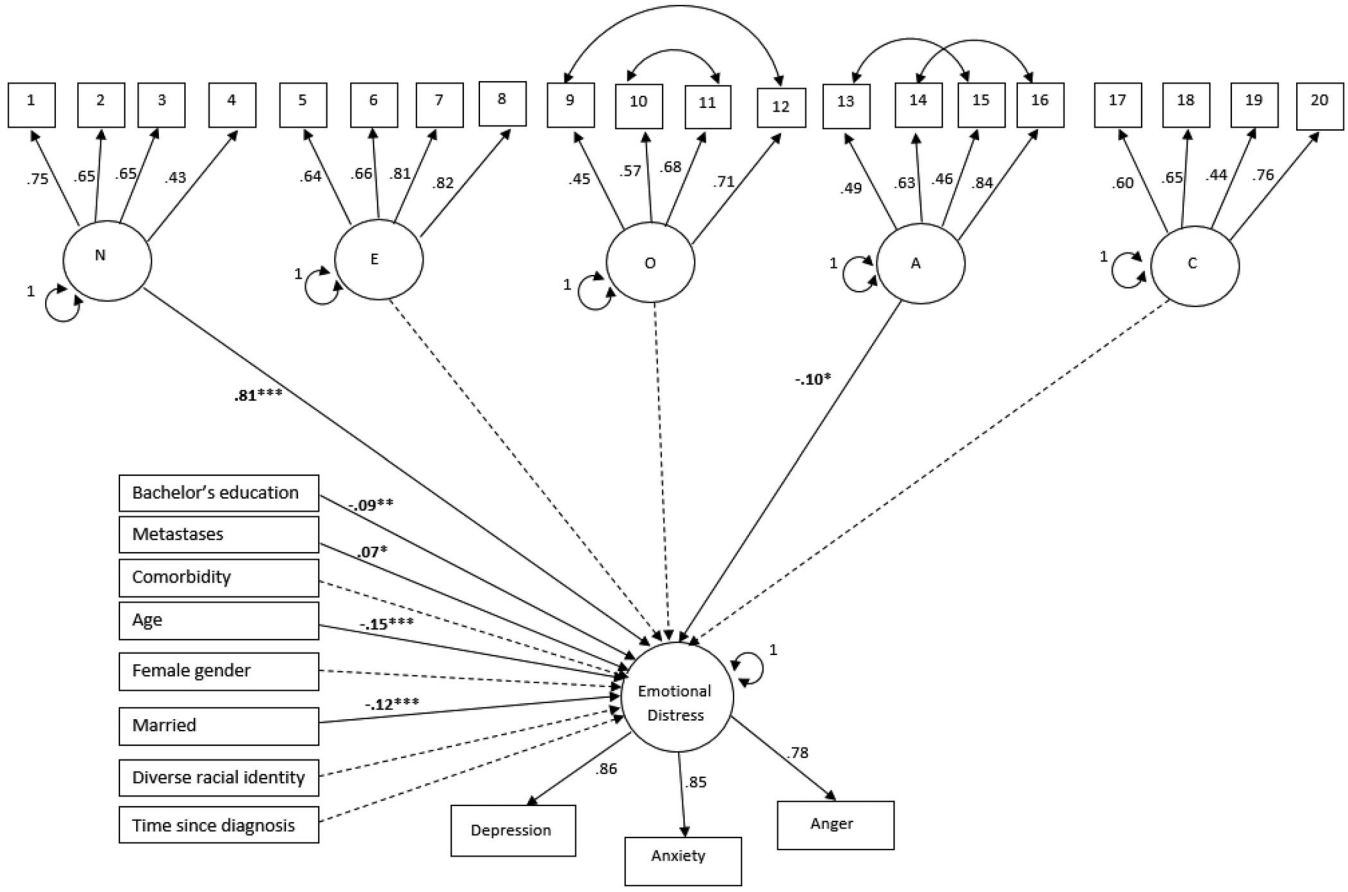

Figure 1. Mini-IPIP personality factors predicting emotional distress in Sample 2. *Note.* Comparative fit index (CFI) = 0.91; Tucker–Lewis index (TLI) = 0.90; root mean square error of approximation (RMSEA) = 0.04; standardized root mean square residual (SRMR) = 0.06; N = neuroticism factor; E = extraversion factor; O = openness factor; A = agreeableness factor. This figure depicts a multiple indicators, multiple causes (MIMIC) model predicting a latent factor of emotional distress from the five personality factors, while controlling for covariates (presence or absence of a bachelor's degree, presence or absence of comorbidity, age, gender, marital status, presence or absence of a diverse racial identity, and time since diagnosis). Personality factors were allowed to covary with one another and covariates were allowed to covary with one another (covariance arrows are not depicted in the figure for simplicity). Solid lines depict significant direct effects, whereas dashed lines depict nonsignificant direct effects. *$p < .05$. **$p < .01$. ***$p \leq .001$.

$p < .001$) had decreased emotional distress. Participants with metastatic cancer had increased emotional distress ($\beta = .07$, $p = .041$).

Discussion

This investigation provides psychometric evidence supporting the use of the Mini-IPIP as a measure of the FFM in samples of adults with cancer. We found evidence for the internal consistency reliability of the scales, and criterion validity demonstrated by associations with measures of emotional distress. Evidence for factor structure was comparable to that found in healthy samples (Baldasaro et al., 2013; Cooper et al., 2010; Donnellan et al., 2006). These findings will encourage future research and clinical practice aiming to reduce emotional distress and improve outcomes in cancer by incorporating personality into risk-prediction models that have historically ignored psychosocial data (Chapman, Lin, Roy, Benedict, & Lyness, 2019; Chapman et al., 2015; Fiscella, Tancredi, & Franks, 2009), and by attending to personality for individualized patient care recommendations.

This study found support for the internal consistency reliability and underlying factor structure of the Mini-IPIP in adults with heterogeneous cancer diagnoses. Across both samples, internal consistency reliability was fair to acceptable ($\alpha = .64$–$.82$) for each personality dimension (neuroticism, extraversion, openness, agreeableness, conscientiousness). In CFAs, a five-factor model achieved reasonable fit on two of four prespecified fit indexes in Sample 1, and four of four in Sample 2. Two fit statistics fell slightly below conventional thresholds for adequate fit in Sample 1. These were the CFI and TLI, which tend to be lower when the average intercorrelation is relatively low; this is unsurprising in this research given that the five personality factors are designed to be minimally correlated. Thus, the RMSEA and SRMR might be more important in this context. The results of the CFA are comparable to those observed in healthy samples (Baldasaro et al., 2013; Cooper et al., 2010; Donnellan et al., 2006), and measurement invariance analyses indicated that the underlying five-factor structure of the Mini-IPIP scores was equally-well supported in both of our samples. In conclusion, these findings support the reliability of Mini-IPIP scores and five-factor structure in adults with cancer.

The second aim of this study found that the Mini-IPIP demonstrated criterion validity with important patient-reported outcomes in cancer, namely emotional distress. As hypothesized, Sample 2 analyses found that neuroticism was robustly associated with worse emotional outcomes in both univariate analyses and multivariate analyses. Specifically, neuroticism was associated with increased levels of anxiety, depression, and anger in univariate correlations. Neuroticism remained associated with increased emotional distress in multivariate analyses, which modeled each latent personality factor's unique contribution to a latent emotional distress factor, while controlling for one's standing on all other personality factors as well as key observed demographic and health covariates. These findings are consistent with a large body of research showing positive associations between neuroticism and emotional distress in both the general public (Hengartner, Tyrer, Ajdacic-Gross, Angst, & Rössler, 2018; Kotov, Gamez, Schmidt, & Watson, 2010) and cancer-specific samples (Hinnen et al., 2008; Hulbert-Williams et al., 2012; Perry et al., 2018; van den Bergh et al., 2009; Van Esch et al., 2012). Individuals higher on neuroticism might be less equipped to cope with the normal levels of stress associated with having a life-limiting illness such as cancer due to ineffective emotional regulation strategies such as escape, avoidance, or substance use (Carver & Connor-Smith, 2010), heightening their risk for significant emotional distress over and above their general predisposition for negative affect (Hengartner et al., 2017).

Several other findings from our criterion validity analyses also warrant discussion. As hypothesized, extraversion was associated with lower anxiety, depression, and anger in univariate analyses. However, counter to our hypotheses, the association with emotional distress was not statistically significant in the multivariate structural regression model. Perhaps the effect was better explained by neuroticism when accounting for all five personality dimensions simultaneously, or the Mini-IPIP extraversion subscale failed to capture the entire content domain (i.e., all items might have assessed the single facet of gregariousness). Future research might wish to examine whether different facets of extraversion (e.g., gregariousness vs. positive affect) better capture the associations between extraversion and emotional distress in cancer samples. Furthermore, agreeableness was not associated with emotional distress in univariate analyses but appeared in the multivariate analysis to be significantly associated with decreased emotional distress. Discrepancies among the results from univariate (correlation) analyses and multivariate (structural regression) analyses could have been due to several factors. These might include the addition of covariates in the structural regression model, differences in the estimation method used, or differences in how the variance was partitioned when using summated scores in correlation analyses (i.e., total variance of each indicator is included) versus factor scores in the structural regression model (i.e., only shared variance among the indicators is included; DiStefano, Zhu, & Mindrila, 2009; Floyd & Widaman, 1995). It is also important to note that results from the covariate-adjusted structural regression model suggested that younger individuals, those with lower socioeconomic status (measured via education), those without a spouse, and those with metastatic disease had significantly higher levels of emotional distress. These findings are consistent with a large body of research examining variables associated with emotional well-being in cancer (Brandão, Schulz, & Matos, 2017; NCCN, 2018; Salvo et al., 2012).

Our findings have implications for efforts aiming to improve oncology care at the population or policy level. Mounting evidence suggests that personality characteristics are reliably associated with important health outcomes (Strickhouser, Zell, & Krizan, 2017), but the question remains how best to incorporate personality assessment into health care settings. Previous research has demonstrated that personality measures can enhance the accuracy of traditional

predictive models in health care that rely solely on demographic and clinical data (Chapman et al., 2019; Chapman et al., 2015). Given that this study supported the validity of the Mini-IPIP in a sample of individuals with heterogeneous cancer diagnoses, this measure might be acceptable for prediction models of emotional distress outcomes in cancer. Future research should examine whether incorporating personality data into models predicting emotional distress, as well as other diagnostic or prognostic outcomes, can improve the accuracy of risk assessment in cancer. Shifting to a personality-informed model of care might also help health care systems reduce costs. For example, certain personality characteristics such as neuroticism have been shown to be associated with increased health care costs (Friedman, Veazie, Chapman, Manning, & Duberstein, 2013), and routinely assessing personality could aid in efforts for forecasting and preventing unnecessary health services use. Future research should conduct cost-effectiveness analyses of personality-informed prediction models compared to traditional methods of risk assessment.

Results from risk prediction models could be used for augmenting clinical recommendations in oncology care that aim to inform treatment plans and allocate resources to those most in need (i.e., risk stratification). Specifically, results of personality-informed prediction models could be used to improve personalized medicine through targeted interventions for individual patients (Chapman, Hampson, & Clarkin, 2014; Chapman et al., 2019; Israel et al., 2014). For example, our results suggest that neuroticism might confer a greater risk for experiencing significant emotional distress after a cancer diagnosis. Therefore, patients who score high on neuroticism might benefit from more intensive distress management intervention, including increased frequency of distress screening or preventive measures such as referral to services aimed at building healthy coping skills that have been shown to improve quality of life in cancer. These might include counselors, supportive care, palliative care, or similar programs (Hoerger, Ramos, et al., 2019; Hoerger, Wayser, Schwing, Suzuki, & Perry, 2019; Warth et al., 2019) as well as increased support from family and friend caregivers (Korotkin et al., 2019). Personality-targeted supportive interventions might also help the distress-prone patient avoid increased medical costs for which they could be at risk (Davidson, Gidron, Mostofsky, & Trudeau, 2007; Dieng, Cust, Kasparian, Mann, & Morton, 2016; Perry et al., 2019). Therefore, assuming availability of robust data on risk prediction, personality assessment could have value in routine cancer care.

In addition to these implications, this study had other strengths worth noting. To our knowledge, this was the first study to examine the psychometric properties of a widely used measure of the FFM in a sample of individuals with a history of cancer. Furthermore, this study examined the performance of the Mini-IPIP in two independent samples, each with relatively large sample sizes, and statistical methodology employed CFA, which is often considered the gold standard for examining the factor structure underlying personality inventories (Hopwood & Donnellan, 2010). As well, a multigroup CFA was conducted to test the generalizability of the five-factor solution across the two samples included in our study. Finally, we also examined associations of the Mini-IPIP with important emotional distress outcomes for patients with cancer, highlighting the clinical applications of our findings.

However, these strengths were qualified by limitations. This was a cross-sectional online study and our sample was mainly White, educated, and married. Furthermore, our sample might have been higher on the personality characteristics of neuroticism, openness, and agreeableness compared to nonclinical samples who completed the Mini-IPIP in the United States (mean age = 29; Baldasaro et al., 2013) and Sweden (mean age = 62; Hansson, Berg, & Thorvaldsson, 2018). Our sample characteristics could have been affected by the fact that individuals tend to experience increases in neuroticism after being diagnosed with a chronic illness such as cancer (Jokela, Hakulinen, Singh-Manoux, & Kivimaki, 2014). Additionally, our estimates might have been prone to a self-selection bias given that more agreeable and open people are more likely to complete online surveys (Nestler, Thielsch, Vasilev, & Back, 2015), and individuals with these characteristics who are living with a cancer diagnosis might also be more likely to sign up for ResearchMatch or belong to online support groups. Future research should examine whether the psychometric properties of the Mini-IPIP generalize to more diverse samples of individuals with cancer with respect to race, ethnicity, and socioeconomic status. Furthermore, follow-up studies with longitudinal designs are needed to examine the feasibility of implementing the Mini-IPIP in clinical research and practice, and to examine the measure's stability over time and its predictive capacity for future patient-reported outcomes in cancer.

To conclude, this study provided reliability and validity evidence of the Mini-IPIP for assessing personality characteristics among adults with cancer. The findings of this investigation have implications for increasing utilization of personality assessments in oncology research and practice. Future studies should investigate potential clinical applications of this scale for use in oncology care and other health care contexts.

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