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ORIGINAL PAPER

# Perceived Stress Mediates the Relationship Between Trait Mindfulness and Physical Symptoms of Stress: a Replication Study Using Structural Equation Modeling

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## Abstract

**Objectives** The mindfulness stress buffering account posits mindfulness may benefit physical health by reducing stress. Previous research supports this account and suggests the non-judging facet of mindfulness may be most strongly associated with physical symptoms of stress, via lower perceived stress. The current replication study used structural equation modeling to analyze relationships between multiple facets of mindfulness, perceived stress, and physical symptoms of stress.

**Methods** Undergraduate students ($n = 534$, 68% White, 65% female) completed surveys measuring trait mindfulness (Five Facet Mindfulness Questionnaire—Short Form), perceived stress (Perceived Stress Scale), and physical symptoms of stress (Cohen-Hoberman Inventory of Physical Symptoms).

**Results** As hypothesized, results showed the negative relationship between four facets of mindfulness (describing, non-judging, non-reactivity, and acting with awareness) and physical symptoms of stress was partially mediated by lower perceived stress. Observing, however, was associated with more physical symptoms of stress.

**Conclusions** The current findings successfully replicated the results of two previous studies in an independent sample, using a more parsimonious analytic strategy that included all variables in a single path model. Results confirm the stress-buffering effect of trait mindfulness, particularly non-judging. Future research may test whether changes in trait mindfulness, particularly non-judging, explain individual differences in objective measures of stress and physical health.

**Keywords** Trait mindfulness · Stress · Physical health · College students · Mindfulness stress buffering account

College life can be stressful. According to the Spring 2021 National College Health Assessment, the vast majority of undergraduate students (81.8%) report "moderate" or "high" stress (American College Health Association [ACHA], 2021). Furthermore, 14% of college students describe their health as "fair" or "poor," an increase over prior years (ACHA, 2021). Students also report physical health concerns, including sleep problems, acne, trouble breathing, chronic pain, and gastrointestinal symptoms (Elflein, 2021). More recently, college students are coping with the risks of contracting COVID-19, which remains a significant medical burden on the student population (Ihm et al., 2021). Causes aside, physical health concerns are positively correlated with high stress in college students (Schneiderman et al., 2005), and high stress at the start of the school year appears to predict later physical symptoms of stress (Hall et al., 2006). Understanding resilience factors which reduce student stress is therefore relevant to both mental *and* physical health in college students. One such resilience factor—mindfulness—may be a mechanism by which students can decrease their stress, and thereby improve their physical health.

Mindfulness is defined as a purposeful, nonjudgmental awareness of the present moment (Kabat-Zinn, 1990). Although mindfulness is commonly associated with meditation training, it can also be measured as a trait varying across individuals (Brown & Ryan, 2003). High trait mindfulness is consistently associated with lower perceived stress (Donald et al., 2016), and it follows that higher trait mindfulness may reduce physical health concerns by decreasing stress (Roberts & Danoff-Burg, 2010). Indeed, trait mindfulness appears to correlate with not only lower stress but also fewer

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physical health concerns (Murphy et al., 2012). There is also theory to support these relationships. The mindfulness stress buffering account suggests mindfulness mitigates stress appraisal, thereby lowering stress and related physical symptoms (Creswell & Lindsay, 2014). Specifically, during primary stress appraisal, mindfulness theoretically increases awareness and acceptance of the present moment. This modifies the stress response to preempt unhelpful emotional and physical reactions to the stressor, thereby "buffering" downstream physical symptoms and health consequences of high stress reactivity.

The mindfulness stress buffering account as it relates to perceived physical health in college students has been investigated in two recent studies. The first, by Roberts and Danoff-Burg (2010), found higher trait mindfulness was associated with better perceived physical functioning, and perceived stress partially mediated this relationship. Ballantyne et al. (2021) replicated and extended that study by examining the mediating effect of stress on physical symptoms across five facets of trait mindfulness: observing, describing, non-judging, non-reactivity, and acting with awareness (Baer et al., 2006). The replication study by Ballantyne et al. (2021) found four facets (describing, non-judging, non-reactivity, and acting with awareness) negatively correlated with "bothersome physical symptoms." This effect was partly mediated by lower perceived stress. Furthermore, the effect of non-judging on physical symptoms through lower perceived stress was strongest, relative to the other facets. However, observing did not show the hypothesized negative relationship with physical symptoms of stress; instead, observing was associated with *higher* stress and physical symptoms. This aligns with prior research suggesting the observing facet of trait mindfulness may relate to stress counterintuitively in non-meditating populations (Gu et al., 2016). As suggested by the mindfulness stress buffering account, these findings indicate stress may partly mediate the relationship between trait mindfulness and perceived physical health. Furthermore, this relationship appears strongest for non-judging, and may not occur for observing, when each facet is analyzed individually. As research on trait mindfulness as a "stress buffer" has progressed, there still remains an important gap in knowledge. Namely, the relative contribution of different facets of mindfulness in explaining individual differences in stress perception and physical health remains unclear, since no prior studies have examined the unique predictive effects of multiple facets in a single explanatory model that adjusts for the other facets.

The current study, therefore, combines the strengths of previous studies, including a large sample size, specific facets of mindfulness, and validated measures of mindfulness, perceived stress, and physical symptoms of stress, to test the proposed mediation model on a demographically diverse sample of undergraduate students. We extend previous research by controlling for several variables known to impact college stress and/or trait mindfulness: gender, race, and meditation experience (Broman, 2005; Calaguas, 2011). Moreover, to account for all facets of mindfulness and covariates simultaneously, the present study uses structural equation modeling (SEM), a parsimonious analytic approach well matched to the research question. Finally, the present study helps advance the field by meeting the need for confirmatory data analysis as a way of moving beyond psychology's replication crisis (Fife & Rodgers, 2022) and helping to "mind the hype" in mindfulness research (Van Dam et al., 2018). Based on both mindfulness stress buffering theory and prior empirical findings, we hypothesized that perceived stress would mediate the relationship between all facets of trait mindfulness (except observing) and physical symptoms, with non-judging showing the strongest effect.

## Methods

### Participants

A convenience sample of undergraduate students aged 18–64 was recruited from introductory psychology courses, emails, and flyers ($n = 534$). Participants were 68% White and 65% female, with a median age of 19 (IQR: 18–21). Full sample characteristics are presented in Table 1.

### Procedure

We conducted a cross-sectional online survey study, conducted from April 2018 to September 2019. The Qualtrics survey consisted of an informed consent page followed by demographic and self-report questionnaires. Once completed, the anonymous survey concluded with a debriefing page linked to a separate survey collecting identifying information for course credit. The protocol was approved by the university institutional review board and was carried out in accordance with the Declaration of Helsinki.

### Measures

Reliability coefficients, means, and standard deviations for all measure are provided in Table 2.

**Five Facet Mindfulness Questionnaire** (FFMQ – Short Form; Gu et al., 2016). The FFMQ-SF is a 15-item scale assessing self-rated trait mindfulness across five domains: observing, describing, non-judging, non-reactivity, and acting with awareness. Items are rated using a Likert scale (0 = never or very rarely true; 5 = very often or always true). Example items include "I find myself doing things without paying attention" and "I tell myself I shouldn't be feeling the

**Table 1** Sample characteristics

| | |
|---|---|
| Age (yrs) | Median = 19, IQR = 18–21 |
| Gender | |
| Female | *n* = 347 (65%) |
| Male | *n* = 179 (34%) |
| Transgender | *n* = 1 (< 1%) |
| Gender variant/non-conforming | *n* = 6 (1%) |
| Not listed | *n* = 1 (< 1%) |
| Race | |
| White | *n* = 359 (67%) |
| Black | *n* = 71 (13%) |
| Native American or American Indian | *n* = 1 (< 1%) |
| Asian/Pacific Islander | *n* = 36 (7%) |
| Multiracial | *n* = 29 (5%) |
| Other race | *n* = 32 (6%) |
| Prefer not to answer | *n* = 6 (1%) |
| Annual household income | |
| > $10,000 | *n* = 60 (11%) |
| $10,000–$30,000 | *n* = 48 (9%) |
| $30,000–$50,000 | *n* = 57 (11%) |
| $50,000–$100,000 | *n* = 85 (16%) |
| $100,000–$150,000 | *n* = 79 (15%) |
| $150,000–200,000 | *n* = 38 (7%) |
| More than $200,000 | *n* = 19 (4%) |
| Prefer not to answer | *n* = 148 (28%) |
| Year in college | |
| 1st year | *n* = 197 (37%) |
| 2nd year | *n* = 151 (28%) |
| 3rd year | *n* = 98 (18%) |
| 4th year | *n* = 67 (13%) |
| 5th year | *n* = 7 (1%) |
| Other | *n* = 12 (2%) |
| Prefer not to answer | *n* = 2 (< 1%) |
| Prior meditation experience (yrs) | $\bar{x}$ = 3.16, range = 0–25, *n* = 241 (43%) |

**Table 2** Bivariate correlations between trait mindfulness, perceived stress, and physical symptoms of stress

| Measures | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| 1. FFMQ-OBS | – | | | | | | |
| 2. FFMQ-DES | .155** | – | | | | | |
| 3. FFMQ-NJ | −.086* | .318** | – | | | | |
| 4. FFMQ-NR | .331** | .225** | −.056 | – | | | |
| 5. FFMQ-AWA | −.148** | .204** | .414** | −.111* | – | | |
| 6. PSS | −.029 | −.321** | −.483** | −.182** | −.367** | – | |
| 7. CHIPS | .142* | −.230** | −.353** | −.049 | −.273** | .516** | – |
| Mean (SD) | 10.3 (2.5) | 9.5 (2.7) | 10.0 (3.1) | 9.1 (2.5) | 9.3 (2.4) | 19.5 (7.0) | 26.3 (20.9) |
| *N* | 534 | 533 | 531 | 530 | 529 | 524 | 534 |
| Cronbach's $\alpha$ | 0.58 | 0.80 | 0.83 | 0.69 | 0.69 | 0.87 | 0.93 |
| McDonald's $\omega$ | 0.58 | 0.81 | 0.84 | 0.69 | 0.73 | 0.87 | 0.93 |

*M* mean, *SD* standard deviation, *OBS* observing, *DES* describing, *NJ* non-judging, *NR* non-reactivity, *AWA* acting with awareness, *PSS* Perceived Stress Scale, *CHIPS* Cohen-Hoberman Inventory of Physical Symptoms

*$p < .05$, **$p < .01$, two-tailed

way I'm feeling." Each facet includes 3 items and summed scores for each facet range from 3 to 15, with higher scores indicating more of the facet being measured.

**Perceived Stress Scale** (PSS-10; Cohen & Janicki-Deverts, 2012). The PSS assesses perceived stress level over the past 30 days. Items are rated using a Likert scale (0 = never; 4 = fairly often). Examples items include "In the last month, how often have you felt nervous and 'stressed'?" and "In the last month, how often have you felt you were on top of things?" Summed total scores range from 0 to 40, with higher scores indicating greater perceived stress.

**Cohen-Hoberman Inventory of Physical Symptoms** (CHIPS; Allen et al., 2017). The CHIPS measures distress associated with 33 physical symptoms of stress over the past 2 weeks using a Likert scale (0 = not bothered at all; 4 = extremely bothered). Physical symptoms assessed include sleep problems, migraine headaches, fatigue, nausea, acne, pulled muscles, and colds/coughs. Summed total score ranges from 0 to 132, with higher scores indicating greater stress-related physical symptoms.

### Data Analyses

Analyses were completed using a confirmatory data analysis approach to replicate prior findings (Fife & Rodgers, 2022). All hypotheses were addressed by first assessing psychometrics, univariate distributions, graphics, and assumptions of normality, linearity, and homoskedasticity (Fife, 2020).

Mediation analyses controlled the dependent variables (perceived stress and physical symptoms of stress) for factors known to influence college stress: gender, race, and prior meditation experience (Broman, 2005; Calaguas, 2011). Structural equation modeling (SEM) was used to test hypothesized relationships simultaneously in a single model, while controlling for covariates (Kline, 2004). The model was analyzed using maximum likelihood estimation with robust standard errors in MPlus version 8.4 (Muthén and Muthén, Los Angeles, CA). Given the large sample size (> 500), bootstrapping was not used to resample the data, and because the mediation model tested was saturated, model fit indices were not applicable (Kline, 2004). Mediation results were interpreted using standardized beta ($\beta$) and 95% confidence intervals (CIs) for indirect effects, in addition to $p$ values. Parameter estimates for path coefficients were tested for statistical significance without alpha adjustment, due to the limited number of specific hypotheses ($z = 1.96$, $\alpha = 0.05$, two-tailed).

It should be noted that other cross-sectional survey studies (e.g., Bergin & Pakenham, 2016) have tested the mindfulness stress buffering account using moderation, rather than mediation analysis. Mediation is used here to directly replicate and extend the work of Roberts and Danoff-Burg (2010) and Ballantyne et al. (2021), while acknowledging that neither analytic approach allows us to infer causality using a cross-sectional dataset (Chmura Kraemer et al., 2008). As recommended, mediation is the most appropriate analytic approach when all variables are related to one another, whereas moderation assumes the predictor and mediator are *independent* (Chmura Kraemer et al., 2008), which is not the case in the present study.

## Results

Means, standard deviations, reliability statistics, and bivariate correlations for all study variables are presented in Table 2. All values were within the expected range for a college student sample. The distribution for Physical Symptoms of Stress (CHIPS) was positively skewed and corrected using the square root transformation.

### Correlations

Bivariate correlations are presented in Table 2. All facets of mindfulness were negatively correlated with perceived stress except observing. There was a strong positive correlation between perceived stress and physical symptoms of stress. Finally, the describing, non-judging, and acting with awareness facets were all negatively correlated with physical symptoms of stress, but there was no significant correlation between non-reactivity and physical symptoms of stress. There was a small positive correlation between observing and physical symptoms of stress.

### The Mediating Effect of Perceived Stress

Results of the mediation analysis are shown in Fig. 1. As expected, when adjusting for covariates and all other trait mindfulness facets in the model, significant indirect effects on physical symptoms of stress were found for describing ($\beta = -0.05$, 95% CI [−0.08, −0.02], $p = 0.003$), non-judging ($\beta = -0.15$, 95% CI [−0.19, −0.10], $p < 0.001$), non-reactivity ($\beta = -0.07$, 95% CI [−0.11, −0.03], $p < 0.001$), and acting with awareness ($\beta = -0.08$, 95% CI [−0.12, −0.04], $p < 0.001$). In contrast to the other facets, observing was uniquely associated with *higher* physical symptoms of stress ($\beta = 0.12$, $p = 0.003$), which was not mediated by perceived stress ($\beta = -0.001$, 95% CI [−0.04, 0.03], $p = 0.978$). The mediation model explained 35% of the variance in both perceived stress ($R^2 = 0.346$) and physical symptoms of stress ($R^2 = 0.354$), large effect sizes for multivariate models (Cohen, 1988).

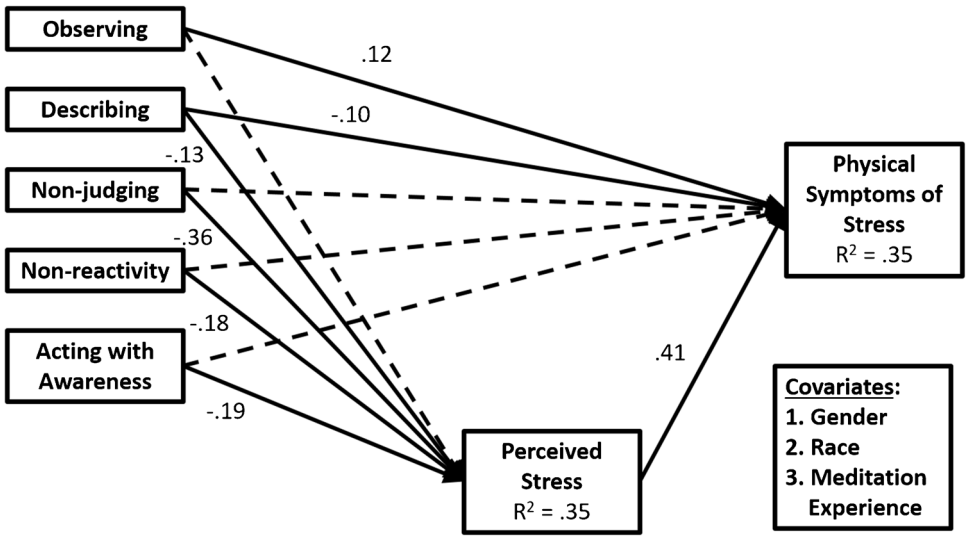


**Fig. 1** Path model of the relationship linking trait mindfulness facets, perceived stress, and physical symptoms of stress. Standardized beta ($\beta$) path coefficients are shown. Solid arrows indicate statistically significant paths. Dashed arrows indicate non-significant paths. $R^2$ values for perceived stress and physical symptoms of stress denote percent variance explained. Perceived stress significantly mediated the effect of four mindfulness facets (describing, non-judging, non-reactivity, and acting with awareness) on physical symptoms of stress. Covariates of perceived stress and physical symptoms of stress included gender, race, and prior meditation experience (paths not shown for simplicity)

## Discussion

The current study supported the hypothesis that the relationship between higher trait mindfulness and fewer physical symptoms of stress can be partly explained by lower perceived stress. Using SEM to test five specific facets of mindfulness simultaneously, while also controlling for covariates, we replicated the results of Ballantyne et al. (2021) and Roberts and Danoff-Burg (2010) by showing significant mediation effects for four out of five facets of mindfulness (describing, non-judging, non-reactivity, and acting with awareness). Non-judging showed the strongest effect, as predicted. These findings, observed in a larger, independent sample of undergraduate students in the USA, lend further credence to the mindfulness stress buffering account (Creswell & Lindsay, 2014). Specifically, individual differences in core qualities of mindfulness relate to differences in perception and appraisal of stress, which, in turn, help explain individual variation in stress-related health symptoms.

Consistent with prior work by Ballantyne et al. (2021), non-judging was the strongest predictor of physical symptoms. This facet of mindfulness refers to one's ability to accept internal experiences without judgment, for example, by noticing an unpleasant emotion without judging oneself for having it. Our study, which found non-judging remained the strongest predictor of physical symptoms even when accounting for all other facets, is consistent with previous research suggesting non-judging may be a more important predictor of psychological distress than other facets of mindfulness (Cash & Wittingham, 2010). Providing further context for the important role non-judging may play, Lindsay and Creswell's Monitor and Acceptance Theory (2017) suggests attention monitoring in isolation is insufficient to reduce stress and its downstream consequences. Instead, acceptance is needed to modify an individual's relationship to a stressor, thereby decreasing emotional reactivity and perceived stress, and in turn improving health-related outcomes. In the present study, describing, non-judging, non-reactivity, and acting with awareness showed the predicted association with *fewer* physical symptoms of stress as a function of lower perceived stress, while observing showed a *positive* relationship with physical symptoms. These findings are consistent with emerging theory indicating the tendency to observe one's thoughts, feelings, and physical sensations can be linked with *more* physical symptoms, even when accounting for the *stress-buffering* effects of other mindfulness facets. In contrast to Ballantyne et al. (2021), the positive relationship between observing and physical symptoms of stress was not mediated by perceived stress, as no association between observing and perceived stress was present.

Although we cannot derive clinical implications from a cross-sectional analysis, these findings may suggest some avenues for future research. Widely studied MBIs, such as mindfulness-based stress reduction (MBSR), are designed to improve physical health by reducing stress (Kabat-Zinn, 1990), and mechanistic studies support this hypothesis in stressed adults (Chin et al., 2019). On college campuses,

mindfulness-based interventions (MBIs) are increasingly offered and reliably decrease stress (Chiodelli et al., 2022; Greeson et al., 2014), but few studies have investigated the impact of mindfulness training on students' physical health (Dawson et al., 2020). Future mechanistic research may build on these cross-sectional findings by exploring the impact of mindfulness training on physical health in college students, and whether this effect, if present, is mediated by lower stress.

Replicated findings from this survey study also support further examining the relationship between trait mindfulness, stress, and *objective* measures of physical health. Previous research has linked high trait mindfulness with healthier heart rate variability (HRV; Prazak et al., 2012), lower resting blood pressure, and potentially lower interleukin-6, a marker of inflammation, in young adults (Tomfohr et al., 2015). Given the present support of the mindfulness stress buffering account for self-reported physical health and documented discrepancies between perceived and objective markers of health (Whitehead & Bergeman, 2016), future research testing the mediating role of stress using objective outcome variables, such as autonomic nervous system (ANS) regulation and/or stress hormones, is needed.

In addition, although perceived stress appears to be an important mediator of the relationship between mindfulness and physical symptoms of stress, other mediators remain of interest. Ballantyne et al. (2021) suggest positive affect may be another mediator of this relationship, given the association between high trait mindfulness and positive affect (Keng et al., 2011) and between positive affect and physical health (Pressman & Cohen, 2005). Other potential mediators may include more consistent health behaviors (Sala et al., 2020), improved emotion regulation (Chambers et al., 2009), and desensitization to unpleasant physical sensations (Shapiro et al., 2006).

Finally, we may obtain stronger evidence for the mediating role of stress by operationalizing stress objectively, for example, by measuring physiological reactivity and recovery from an emotional stressor. Indeed, there is preliminary evidence high trait mindfulness may be associated with more efficient cardiovascular recovery from emotional stress, as measured by high-frequency HRV (Fogarty et al., 2015). Because exaggerated *and* diminished physiological stress reactivity, as well as prolonged recovery, are linked to a variety of poor health outcomes (Lovallo, 2005), future research may therefore test physiological reactivity and recovery from stress as potential mediators of the relationship between mindfulness and physical health. Operationalizing stress objectively may also be important for clarifying the unique role of non-judging within the mindfulness stress buffering account. Experimental research suggests acceptance training, the parallel skill for the non-judging facet of mindfulness, drives improvements in cortisol and systolic blood pressure reactivity to a laboratory stressor (Lindsay et al., 2018). It may be helpful, therefore, to directly test whether improved stress reactivity and recovery mediate the relationship between non-judging and physical health.

## Limitations and Future Research

There are several limitations to the present study. Because this research was conducted using cross-sectional survey data, causality cannot be inferred without longitudinal or intervention research. Similarly, because all measures in this study were subjective self-report scales, objective measures of mindfulness, stress, and health are needed to test the mindfulness stress buffering hypothesis in future studies. In addition, although we tested a theoretically informed mediation model, the relationship between trait mindfulness and perceived stress is likely bidirectional. Specifically, high mindfulness may decrease stress, and low stress may also increase mindfulness (Zimmaro et al., 2016). As such, both variables may influence each other in a bidirectional feedback process to ultimately impact physical health.

This study also had several methodological strengths. We used reliable, validated psychometric scales, controlled for confounds thought to impact trait mindfulness and physical health, investigated multiple facets of mindfulness, and analyzed a large, demographically diverse sample. In addition, this study makes an important methodological advance by using a more parsimonious analytic strategy than previous studies in which all facets of mindfulness and covariates are accounted for simultaneously in a single model, which identifies the unique predictive value and relative importance of different trait mindfulness facets. Our confirmatory data analysis approach also used an independent dataset to replicate the findings of two other research teams, thereby providing robust support for the presumptive explanatory model. Finally, this study helps advance the field by testing underlying mechanisms, namely stress-buffering, that connect specific facets of mindfulness to specific outcomes, like stress-related physical symptoms (Creswell et al., 2019) .

In summary, this study supported the hypothesis that all facets of trait mindfulness, except observing, are related to fewer physical symptoms of stress in college students via lower perceived stress. Our results replicate prior analyses of mindfulness, stress, and physical health in college students, further support the mindfulness stress buffering account, and emphasize the stress-buffering effect of non-judging. Future research is needed to test decreased stress as a causal mechanism driving the beneficial effect of mindfulness training on physical symptoms of stress in college students and to investigate whether this relationship holds for objective measures of stress and health.

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**Author Contribution** EEM: assisted with data analyses and wrote the paper; GRC: analyzed the data and wrote part of the introduction and results; KSC: wrote part of the introduction and collaborated in the editing of the final manuscript; JMG: designed and executed the study, analyzed the data, and collaborated in the writing and editing of the final manuscript.

**Data Availability** The data that support the findings of this study are publicly available from Rowan Digital Works: https://rdw.rowan.edu/datasets/2/.

**Code Availability** The syntax used to support the analyses in this study is available from the corresponding author, JMG, upon reasonable request.

## Declarations

**Ethics Approval** This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Institutional Review Board (IRB) of Rowan University.

**Consent to Participate** Informed consent was obtained from all individual participants included in the study.

**Consent for Publication** The authors affirm that the human research participants provided informed consent for the publication of their de-identified survey data.

**Conflict of Interest** The authors declare no competing interests.
Informed Consent Statement.
Informed consent was obtained from all individual participants included in the study. The authors affirm that human research participants provided informed consent for the publication of their de-identified survey data.

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