RESEARCH

Developing a Framework of Relationships Among Noncognitive Factors in Doctor of Pharmacy Students’ Academic Performance

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Objective. To develop a framework of the effects of select noncognitive factors (grit, perceived stress, internal locus of control, and select Big Five personality traits) on pharmacy students’ academic performance.

Methods. A survey measuring select noncognitive factors was administered to two cohorts of first professional year (P1) pharmacy students (entering classes of 2019 and 2020, n = 374) during fall orientation. Demographics, pre-pharmacy GPA, and P1 fall semester GPA were collected from student records. Structural equation modeling was conducted to assess the proposed framework.

Results. Academic performance was directly influenced by students’ (n = 367; 98.1%) perceived stress and neuroticism and indirectly influenced by internal locus of control and neuroticism (via perceived stress as mediator). Neuroticism has a complex relationship in the models as it was directly and positively associated with academic performance, and indirectly contributed to decreased academic performance via a positive association with perceived stress. Squared multiple correlations indicated 13% and 9% of the variance in academic performance in the first final model (academic performance measured by pre-pharmacy GPA and P1 fall GPA) and second final model (academic performance measured by P1 fall GPA), respectively, were explained by the predictor variables.

Conclusion. Evidence provided by structural equation modeling supports the conclusion that select noncognitive factors, namely perceived stress, neuroticism, and internal locus of control, have direct and indirect effects on the academic success of P1 students. The model variances of 9% and 13% represent 36% to 52% of the predictive value of the most accepted cognitive measures used to determine students’ potential for academic success.

Keywords: academic performance, big five personality traits, grit, locus of control, perceived stress

INTRODUCTION

Academic success is a major concern for pharmacy students and their families as well as educational institutions. Improved understanding of factors predictive of academic performance is vital to developing strategies and interventions to promote student success. Meagher and colleagues1 noted the cognitive measures of pre-pharmacy grade point average (GPA) and Pharmacy College Admission Test (PCAT) combined explained approximately 25% of the variance in first-year pharmacy (P1) GPA. As Novovic and colleagues2 summarized, although cognitive measures such as GPA and PCAT are “somewhat predictive of success during pharmacy school, they still do not explain the majority of variance observed in student achievement.”

A range of noncognitive attributes, described by Stoffel and Cain3 as “those skills associated with motivation, attitude, and temperament rather than intellect,” exist and may play a role in student performance. Such attributes include (but are not limited to) self-perceptions or constructs, self-control, work and social behaviors (eg, perseverance), attitude or emotion toward a task, and personality traits.4-8 Given this broad scope, a focus on select factors reflective of the diversity of noncognitive attributes is appropriate. Previous studies indicate the select noncognitive factors of grit, locus of control, the Big Five personality traits, and perceived stress may be associated with learning and academic success among health professions students.9-20 For example, studies
conducted by Munro,19 Ofori and Charlton,14 and Webb and colleagues20 found higher internal locus of control (or perceptions of control over one’s life) was associated with better academic performance among nursing and medical students. Among 16 studies specifically involving pharmacy students, inconsistent relationships between these noncognitive factors and academic performance were generally noted (Appendix 1).15,17,21-34 For example, Gruenberg and colleagues26 found grit (ie, persistence in and passion for a task/goal) was not associated with either GPA or matching to a postgraduate pharmacy residency program, while other studies found significant associations between increased grit, residency matching, and higher GPA.15,28 Studies of the Big Five personality traits (dimensions of personality defined as agreeableness, conscientiousness, extraversion, neuroticism, and openness) were likewise inconsistent, although inverse associations were noted between academic outcomes and the traits of agreeableness, extraversion, and neuroticism.22,29,33,34 Although less well-studied than in medical students, studies examining perceived or self-reported stress (ie, emotional strain) among pharmacy students were typically consistent with all but two of eight studies reporting increased stress was associated with poorer academic performance.17,21,24,25,27,30-32

Because of the high cost of pharmacy school, risk of attrition and emerging emphasis placed on inclusion of noncognitive skills in the Doctor of Pharmacy (PharmD) curriculum, academic leaders must develop a better understanding of these noncognitive factors, their relationship with academic success, and potential strategies to use noncognitive factors to limit student attrition.15 While several studies examined the association between academic success and individual factors, a literature search failed to produce a framework of the relationships among grit, perceived stress, locus of control, select Big Five personality traits, and pharmacy students’ academic performance. Therefore, the purpose of this study was to develop such a framework, as confirmed through structural equation modeling.

METHODS

As most attrition and poor academic performance occur early in the didactic portion of the PharmD curriculum, this study focused on academic success in the fall semester of the first year of pharmacy school.36-39 A survey composed of instruments measuring the noncognitive factors of interest was administered to two cohorts of first professional year (P1) pharmacy students at the University of Tennessee Health Science Center (UTHSC) College of Pharmacy. All P1 students entering in fall 2019 (n=204) and fall 2020 (n=177) were eligible to participate. Survey administration was conducted during first-year fall orientation in 2019 and 2020. The study was approved by the UTHSC Institutional Review Board.

Figure 1 depicts the proposed framework (model) being tested, derived from knowledge gained from previously described studies of the select noncognitive factors influencing academic performance of health professions students. Noncognitive factors included in the proposed model are defined in Table 1.3,4,40-45 P1 fall GPA and pre-pharmacy GPA were selected as indicators for academic performance for two reasons: pre-pharmacy GPA, based on prerequisite undergraduate coursework primarily comprised of science and math courses, has been demonstrated to play a role in academic success in pharmacy school; and P1 fall GPA, resulting from grades earned for the courses in Appendix 2, is a measure of early pharmacy school performance.1,38,46-49 Based on the pervasive underlying influence of perceived stress on individuals’ daily lives, in the proposed model we hypothesize perceived stress mediates the effects of grit, locus of control, and the select Big Five personality traits on academic performance (mediation is defined by Hopwood50 as “a case in which a third variable is a pathway for the effect of a predictor on an outcome”).51

To test the proposed model, valid and reliable instruments previously used in pharmacy and other health professions student populations were selected to measure the select noncognitive factors.15,17,25,31,52 Cronbach alphas were calculated to determine the internal consistency (reliability) of the instruments. Cronbach alpha of .7 or greater is considered acceptable, with at least .5 considered “minimally adequate.”53,54 Other data were collected from student records, including demographics (gender and race/ethnicity), pre-pharmacy GPA, and P1 fall GPA, and entered in a study database. A cross-check for accuracy was conducted of a random sample of data entered into the database as a quality control measure.

The eight-item Short Grit Scale (Grit-S) uses a five-point Likert scale to assess level of response to each item, ranging from 1 = “not like me at all” to 5 = “very much like me” (note: the total Grit-S, rather than its two subscales, was the focus of this study).55 The Grit-S includes reverse-scored items in which the wording of these four items was in the opposite direction of the wording of the remaining four items (ie, negatively worded [less grit] vs positively worded [more grit], respectively). Scores of these four items are “reversed” to be consistent with the directionality of the remaining four items, for example, a score of 1 is changed to 5. The eight item scores are averaged and total scores range from 1 to 5, with higher scores indicating greater grit. Prior studies reported Cronbach
alpha values for the Grit-S of .73 to .83 in student populations, including pharmacy students.\(^\text{15,55,56}\)

The Perceived Stress Scale-10 (PSS-10) is a shortened, validated version of the original Perceived Stress Scale and includes 10 items scored using a Likert scale ranging from 0 = never to 4 = very often.\(^\text{57,58}\) Four items are reverse-scored. Total scores range from 0 to 40, with higher scores indicating greater perceived stress. Spivey and colleagues reported Cronbach alpha values of .83, .87, and .89 in administrations of the PSS-10 to P1 students.\(^\text{31}\)

The Big Five Inventory (BFI) is a measure of five personality traits: extroversion, agreeableness, conscientiousness, neuroticism, and openness (note, conscientiousness and openness subscale scores were not used in this analysis to be parsimonious as there is a lack of evidence concerning their relationships to academic performance among pharmacy students).\(^\text{9,59,60}\) The BFI includes 44 items scored on a 5-point Likert scale ranging from 1 = disagree strongly to 5 = agree strongly. Scores were calculated for each subscale/personality trait, with multiple reverse-scored items. Total scores range from 1 to 5, with higher scores indicating greater preference for a given trait. The agreeableness subscale is comprised of nine items, and the extraversion and neuroticism subscales are each comprised of eight items. John and colleagues\(^\text{60}\) reported Cronbach alpha values of these three subscales ranging from .79 to .87.

The brief version of Levenson’s Locus of Control Scale was used because it attempted to address shortcomings in other versions of commonly used locus of control scales.\(^\text{54}\) Although this scale includes three subscales, this study focused on the Internal Locus of Control subscale based on existing literature among health professions students, suggesting an association between greater internal locus of control and better academic performance.\(^\text{14,19,20}\) Items were scored using a Likert scale ranging from 1 = disagree strongly to 5 = agree strongly. Total scores range from 3 to 15. Higher scores indicate the individual strongly believes he or she is in control of their own experiences, while lower scores indicate the individual does not tend to believe he or she is in control of their own experiences. Sapp and Harrod\(^\text{54}\) reported a Cronbach alpha value of .59 for Internal Locus of Control.
Data analysis was performed using IBM SPSS Statistics 26.0 and IBM SPSS AMOS 26. Descriptive statistics were calculated to summarize student characteristics, noncognitive factor scores, and GPAs. Mann-Whitney U tests were performed to determine if significant differences exist between demographic groups (eg, female vs male, non-Hispanic White vs minority) based on noncognitive factor scores, pre-pharmacy GPA, and P1 fall GPA. As a total of 16 Mann-Whitney U tests were performed, the Bonferroni adjustment was used (.05 divided by 16), resulting in an alpha level of .003.

Structural equation modeling (SEM) was conducted to test and confirm the findings of the proposed model (Figure 1). A power analysis (sample size calculation) was conducted using the following parameters: anticipated effect size of .5, desired power level of .8, probability (alpha) level of .05, seven latent variables (noncognitive factors and academic performance), and 48 observed variables (including items which compose the various noncognitive scales, pre-pharmacy GPA, and P1 fall GPA). Minimum sample size required was 366. In the first step of the SEM, bias-corrected bootstrapping was used to test for mediation, as a full mediation model (Figure 1) was hypothesized by investigators. The number of bootstrap samples was set at 5000 and the bias-corrected confidence interval was set at 95%. Bias-corrected bootstrapping assesses the statistical significance of both the direct effect of the relationship between the given noncognitive factor (grit, internal locus of control, agreeableness, extraversion, neuroticism) and academic performance, as well as the indirect effect of the relationship between the given noncognitive factor and academic performance as mediated by perceived stress. Following mediation testing, a model generating scenario was used in step two of the SEM in which the proposed model (referred to as Model One) was tested for goodness of fit. As needed, the model was modified and re-estimated “to determine a model that better describes the sample data.”

A second model (referred to as Model Two) in which P1 fall GPA was the sole indicator of academic performance was also tested to determine consistency and fit of the model when pharmacy school performance alone was considered. To address missing data, the regression imputation method within AMOS was used. The following model fit indices are indicative of good fit: chi square to degrees of freedom ratio (CMIN/DF) less than 2 (between 2 and 3 is considered adequate); comparative fit index (CFI) greater than 0.95; standardized root mean square residual (SRMR) less than .05; and root mean square error of approximation (RMSEA) less than .05. An alpha level of .05 was used to determine statistical significance.

RESULTS

Among 381 students in the entering classes of 2019 and 2020, seven withdrew prior to the end of the P1 fall semester and were excluded from the study (students remaining in the 2019 class, n=200, and in the 2020 class, n=174). Of note, 43% of the seven students who withdrew were male, with mean age of 22 years (SD=3.73 years). Six of the seven students completed the survey
instruments and did not significantly differ from study participants on pre-pharmacy GPA or noncognitive scale scores. Of the 200 remaining students in the entering class of 2019, 193 (96.5%) participated in the study, while all 174 (100%) remaining students in the entering class of 2020 participated, for a total of 367 participants (resulting in a 98.1% overall response rate). The majority of participants were female (n=238 [64.9%]) and non-Hispanic White (n=214 [58.3%]). Mean and median GPAs and noncognitive factor scale scores as well as Cronbach alpha values for each scale are presented in Table 2.

Significant differences (p=.001) in pre-pharmacy GPA were found between non-Hispanic White students (M=3.42, SD=0.39, Median=3.46) and minority students (M=3.29, SD=0.36, Median=3.29). Significant differences (p<.001) in P1 fall GPA were also found between non-Hispanic White students (M=3.37, SD=0.52, Median=3.46) and minority students (M=3.12, SD=0.57, Median=3.18). No significant differences in noncognitive scale scores were found based on race/ethnicity. Female students had significantly (p<.001) higher scores than male students on the following BFI subscales: agreeableness (female students, M=4.36, SD=0.48, median=4.44; male students, M=4.12, SD=0.6, Median=4.24); and neuroticism (female students, M=2.9, SD=0.69, Median=2.88; male students, M=2.55, SD=0.8, Median=2.5). No other significant differences were found based on gender.

Mediation testing of the proposed model (Figure 1) supported that relationships between academic performance and grit, internal locus of control, agreeableness, and extraversion were fully mediated by perceived stress. However, the relationship between neuroticism and academic performance was partially mediated, meaning there was evidence of a direct relationship between the two variables and an indirect relationship mediated by perceived stress. The proposed model was revised to reflect this.

Goodness of fit testing of the full Model One, in which academic performance was indicated by pre-pharmacy GPA and P1 fall GPA, found that model fit was less than acceptable, with CFI of .75 and SRMR of .08 (although RMSEA and CMIN/DF were acceptable at .06 and 2.34, respectively). To improve fit, the model was modified as follows: grit, agreeableness, and extraversion were removed because they were not significantly associated with perceived stress in the full model (p>.05). Goodness of fit indices of the modified Model 1 (Figure 2) indicated acceptable to good fit: CMIN/DF of 1.82, CFI of .93, SRMR of .05, and RMSEA of .05. Squared multiple correlation of .13 indicated 13.4% of the variance in academic performance was explained by the predictor variables in the model. The standardized regression weight

| Table 2. Summary of Data in a Study to Determine Effects of Select Noncognitive Factors on Pharmacy Students’ Academic Performance |
|---------------------------------|-----------------|-----------------|
| **Student Demographics and Data** | **Participants** |
| **Gender** | **(n=367)** |
| Female, n (%) | 238 (64.9) |
| Male, n (%) | 126 (34.3) |
| Other | 3 (0.8) |
| **Race/Ethnicity** | |
| Non-Hispanic White, n (%) | 214 (58.3) |
| Minority, a n (%) | 151 (41.1) |
| Missing | 2 (0.5) |
| **Pre-pharmacy GPA** | |
| Mean (SD) | 3.37 (0.39) |
| Median (IQR) | 3.37 (0.59) |
| **P1 Fall GPA** | |
| Mean (SD) | 3.27 (0.56) |
| Median (IQR) | 3.34 (0.75) |
| **BFI Agreeableness Score** | |
| Mean (SD) | 4.28 (0.53) |
| Median (IQR) | 4.33 (0.67) |
| Cronbach’s alpha | 0.74 |
| **BFI Extraversion Score** | |
| Mean (SD) | 3.34 (0.84) |
| Median (IQR) | 3.33 (1.25) |
| Cronbach’s alpha | 0.85 |
| **BFI Neuroticism Score** | |
| Mean (SD) | 2.78 (0.75) |
| Median (IQR) | 2.75 (1) |
| Cronbach’s alpha | 0.81 |
| **Grit-S Score** | |
| Mean (SD) | 3.75 (0.55) |
| Median (IQR) | 3.8 (0.73) |
| Cronbach’s alpha | 0.74 |
| **Internal Locus of Control Score** | |
| Mean (SD) | 12.4 (1.96) |
| Median (IQR) | 13 (3) |
| Cronbach’s alpha | 0.62 |
| **Perceived Stress Scale-10 Score** | |
| Mean (SD) | 16.25 (5.92) |
| Median (IQR) | 16 (8) |
| Cronbach’s alpha | 0.85 |

Abbreviations: BFI=Big Five Inventory, GPA=grade point average, Grit-S=Short Grit Scale, IQR=interquartile range=a measure of variability defined as the difference between the midpoints of the third quartile (upper quarter) and first quartile (lower quarter) of data.

a “Minority” is defined as any student who identified as non-White and/or Hispanic.
estimates are displayed in Figure 2, and unstandardized regression weight estimates are presented in Table 3.

In Model 2, in which academic performance was indicated by P1 fall GPA only, fit of the full model was less than acceptable, with CFI of .75 and SRMR of .08 (although RMSEA and CMIN/DF were acceptable at .06 and 2.39, respectively). Similar to Model 1, to improve fit, Model 2 was modified as follows: grit, agreeableness, and extraversion were removed because they were not significantly associated with perceived stress in the full model ($p > .05$). Goodness of fit indices of the modified Model 2 (Figure 2) indicated acceptable to good fit: CMIN/DF of 1.97, CFI of .92, SRMR of .05, and RMSEA of .05. Squared multiple correlation of .09 indicated 9% of the variance in academic performance was explained by the predictor variables in Model 2. The standardized regression weight estimates are displayed in Figure 2, and unstandardized regression weights are presented in Table 3.

**DISCUSSION**

The current study is the first to examine a structural equation model of the associations among the selected noncognitive factors and P1 students’ academic performance. The final models reveal interesting relationships among the variables. First, the models demonstrate the influence of perceived stress on academic performance, indicating higher perceived stress contributes to poorer performance or vice versa (Figure 2), which is consistent with prior studies. Perceived stress is therefore a critical target for intervention to support student success. In a systematic review of interventions to decrease perceived stress among graduate students, Stillwell and colleagues found evidence that several strategies (often used in combination) were effective in reducing perceived stress, including training on relaxation skills, breathing and body awareness techniques, time management, mindfulness, meditation, yoga, mindful eating, and controlling negative or irrational thoughts. Such interventions may be
of benefit to pharmacy students, and future studies should consider implementation and evaluation of stress management strategies, including effects on academic performance, in this population.

The second interesting finding was that students’ internal locus of control indirectly influenced their academic performance via a mediated relationship with perceived stress. Internal locus of control decreased as perceived stress increased (or vice versa); in turn, as perceived stress increased, academic performance decreased (or vice versa). Thus, lower internal locus of control indirectly contributed to poorer academic performance, and likewise higher internal locus of control indirectly contributed to better academic performance. This is consistent with previous studies of the association between internal locus of control and academic performance.\textsuperscript{14,19,20} Prior studies suggest several strategies that may be used among pharmacy students to improve internal locus of control, which may ultimately reduce stress and/or benefit academic performance.\textsuperscript{71-73} These strategies include problem-based education to encourage problem-solving and self-directed learning; online videos discussing locus of control and growth mindset and how they may be utilized by students during their education; and mentoring programs to build supportive and nurturing connections.\textsuperscript{71-73} For example, Demir and colleagues\textsuperscript{71} found that a peer mentoring program in which fourth-year nursing students served as mentors for first-year nursing students contributed to increased internal locus of control and improved ability to cope with stress among the first-year students.

The third interesting finding was that neuroticism both directly and indirectly affected students’ academic performance in the final models. Pertaining to the direct effect, neuroticism was positively associated with academic performance, meaning as neuroticism increased, academic performance increased (or vice versa). Neuroticism also indirectly influenced academic performance via perceived stress as the mediator. To explain further, neuroticism and perceived stress were positively associated, and perceived stress and academic performance were inversely associated. This means higher neuroticism indirectly contributed to decreased academic performance via increased perceived stress (or vice versa). Prior studies of neuroticism in pharmacy students are limited and do not shed much light on the complex relationship with academic performance suggested in this study.\textsuperscript{22,34} In their study of personality traits and academic performance among medical students, Lourinho and colleagues\textsuperscript{74} found that neuroticism was positively associated ($p = .014$) with achievement, and suggested, “the anxiety component of neuroticism due to its anticipatory ability can have facilitated performance in … individuals who may have strategically channeled the negative affect to promote high levels of preparation, competitiveness, and striving to attain a better position.” However, Lourinho and colleagues\textsuperscript{74} also caution that high levels of neuroticism may cause greater stress and burnout among health professions students. Therefore, we postulate a certain amount of anxiety (neuroticism) may be motivating for students, but if that neuroticism becomes overwhelmingly stressful, then academic performance can be negatively impacted. This phenomenon may suggest a healthy and delicate balance of neuroticism and stress is needed for optimal academic performance. To assist in achieving this healthy balance, previous studies suggest mindfulness training may have

| Relationship | Estimate\textsuperscript{b} | Standard Error | $p$ value |
|--------------|-----------------|----------------|-----------|
| **Modified Model One** | | | |
| Perceived Stress-Internal Locus of Control | -.199 | .066 | .003 |
| Perceived Stress-Neuroticism | .501 | .055 | <.001 |
| Academic Performance-Perceived Stress | -.114 | .049 | .02 |
| Academic Performance-Neuroticism | .075 | .034 | .03 |
| **Modified Model Two** | | | |
| Perceived Stress-Internal Locus of Control | -.201 | .066 | .002 |
| Perceived Stress-Neuroticism | .500 | .055 | <.001 |
| Academic Performance-Perceived Stress | -.309 | .071 | <.001 |
| Academic Performance-Neuroticism | .200 | .056 | <.001 |

Abbreviations: GPA  = grade point average.
\textsuperscript{a} Academic performance as indicated by pre-pharmacy GPA and P1 fall GPA in Modified Model One and P1 Fall GPA only in Modified Model Two
\textsuperscript{b} Unstandardized regression weight estimates
protective effects for students who score highly on neuroticism.75,76 Mentioned earlier as a possible intervention to reduce perceived stress, mindfulness training focuses on improving emotional awareness and developing skills related to emotional regulation and therefore may assist students in managing anxiety and emotional distress during pharmacy school. Future studies should thus consider the potential role of mindfulness training as a support strategy for pharmacy students.

Among the current study’s additional findings, no significant differences in noncognitive factor scores were found based on race/ethnicity, although non-Hispanic White students had significantly higher pre-pharmacy GPA and P1 fall GPA. Previous studies are not consistent regarding the relationship between race/ethnicity, pre-pharmacy GPA, and pharmacy school GPA.77,78 Additionally, female compared to male students had significantly higher scores on agreeableness and neuroticism, which is consistent with prior studies of gender differences on the Big Five personality traits.79,80 Given these findings, future studies should consider how the final models function when race/ethnicity and gender are introduced.

Like all studies, this study has both strengths and limitations. Strengths include a high response rate (greater than 98%) and the desired sample size indicated in the power analysis, supporting the robustness of the data and analysis, as well as a sample generally representative of the national PharmD student population in terms of gender and race and ethnicity.81 However, as noncognitive data were self-reported, response bias may have occurred in which participants provided answers they believed were preferred by investigators, selected the neutral answer option for all or most scale items, or “agreed” or “disagreed” with all or most scale items.82 To minimize response bias, participants were assured of confidentiality and provided ample time to read and complete the survey instrument. Additionally, the noncognitive instruments included reverse-scored items that might facilitate greater consideration of the item (because of differences from other items) and disrupt any biased patterns in responses. Another limitation includes the timing of the survey. Survey data were collected during orientation, prior to the start of classes. It is unknown if noncognitive factors may have changed throughout the semester. However, a better understanding of these factors, as measured at a baseline point such as pharmacy school orientation, may be helpful in developing early targeted programming to support student success.

At first glance, the variances reported in the final models may not seem impressive or impactful. However, prior studies have found that standard cognitive measures, such as prior GPA and standardized tests, only predict approximately 25% of the variance in pharmacy school GPA.1 In that context, these model variances of 9% and 13% represent 36% to 52% of the predictive value of the most accepted cognitive measures used to assess potential future academic performance. Although a notable portion of the variance in academic performance was explained by the final models, a large percentage remains unexplained, suggesting there are other factors at play in determining student success. Nevertheless, this study represents a critical first step in exploring the effects of perceived stress, grit, internal locus of control, agreeableness, extraversion, and neuroticism on academic performance.

CONCLUSION
The evidence supports how a framework (structural model) of select noncognitive factors, namely perceived stress, neuroticism, and internal locus of control, affects the academic performance of first-year pharmacy students. Application of this knowledge may be beneficial to pharmacy schools during the admissions process, in monitoring academic performance, and when developing and implementing programming to support pharmacy student success.

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Appendix 1. Studies of the Relationships Between Select Noncognitive Factors and Academic Outcomes in Pharmacy Students (N=16)

| Study                        | Noncognitive Factor(s) | Findings                                                                                                                                 |
|------------------------------|------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| Alshammari (2019)21          | Perceived Stress       | No significant correlations were noted between indicators of stress and GPA (n=240 participants).                                            |
| Azmi et al. (2014)22         | Conscientiousness,     | In a sample of 1018 students, neuroticism and GPA were significantly, but weakly correlated (Spearman rho = -.076, p=.015); however, conscientiousness and extraversion were not significantly correlated with GPA. |
|                             | Extraversion,          |                                                                                                                                          |
|                             | Neuroticism            |                                                                                                                                          |
| Dy-Boarman et al. (2018)23   | Grit                   | No significant differences were found in total grit score between students who passed all components of a laboratory practical examination on the first attempt and those requiring remediation/re-examination (n=163 participants). |
| Garber et al. (2019)24       | Perceived Stress       | In a sample of 352 students, greater stress was significantly associated with lower GPA (p=.015).                                           |
| Geslani & Gaebelein (2013)25 | Perceived Stress       | In a sample of 139 students, those with a GPA ≤3.0 had significantly higher stress than those with a GPA >3.0 (p<.04).                       |
| Gruenberg et al. (2019)26    | Grit                   | Grit was not significantly associated with GPA, APPE evaluation, or ASHP residency match (n=852 participants).                               |
| Kristina et al. (2020)27     | Perceived Stress       | In a sample of 330 students, those with a GPA >3.5 reported significantly greater stress than students with a GPA <3.0 (OR= 1.32, 95% CI= 1.03, 2.23); however, stress level was not significantly different between students with a GPA of 3 to 3.5 vs. <3.0. |
| Palisoc et al. (2017)28      | Grit                   | In a sample of 98 students, total grit score and academic success, defined as GPA ≥3.0 and no course failure, were not significantly correlated; however, total grit score was significantly associated with attaining postgraduate training (OR= 34.6, 95% CI= 2.5, 482.8). |
| Pate et al. (2017)15         | Grit                   | In a sample of 724 students, higher total grit score was significantly associated with GPA ≥3.5 vs. GPA 3.0 to 3.49 (RR= 1.8, 95% CI= 1.5, 2.3), but was not significantly associated with GPA <3.0 vs. GPA 3.0 to 3.49. There were no significant differences in total grit score between students who reported no grades of D or F vs. those who reported having D or F grades. |
| Rothmann et al. (2000)29     | Extraversion/          | Introversion was significantly, moderately correlated with academic performance among P4 students (r = .34 to .47, p value not reported), but extraversion/introversion was |
|                             | Introversion           |                                                                                                                                          |

(Continued)
## Appendix 1. (Continued)

| Study                          | Noncognitive Factor(s) | Findings                                                                                                                                 |
|-------------------------------|------------------------|------------------------------------------------------------------------------------------------------------------------------------------|
| Shin & Gruenberg (2019)<sup>30</sup> | Perceived Stress      | In a sample of 243 students, stress was not significantly associated with changes in therapeutics course test scores.                     |
| Spivey et al. (2020)<sup>31</sup> | Perceived Stress      | Stress score (measured in P1 spring semester, n=110) was significantly, weakly correlated ($p<.05$) with P1 fall GPA ($r = -0.2$), P1 spring GPA ($r = -0.24$), and P1 year GPA ($r = -0.22$). In multiple linear regression analysis (n=201), stress score (measured at beginning of P1 year) was significantly associated with P1 year GPA ($p = .006$). |
| Sun & Zoriah (2015)<sup>32</sup> | Perceived Stress      | In a sample of 273 students, stress and GPA were significantly, but weakly correlated ($r = -0.159$, $p = .009$).                           |
| Votta & Benau (2013)<sup>17</sup> | Perceived Stress      | In a sample of 2232 students, those with a GPA 2.0 to 2.49 had significantly higher stress than students with a GPA 3.0 to 3.49 and 3.5 to 4.0 ($p < .001$); however, there were no significant differences in stress levels between students with a GPA 2.0 to 2.49 and 2.5 to 2.99. Students with a GPA 2.5 to 2.99 had significantly higher stress than students with a GPA 3.0 to 3.49 and 3.5 to 4.0 ($p < .001$). There were no significant differences in stress levels between students with a GPA 3.0 to 3.49 and 3.5 to 4.0. Students with a GPA ≥2.99 had significantly greater stress than students with a GPA ≥3.0 ($p < .001$). |
| Ware (2019)<sup>33</sup>      | Extraversion           | In a sample of 119 students, those with extraversion personality scored 9.5 points lower on NAPLEX compared to those with introversion personality ($r = 3.5$, $p < .01$, 95% CI = 4.2, 14.9). |
| Wolcott et al. (2019)<sup>34</sup> | All Big Five Personality Traits<sup>b</sup> | In a sample of 135 students, agreeableness and situational judgment test (SJT) performance were significantly, but weakly correlated ($r = -0.21$ to $-0.16$, $p < .05$). The remaining Big Five Personality Traits were not significantly correlated with SJT performance. |

**Abbreviations:** APPE=advanced pharmacy practice experience, ASHP=American Society of Health-System Pharmacists, CI=confidence interval, GPA=grade point average, NAPLEX=North American Pharmacist Licensure Examination, OR=odds ratio, P1=first-year pharmacy, P3=third-year pharmacy, P4=fourth-year pharmacy, RR=relative risk.

<sup>a</sup> For each study in the table, we present the number of students who participated in or completed the study, ie, final sample size.

<sup>b</sup> Big Five Personality Traits=agreeableness, conscientiousness, extraversion, neuroticism, openness.
Appendix 2. First-year Fall Semester Courses of the Doctor of Pharmacy Program

| Courses                                                        | Credit Hours |
|----------------------------------------------------------------|--------------|
| Biochemistry (PHCY 1100)                                       | 2.5          |
| Fundamentals of Drug Action (PHCY 1101)                       | 2            |
| Pharmacy Math (PHCY 1102)                                     | 1            |
| Foundations of Pharmacy (PHCY 1104)                           | 2.5          |
| Interprofessional Education & Clinical Simulation (IPECS) I    | 2            |
| IPPE I: Introduction to Patient Care (PHCY 1106)              | -            |
| Pharmacy Professional Development I (PHCY 1107)               | 1            |
| Self-Care and Dermatology (PHCY 1111)                        | 2            |
| Introduction to Therapeutics (PHCY 1109)                      | 2.5          |
| Dosage Design, Delivery, and Dispensing (D4) I (PHCY 1110)    | 3            |
| Recitation                                                    | -            |
| **Totals**                                                    | **18.5**     |