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Measurements of Resilience and Grit among Internal Medicine Residents: Validity and Correlations with Medical Knowledge, Professionalism, and Clinical Performance

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Measurements of Resilience and Grit among Internal Medicine Residents: Validity and Correlations with Medical Knowledge, Professionalism, and Clinical Performance

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Abstract

Objectives: There has been limited research on the positive aspects of physician wellness and to our knowledge there have been no validity studies on measures of resilience and grit among internal medicine (IM) residents. We aimed to investigate the validity of resilience (CD-RISC 10) and grit (GRIT-S) scores among IM residents, and assess potential associations with previously validated measures of medical knowledge, clinical performance, and professionalism.

Setting: Large academic center in Rochester, MN between July 2017 and June 2019.

Participants: IM residents.

Primary and secondary outcome measures: We evaluated CD-RISC 10 and GRIT-S scores. We analyzed dimensionality, internal consistency reliability, and criterion validity in terms of relationships between resilience and grit, with standardized measures of residents' medical knowledge (in-training examination [ITE]), clinical performance (faculty and peer evaluations and mini-clinical evaluation exercise [mini-CEX]), and professionalism/dutifulness (conference attendance and evaluation completion).

Results: A total of 213 out of 253 (84.2%) survey-eligible IM residents provided both CD-RISC 10 and GRIT-S survey responses. Internal consistency reliability (Cronbach alpha) was excellent for CD-RISC 10 (0.93) and GRIT-S (0.82) overall, and for the GRIT subscales of consistency of interest (0.84) and perseverance of effort (0.71). CD-RISC 10 scores were negatively associated with ITE percentile ($\beta = -3.4$, 95% CI: -6.2 to -0.5, $P=0.02$) and mini-CEX ($\beta = -0.2$, 95% CI: -0.5 to -0.02, $P=0.03$). GRIT-S scores were positively associated with evaluation completion percentage ($\beta = 2.51$, 95% CI: 0.35 to 4.67, $P=0.02$) and conference attendance ($\beta = 2.70$, 95% CI: 0.11 to 5.29, $P=0.04$).

Conclusions: This study revealed favorable validity evidence for CD-RISC 10 and GRIT-S among IM residents. Residents demonstrated resilience within a competitive training environment despite less favorable test performance and grittiness that was manifested by completing tasks. This initial validity study provides a foundation for further research on resilience and grit among physicians-in-training.

Strengths and limitations of this study

- This is the first validity study of CD-RISC 10 and Grit-S scores among IM residents for resilience and grit respectively, and was completed at a large academic center in the U.S.
- This study evaluated the dimensionality, internal consistency reliability, and the criterion validity of these two measures among IM residents.
- This study provides a foundation for further research on resilience and grit among physicians in training.
- This was an observational study, which limits the ability to draw causal inferences about the relationships found.
- The analysis did not adjust for resident age, gender, or international versus U.S. medical graduation status, as they are non-modifiable variables in terms of career development and enhancing residency curricula.

BACKGROUND

The phenomenon of “physician burnout” was first defined in the 1970s as “chronic stress associated with emotionally intense work demands, for which resources are inadequate”.^{1,2} It is typically described as a workplace syndrome involving emotional exhaustion, depersonalization, and a sense of reduced personal accomplishment. Emotional exhaustion pertains to feeling drained by work with limited reserve for offering empathetic support to patients. Depersonalization includes feelings of callousness toward patients and treating them more like objects than human beings.³ Reduced personal accomplishment means feeling ineffective in helping patients along with a sense of nihilism regarding work-related efforts such as professional advancement.⁴ The prevalence of physician burnout in the US is estimated to be approximately 50% among physicians-in-training⁵⁻⁸ and practicing physicians.⁹⁻¹¹ Notably, burnout rates are higher for physicians than other professionals even after adjusting for work hours.¹²

It is unclear why burnout rates are higher in certain residency programs and among particular individuals within the same clinical settings.¹⁴ Since burnout seems to begin during medical school,^{7,15} tackling this problem at earlier stages could help mitigate its consequences later. Furthermore, although there has been much research on correlates of burnout,⁴ there is limited research on the positive aspects of physician wellness and very little known about resilience and grit among internal medicine residents.

The American Psychological Association (APA) describes resilience as adapting effectively to stressors such as relationship problems, serious health issues, or workplace and financial challenges.¹⁶ That is, resilience is the capacity to respond to adversity such that goals are achieved at minimal psychological and physical cost. Essentially, resilient individuals “bounce back” after challenges while also growing stronger.¹⁷ Although several models of resilience have evolved over the years,¹⁸ the dominant paradigm of resilience is dynamic, linking neurobiology, behavior, and environmental conditions.¹⁹ Resilience is considered essential for enhancing quality of medical care, empathy for patients, and sustainability of the healthcare workforce as a whole.¹⁷ Moreover, low resilience may impair brain function, even resulting in posttraumatic stress disorder (PTSD), depression, and other psychiatric disorders.²⁰ Yet, most people do not develop such conditions after experiencing difficult life events and are thus considered to be “resilient”. Resilience as a successful adaptation relies on effective responses to environmental challenges and, ultimately, resistance to the harmful effects of stress.²¹ Therefore, a greater understanding of the factors that promote resilience is critical.²²

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3 The most widely used assessment of resilience is the Connor-Davidson Resilience
4 Scale (CD-RISC) which consists of 25 items rated on 5-point scales ranging from 0 to 4,
5 with higher scores indicating greater resilience.²³ It has sound psychometric properties
6 and distinguishes between those with greater and lesser resilience levels. Use of the
7 CD-RISC has shown that resilience is modifiable and can be improved. A shorter
8 version of this scale, which has similar psychometric properties, is the 10-item, CD-
9 RISC 10.²⁴ Evidence based on the use of this assessment measure suggests that
10 resilience can be promoted in healthcare workplaces,²⁵ although research on
11 physicians is scarce.
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16 Grit is defined as the perseverance and passion for long-term goals.²⁶⁻²⁸ Rather than
17 avoidance and shying away, grit means working towards achieving specific outcomes
18 despite difficulty, failure, or adversity.²⁹ Individuals who remain focused on a goal or
19 task and see it through to satisfactory completion would be described as “gritty”.³⁰ Grit
20 is a predictor of success in stressful, high-achievement fields including, but not limited
21 to, surgical residency,³¹⁻³³ emergency residency,³⁴ military,²⁷ and pharmacy.³⁵ The
22 original Grit Scale (Grit-O) consists of 12 items, each rated on a 5-point scale, (1-5)
23 classified under two main domains: 1) consistency of interest, and 2) perseverance of
24 effort, with six elements each.²⁶ Subsequently, an abbreviated (8-question) scale with
25 improved psychometric properties was developed by the same investigators to measure
26 trait-level perseverance and passion for long-term goals (Grit-S),²⁷
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31 Although there has been ample research on relationships between burnout and various
32 aspects of professionalism and clinical performance among resident physicians,³⁶⁻⁴⁰ to
33 our knowledge the CD-RISC 10 and Grit-S scales have not been previously validated in
34 U.S. internal medicine residents.
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37 In this study we assessed the validity of CD-RISC 10 and Grit-S scores among internal
38 medicine (IM) residents at a large academic medical center. Additionally, we examined
39 associations between resident resilience and grit based on CD-RISC 10 and Grit-S
40 scores, respectively, with previously standardized measures of medical knowledge (the
41 in-training examination), professionalism (dutifulness based on conference attendance
42 and evaluation completion), and clinical performance (validated, multisource, clinical
43 performance evaluations).
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47 **METHODS**

48 **Study Design and Sample**

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50 This was a longitudinal cohort study of IM residents training at Mayo Clinic Rochester
51 between July 2017 and June 2019 who were invited to participate in the Mayo Internal
52 Medicine Well-Being (IMWELL) Study. We used existing survey data from the IMWELL
53 study in addition to administrative data collected routinely on IM residents at Mayo Clinic
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3 in Rochester, MN. This study was deemed exempt by the Mayo Institutional Review
4 Board.
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6 **The Mayo IMWELL Study**

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8 The prospective, longitudinal, Mayo IMWELL study was initiated in 2003 to evaluate IM
9 residents' burnout, quality of life, and empathy, along with other measures of well-being
10 ⁴¹⁻⁴⁴. Enrollment is voluntary and is offered during the orientation of all new interns
11 (categorical and preliminary) in the IM residency program. For the time frame between
12 July 2017 to June 2019, 253 residents were eligible to be enrolled as participants and
13 were surveyed twice per year. An additional survey was sent each spring to graduating
14 categorical residents. Identities of participants were anonymized during data collection
15 and before analysis using numerical codes. The CD-RISC 10 and Grit-S instruments
16 were added to the IMWELL study surveys starting July 2017. The CD-RISC 10 and Grit-
17 S scores from the IMWELL study for each resident were merged with each resident's
18 residency performance metrics during the subsequent 6 months (July to December or
19 January to June) on the other relevant instruments described below.
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25 **Instruments and Scales Used**

26
27 Short Grit Scale (Grit-S): An 8-item assessment, each rated on a 5-point scale (1=Not
28 like me at all, 2=Not much like me, 3=Somewhat like me, 4=Mostly like me, 5=Very
29 much like me), covering two factors, ²⁷ that measures trait-level perseverance and
30 passion for long-term goals. It has 4 fewer items than the original grit scale (Grit-O) ²⁶
31 with improved psychometric properties. The Short Grit (Grit-S) scale is a brief version of
32 the original 12-item Grit-O scale. Previous studies have shown that it has predictive
33 validity, consensual validity, and test-retest stability. Factor analysis, and later
34 confirmatory factor analysis, has supported a 2-factor structure of the scale reflecting
35 "consistency of interest" and "perseverance of effort". Both factors showed adequate
36 internal consistency reliability. ²⁷
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42 10 item Connor-Davidson Resilience Scale (CD-RISC 10): An assessment consisting of
43 10 items, rated on a 5-point scales (0=Not true at all, 1=Rarely true, 2=Sometimes true,
44 3=Often true, 4=True nearly all of the time), with higher scores indicating greater
45 resilience. ²³ It has ability to distinguish between those with greater and lesser resilience
46 levels, and to demonstrate that resilience is modifiable and can be improved. The
47 reliability and validity of the Connor-Davidson Resilience scale (CD-RISC) were
48 previously evaluated and performed well in other settings. Factor analysis revealed five
49 factors for the CD-RISC scale. ²³ CD-RISC 10 is a 10-item version of this scale with
50 good internal consistency and evidence to support construct validity. ²⁴ Further
51 validation studies have shown excellent performance of the CD-RISC 10 among the
52 general population ⁴⁵ and trainees in the United States Air Force. ⁴⁶
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3 Knowledge measures: This included In-Training Exam (ITE) score percentiles.
4 Residents were administered the ITE annually each fall. Validity of the ITE scores has
5 been established in several studies.^{47 48}
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8 Professionalism and dutifulness measures: This included conference attendance and
9 evaluation completion, which were validated in our previous studies of residents at the
10 Mayo Clinic.⁴⁹ Conference attendance was assessed using in-person card-swipe data.
11 Evaluation completion percentage was determined from the MedHub® residency
12 evaluation system for our study's time frame.
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15 Clinical performance: This was determined by faculty and peer evaluations and the
16 standardized Mini Clinical Evaluation Examination (Mini-CEX).^{50 51} The Mini-CEX
17 evaluates core clinical skills by trainees, namely medical interviewing, physical
18 examination, informed decision-making/counseling, and clinical judgment/reasoning.
19 The Mini-CEX has demonstrated validity evidence among internal medicine residents.
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The Mini-CEX used at Mayo Clinic Rochester incorporates a 5-point scale. Multisource assessments of residents' clinical performance at Mayo Clinic Rochester are completed by faculty, peers and senior medical residents. Items within these clinical performance assessments have shown multi-dimensionality and excellent internal consistency reliability.^{54 55} The clinical performance evaluations (peer evaluations, faculty evaluations, and mini-CEX ratings) are administered by the residency evaluation platform, MedHub®. Aggregate reports of evaluations can be obtained by timeframe of interest, with all assessments standardized to a score in the range of 0-10.

Data Analysis

Participants' demographics were summarized using descriptive statistics. Continuous variables such as age were summarized as mean (standard deviation). Nominal variables, such as gender, were reported using a count (percent of total). A threshold of $p < 0.05$ was used to determine statistical significance. Statistical analyses were conducted using SAS version 9.4 (SAS Institute, Inc., Cary, NC).

Validation of the CD-RISC 10 and Grit-S Scales among Internal Medicine Residents

It has been recommended to re-examine the validity of assessments when applying them to specific contexts and educational settings.⁵⁶ Therefore, we evaluated the internal structure validity of the CD-RISC 10 and Grit-S for this study as follows:

1. Factor analyses of the CD-RISC 10 & Grit-S instruments were done using principal components analysis with a minimum eigenvalue of 1 criterion. An orthogonal Varimax rotation was used to estimate item loadings. Items with factor loadings of 0.48 or more were retained.⁵⁷ Internal consistency reliabilities for

items comprising each factor and overall were determined using Cronbach alpha, where alpha >0.7 was considered acceptable.⁵⁷ Scale values were reversed for the 'Consistency of Interest' factor items of Grit-S (1, 3, 5, and 6) so that 1=very much like me, 2=mostly like me, 3=somewhat like me, 4=not much like me, 5=not like me at all, so that higher item scores reflect increased 'Grit'.

2. Criterion validity (relations to other variables): Unadjusted bivariate associative analyses used generalized linear models with normal response distributions and identity link functions estimated via generalized estimating equations (GEEs) with an exchangeable covariance matrix. The CD-RISC 10 and Grit-S scores were treated as the explanatory variables, and residency performance in the various metrics during the subsequent 6 months were the outcome variables.

Patient and public involvement:

Patients and the public were not involved in this research study.

RESULTS

Sample Characteristics

From a total of 253 eligible IM residents training at Mayo Clinic Rochester between July 2017 and June 2019, 213 (84.2%) completed at least 1 IMWELL survey, resulting in 468 completed CD-RISC 10 and 472 Grit-S surveys from a total of 801 possible surveys. A total of 461 IMWELL surveys included complete responses for both scales. There were 193 ITE percentiles and 358 mini-CEX evaluations available for the same time period. The demographic characteristics of the participants are shown in Table 1.

Medical Knowledge, Clinical Performance, and Professionalism Metrics

The ITE score percentiles among residents in our study (N=193) ranged from 18-100, with a mean (SD) of 83.3 (15.5). Clinical performance, as reflected by faculty evaluations (N=429), peer evaluations (N=362), and mini-CEX (N=358) showed mean (SD) scores of 7.84 (0.69), 8.09 (0.83), and 8.19 (1.59), respectively. Performance measure summaries are shown in Table 2.

Validity Analyses of the CD-RISC 10 and GRIT-S Instruments

Regarding the internal structure validity evidence for the scales among IM residents, the CD-RISC 10 index demonstrated a single dimension of resilience while the GRIT-S index demonstrated two dimensions of grittiness. The internal consistency reliability for both scales overall, and for the GRIT subscales, was high (Cronbach α 's>0.7, Tables 3 and 4).

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3 The 468 completed CD-RISC 10 scales showed mean scores for individual items
4 ranging from 2.74 (not easily discouraged by failure) to 3.34 (can achieve goals despite
5 obstacles) on the 0-4 scale [Table 3]. The overall mean summed (SD) CD-RISC score
6 was 31.5 (6.1). The 472 completed GRIT-S scales showed individual-item mean scores
7 ranging from 2.99 (new ideas and projects sometimes distract me from previous ones)
8 to 4.48 (I am a hard worker) on the 1-5 scale [Table 4]. The overall mean (SD) GRIT-S
9 score was 3.72 (0.59).

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13 Regarding relations to other variables (i.e., criterion) validity evidence, the CD-RISC 10
14 overall summed scores correlated negatively with medical knowledge acquisition as
15 measured by ITE score percentile ($\beta = -0.34$, 95% CI: -0.62 to -0.05, $P=0.02$). The CD-
16 RISC 10 overall summed scores also correlated negatively with clinical performance as
17 measured by the mini-CEX ($\beta = -0.02$, 95% CI: -0.05 to -0.002, $P=0.03$) (Table 5).

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21 The GRIT-S overall mean score correlated positively with evaluation completion
22 percentage ($\beta = 2.51$, 95% CI: 0.35 to 4.67, $P=0.02$) and in-person conference
23 attendance ($\beta = 2.70$, 95% CI: 0.11 to 5.29, $P=0.04$) (Table 5), which are measures of
24 the dutifulness aspect of professionalism.
25

26 27 **DISCUSSION**

28
29 The CD-RISC 10 and GRIT-S instruments have strong validity in measuring resilience
30 and grit in several populations^{24 27 46 58} and there have been studies of grit in surgical³²
31^{33 59} and emergency medicine residents.³⁴ However, to our knowledge, this is the first
32 validity study of the CD-RISC 10 and GRIT-S among IM residents. Both instruments
33 showed excellent internal consistency reliability, statistically significant associations with
34 previously validated measures of resident physician performance, and dimensionality
35 characteristics that are consistent with previous research.
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39 We identified a negative association between residents' CD-RISC 10 scores and
40 measures of clinical performance (mini-CEX) and medical knowledge (ITE). This finding
41 might reflect resilient residents' abilities to thrive within a high-pressured IM training
42 environment, despite performing less favorably on standardized assessments within this
43 setting. This finding may be supported by the residents' highest score on the item,
44 "achieve goals despite obstacles." We also identified a positive association between
45 GRIT-S scores and evaluation completion, which is a dutifulness aspect of
46 professionalism.^{26 60} These findings suggest that, as expected, residents with grittiness
47 tend to finish tasks. Additionally, this finding corresponds to residents' highest score on
48 the item, "I am a hard worker." Overall, our research should inform future interventions
49 to decrease resident burnout and improve resident performance and well-being, by
50 using specific dimensions of the CD-RISC 10 and GRIT-S as roadmaps for curricular
51 interventions.
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3 Compared to the general U.S. population included in the original validation studies,^{23 58}
4⁶¹ the overall mean (SD) resilience score in our sample was comparable [31.5 (6.1)
5 versus 32.1 (5.8) and 31.8 (5.4)]. However, compared to the reference group aged 25-
6 34 years in the original validation study, the overall mean (SD) GRIT-S score in our
7 sample was higher [3.72 (0.59) versus 3.2 (0.7)].²⁷ Our study participants noted strong
8 perseverance as reflected by their highest GRIT-S score on the item “I am a hard
9 worker.” Additionally, the dimensionalities for the GRIT-S and CD-RISC 10 scales in our
10 study were consistent with findings from research in different populations.^{62 63}
11 However, despite having higher grit and comparable resilience as compared to the
12 general population, burnout rates among physicians and physicians-in-training appear
13 to be greater than that of the U.S. working population.^{7 12} This suggests that the
14 medical profession selects gritty and resilient individuals, yet still manages to burn them
15 out. Furthermore, research shows that wellbeing indicators are highest upon
16 matriculation to medical school, and subsequently wane throughout medical training.⁶⁴
17 Consequently, future research should examine the interactions between burnout,
18 empathy, resilience, and grit.
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25 This study has several limitations. First, it was observational, which constrains the ability
26 to draw causal inferences about the relationships that were identified. Second, the
27 analysis did not adjust for age, gender, and international versus U.S. medical
28 graduation status. Nonetheless, these are non-modifiable variables that would not
29 facilitate efforts at professional development or enhancing residency curricula. Third,
30 this study involved IM residents at a large academic medical center, which may limit
31 generalization to some other specialties and settings.
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35 Resilience and grit may lessen burnout, yet these relationships remain unclear among
36 physicians in training. Thus, research on resilience and grit could assist interventions to
37 mitigate physician burnout^{65 66} and provide a deeper understanding of dynamics
38 between the issues at play.⁶⁷ Findings from this study support use of the CD-RISC
39 10 and GRIT-S among internal medicine residents and should serve as a foundation for
40 future research on resilience and grit in medical learners. This research should examine
41 associations among IM residents between CD-RISC 10 and GRIT-S, with validated
42 measures of burnout and well-being. It is noteworthy that burnout is prevalent within
43 current medical education and training systems and may be an indicator of
44 organizational health.^{68 69} Therefore, improved understanding of resilience and grit may
45 enhance graduate medical education curricula^{40 70-73} and the wellbeing of physicians.
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51 There have been ample investigations on physician burnout and depression, yet there
52 has been less research on positive aspects of physician wellness including resilience
53 and grit among internal medicine residents. Especially during this era of the COVID
54 pandemic, it is necessary to better understand characteristics of physicians that allow
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3 them to surmount adversity and thrive. We are hopeful that further study of residents'
4 resilience and grit will help to improve their quality of life. ^{31 59 74}
5

6
7 **Author contributions:**

8 Idea conception: TJB, FA, CPW, VMM

9 Study design and methodology: FA, TJB, AJH

10 Data management and analysis: AJH, JNM

11 Interpretation of the data: FA, AJH, TJB

12 Manuscript drafting: FA

13 Supervision: TJB

14 Revising, editing, and final approval of manuscript: all authors.
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18 **Disclosure:**

19 No conflicts of interest, financial or other, to declare by any of the authors.
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22 Dissemination of study results to study participants is not applicable.
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24 No additional data available.
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Table 1. Baseline Characteristics of 253 Survey Eligible IM Resident Physicians from July 2017 Through June 2019 (213 [84.2%] IM Resident Physicians Completed 461 [57.6%] CD-RISC 10 / Grit-S Surveys out of 801 possible)

Variable	Level	Total (N=253)	≥1 Survey (N=213)	No Survey (N=40)	P value
Sex	Male	165 (65.2%)	137 (64.3%)	28 (70.0%)	0.59
	Female	88 (34.8%)	76 (35.7%)	12 (30%)	
Program	Categorical	196 (77.5%)	170 (79.8%)	26 (65.0%)	0.06
	Preliminary	57 (22.5%)	43 (20.2%)	14 (35.0%)	
Match Year	2015	50 (19.8%)	40 (18.8%)	10 (25.0%)	0.40
	2016	47 (18.6%)	39 (18.3%)	8 (20.0%)	
	2017	78 (30.8%)	70 (32.9%)	8 (20.0%)	
	2018	78 (30.8%)	64 (30.1%)	14 (35.0%)	
Age	Mean (SD)	253 (100%)	27.69 (2.66)	27.90 (2.43)	0.62
Possible Surveys	Mean (SD)	253 (100%)	3.20 (1.17)	3.00 (1.18)	0.33
Completed Surveys	Mean (SD)	253 (100%)	2.16 (1.08)	-	-

Table 2. Medical Knowledge, Professionalism, and Clinical Performance Measures for 210 IM Resident Physicians Providing Data from July 2017 to June 2019 (N=429)

Variable	Metric (scale)	n (Eligible)	n (Responses)	Mean (SD)	Range
Medical Knowledge	IM-ITE, percentile	353	193	83.3 (15.5)	18-100
Professionalism	Conference Attendance, number	705	429	53.8 (14.3)	6-95
	Evaluation Completion, %	705	429	77.3 (11.5)	22-100
Clinical Performance	Faculty Evaluations (0-10)	705	429	7.84 (0.69)	4.49-9.37
	Peer Evaluations (0-10)	705	362	8.09 (0.83)	4.13-10
	Mini-CEX (0-10)	705	358	8.19 (1.59)	4.00-10

Table 3. IM Resident Physicians' Mean Scores on, Factor Loadings of, and Internal Consistency Reliability of the CD-RISC 10 (N=468)

Item	Mean Score (SD)	Item Loading	Cronbach α
CD-RISC 10 overall (0-40)	31.5 (6.1)		0.93
1. Able to adapt to change	3.29 (0.68)	0.80	
2. Can deal with whatever comes	3.18 (0.74)	0.82	
3. Tries to see humorous side of problems	3.19 (0.79)	0.71	
4. Coping with stress can strengthen me	3.11 (0.79)	0.72	
5. Tend to bounce back after illness or hardship	3.25 (0.76)	0.83	
6. Can achieve goals despite obstacles	3.34 (0.71)	0.82	
7. Can stay focused under pressure	3.03 (0.78)	0.81	

8. Not easily discouraged by failure	2.74 (0.91)	0.75	
9. Thinks of self as strong person	3.20 (0.78)	0.83	
10. Can handle unpleasant feeling	3.19 (0.73)	0.81	

Table 4. IM Resident Physicians' Mean Scores on, Factor Loadings of, and Internal Consistency Reliability of the Grit-S (N=472)

Item	Mean Score (SD)	Item Loading		Cronbach α
		Consistency of Interest	Perseverance of Effort	
Consistency of Interest (reverse-scored)				0.84
1. New ideas and projects sometimes distract me from previous ones.	2.99 (0.95)	0.83	0.002	
3. I have been obsessed with a certain idea or project for a short time but later lost interest.	3.39 (0.95)	0.84	0.11	
5. I often set a goal but later choose to pursue a different one.	3.63 (0.88)	0.80	0.26	
6. I have difficulty maintaining my focus on projects that take more than a few months to complete.	3.56 (1.03)	0.76	0.29	
Overall Consistency of Interest mean	3.39 (0.79)			
Perseverance of Effort				0.71
2. Setbacks don't discourage me.	3.40 (0.94)	0.08	0.49	
4. I am a hard worker.	4.48 (0.70)	0.05	0.86	
7. I finish whatever I begin.	3.95 (0.84)	0.47	0.63	
8. I am diligent.	4.33 (0.72)	0.17	0.87	
Overall Perseverance of Effort mean	4.04 (0.59)			
Grit-S Overall (1-5)	3.72 (0.59)			0.82

Table 5. Associations of Performance Measures with CD-RISC 10 and Grit-S

Variable	Metric (scale)	CD-RISC 10 (0-40)			Grit-S (1-5)		
		β	95% CI	p-value	β	95% CI	p-value
Medical Knowledge	IM-ITE, percentile	-0.34	-0.62, -0.05	0.02	0.42	-3.29, 4.12	0.83
Professionalism	Conference Attendance, number	-0.07	-0.31, 0.18	0.59	2.70	0.11, 5.29	0.04
	Evaluation Completion, %	0.19	-0.05, 0.43	0.13	2.51	0.35, 4.67	0.02
Clinical Performance	Faculty Evaluations (0-10)	0.0002	-0.01, 0.01	0.98	0.06	-0.08, 0.20	0.38
	Peer Evaluations (0-10)	0.02	-0.0006, 0.03	0.06	0.09	-0.09, 0.26	0.33
	Mini-CEX (0-10)	-0.02	-0.05, -0.002	0.03	-0.20	-0.47, 0.06	0.13

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How Do We Assess Resilience and Grit among Internal Medicine Residents at the Mayo Clinic? A Longitudinal Validity Study Including Correlations with Medical Knowledge, Professionalism, and Clinical Performance

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Abstract

Background: There has been limited research on the positive aspects of physician wellness and to our knowledge there have been no validity studies on measures of resilience and grit among internal medicine (IM) residents.

Objectives: To investigate the validity of resilience (CD-RISC 10) and grit (GRIT-S) scores among IM residents at a large academic center, and assess potential associations with previously validated measures of medical knowledge, clinical performance, and professionalism.

Methods: We evaluated CD-RISC 10 and GRIT-S instrument scores among IM residents at the Mayo Clinic Rochester, Minnesota between July 2017 and June 2019. We analyzed dimensionality, internal consistency reliability, and criterion validity in terms of relationships between resilience and grit, with standardized measures of residents' medical knowledge (in-training examination [ITE]), clinical performance (faculty and peer evaluations and mini-clinical evaluation exercise [mini-CEX]), and professionalism/dutifulness (conference attendance and evaluation completion).

Results: A total of 213 out of 253 (84.2%) survey-eligible IM residents provided both CD-RISC 10 and GRIT-S survey responses. Internal consistency reliability (Cronbach alpha) was excellent for CD-RISC 10 (0.93) and GRIT-S (0.82) overall, and for the GRIT subscales of consistency of interest (0.84) and perseverance of effort (0.71). CD-RISC 10 scores were negatively associated with ITE percentile ($\beta = -3.4$, 95% CI: -6.2 to -0.5, $P=0.02$) and mini-CEX ($\beta = -0.2$, 95% CI: -0.5 to -0.02, $P=0.03$). GRIT-S scores were positively associated with evaluation completion percentage ($\beta = 2.51$, 95% CI: 0.35 to 4.67, $P=0.02$) and conference attendance ($\beta = 2.70$, 95% CI: 0.11 to 5.29, $P=0.04$).

Conclusions: This study revealed favorable validity evidence for CD-RISC 10 and GRIT-S among IM residents. Residents demonstrated resilience within a competitive training environment despite less favorable test performance and grittiness that was manifested by completing tasks. This initial validity study provides a foundation for further research on resilience and grit among physicians-in-training.

Strengths and limitations of this study

- This is the first validity study of CD-RISC 10 and Grit-S scores among IM residents for resilience and grit respectively, and was completed at a large academic center in the U.S.
- This study evaluated the dimensionality, internal consistency reliability, and the criterion validity of these two measures among IM residents.

- This study provides a foundation for further research on resilience and grit among physicians in training.
- This was an observational study, which limits the ability to draw causal inferences about the relationships found.
- The analysis did not adjust for resident age, gender, or international versus U.S. medical graduation status, as they are non-modifiable variables in terms of career development and enhancing residency curricula.

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BACKGROUND

The prevalence of physician burnout in the US is estimated to be approximately 50% among physicians-in-training (1-4) and practicing physicians. (5-7) Notably, burnout rates are higher for physicians than other professionals even after adjusting for work hours. (8, 9) It is unclear why burnout rates are higher in certain residency programs and among particular individuals within the same clinical settings. (10) Since burnout seems to begin during medical school, (3, 11) tackling this problem at earlier stages could help mitigate its consequences later. Furthermore, although there has been much research on correlates of burnout, (12) there is limited research on the positive aspects of physician wellness and very little known about resilience and grit among internal medicine residents.

The American Psychological Association (APA) describes resilience as adapting effectively to stressors such as relationship problems, serious health issues, or workplace and financial challenges. (13) That is, resilience is the capacity to respond to adversity such that goals are achieved at minimal psychological and physical cost. Essentially, resilient individuals "bounce back" after challenges while also growing stronger. (14) Although several models of resilience have evolved over the years, (15) the dominant paradigm of resilience is dynamic, linking neurobiology, behavior, and environmental conditions. (16) Resilience is considered essential for enhancing quality of medical care, empathy for patients, and sustainability of the healthcare workforce as a whole. (14) Moreover, low resilience may impair brain function, even resulting in posttraumatic stress disorder (PTSD), depression, and other psychiatric disorders. (17) Yet, most people do not develop such conditions after experiencing difficult life events and are thus considered to be "resilient". Resilience as a successful adaptation relies on effective responses to environmental challenges and, ultimately, resistance to the harmful effects of stress. (18) Therefore, a greater understanding of the factors that promote resilience is critical. (19)

The most widely used assessment of resilience is the Connor-Davidson Resilience Scale (CD-RISC). Use of the CD-RISC has shown that resilience is modifiable and can be improved. A shorter version of this scale, which has similar psychometric properties, is the CD-RISC 10. (20) Evidence based on the use of this assessment measure suggests that resilience can be promoted in healthcare workplaces, (21) although research on physicians is scarce.

Grit is defined as the perseverance and passion for long-term goals. (22-24) Rather than avoidance and shying away, grit means working towards achieving specific outcomes despite difficulty, failure, or adversity. (25) Individuals who remain focused on a goal or task and see it through to satisfactory completion would be described as "gritty". (26) Grit is a predictor of success in stressful, high-achievement fields including,

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3 but not limited to, surgical residency, (27-29) emergency residency,(30) military, (23)
4 and pharmacy. (31) The original Grit Scale (Grit-O) consists of 12 items, each rated on
5 a 5-point scale, (1-5) classified under two main domains: 1) consistency of interest, and
6 2) perseverance of effort, with six elements each. (22) Subsequently, an abbreviated (8-
7 question) scale with improved psychometric properties was developed by the same
8 investigators to measure trait-level perseverance and passion for long-term goals (Grit-
9 S), (23)
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13 Although there has been ample research on relationships between burnout and various
14 aspects of professionalism and clinical performance among resident physicians, (32-36)
15 to our knowledge the CD-RISC 10 and Grit-S scales have not been previously validated
16 in U.S. internal medicine residents. Furthermore, there remains the need for further
17 research on positive aspects of physician wellness – such as resilience and grit – which
18 may serve to counterbalance burnout.
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22 In this study we assessed the validity of CD-RISC 10 and Grit-S scores among internal
23 medicine (IM) residents at a large academic medical center. Additionally, we examined
24 associations between resident resilience and grit based on CD-RISC 10 and Grit-S
25 scores, respectively, with previously standardized measures of medical knowledge (the
26 in-training examination), professionalism (dutifulness based on conference attendance
27 and evaluation completion), and clinical performance (validated, multisource, clinical
28 performance evaluations).
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32 **METHODS**

33 **Study Design and Sample**

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35 This was a longitudinal cohort study of IM residents training at Mayo Clinic Rochester
36 between July 2017 and June 2019 who were invited to participate in the Mayo Internal
37 Medicine Well-Being (IMWELL) Study. We used existing survey data from the IMWELL
38 study in addition to administrative data collected routinely on IM residents at Mayo Clinic
39 in Rochester, MN. This study was deemed exempt by the Mayo Institutional Review
40 Board.
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45 **The Mayo IMWELL Study**

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47 The prospective, longitudinal, Mayo IMWELL study was initiated in 2003 to evaluate IM
48 residents' burnout, quality of life, and empathy, along with other measures of well-being
49 (37-40). Enrollment is voluntary and is offered during the orientation of all new interns
50 (categorical and preliminary) in the IM residency program. For the time frame between
51 July 2017 to June 2019, 253 residents were eligible to be enrolled as participants and
52 were surveyed twice per year. An additional survey was sent each spring to graduating
53 categorical residents. Identities of participants were anonymized during data collection
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3 and before analysis using numerical codes. The CD-RISC 10 and Grit-S instruments
4 were added to the IMWELL study surveys starting July 2017. The CD-RISC 10 and Grit-
5 S scores from the IMWELL study for each resident were merged with each resident's
6 residency performance metrics during the subsequent 6 months (July to December or
7 January to June) on the other relevant instruments described below.
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10 **Validity Evidence**

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12 The validity argument for this study was based on a modern approach to validity which
13 states that all validity is construct validity, and that validity evidence is gathered from the
14 categories of content, internal structure, relations to other variables, response process,
15 and consequences. (41) Content refers to relationships between an assessment's
16 wording and the construct that it purportedly measures. Internal structure refers to the
17 degree to which instrument items fit the underlying construct and is often reported in
18 terms of dimensionality and reliability. Relations to other variables evidence is the
19 relationship between scores and other variables relevant to the construct being
20 measured, such that the relationships may be positive or negative depending on the
21 constructs being measured. (42) Notably, research has indicated that commonly
22 reported categories of validity evidence among education research studies come from
23 the categories of content, internal structure, and relations to other variables. (42)
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29 **Instruments and Scales Used**

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31 Short Grit Scale (Grit-S): An 8-item assessment, each rated on a 5-point scale (1=Not
32 like me at all, 2=Not much like me, 3=Somewhat like me, 4=Mostly like me, 5=Very
33 much like me), covering two factors, (23) that measures trait-level perseverance and
34 passion for long-term goals. It has 4 fewer items than the original grit scale (Grit-O) (22)
35 with improved psychometric properties. The Short Grit (Grit-S) scale is a brief version of
36 the original 12-item Grit-O scale. Previous studies have shown that it has predictive
37 validity, consensual validity, and test-retest stability. Factor analysis, and later
38 confirmatory factor analysis, has supported a 2-factor structure of the scale reflecting
39 "consistency of interest" and "perseverance of effort". Both factors showed adequate
40 internal consistency reliability. (23)
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46 10 item Connor-Davidson Resilience Scale (CD-RISC 10): An assessment consisting of
47 10 items, rated on a 5-point scales (0=Not true at all, 1=Rarely true, 2=Sometimes true,
48 3=Often true, 4=True nearly all of the time), with higher scores indicating greater
49 resilience. (43) It has ability to distinguish between those with greater and lesser
50 resilience levels, and to demonstrate that resilience is modifiable and can be improved.
51 The reliability and validity of the Connor-Davidson Resilience scale (CD-RISC) were
52 previously evaluated and performed well in other settings. Factor analysis revealed five
53 factors for the CD-RISC scale. (43) CD-RISC 10 is a 10-item version of this scale with
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3 good internal consistency and evidence to support construct validity. (20) Further
4 validation studies have shown excellent performance of the CD-RISC 10 among the
5 general population (44) and trainees in the United States Air Force. (45)
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8 Knowledge measures: This included In-Training Exam (ITE) score percentiles. The ITE
9 is administered to all U.S. IM residents annually. Residents in this study were
10 administered the ITE annually each fall. Validity of the ITE scores has been established
11 in several studies. (46, 47)
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14 Professionalism and dutifulness measures: This included conference attendance and
15 evaluation completion, which were validated in our previous studies of residents at the
16 Mayo Clinic. (48) Conference attendance was assessed using in-person card-swipe
17 data. Evaluation completion percentage was determined from the MedHub[®] residency
18 evaluation system for our study's time frame.
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21 Clinical performance: We selected clinical performance measures as association
22 variables for this study, because we believed that standardized assessments of
23 performance are among the most rigorous challenges for testing residents' resilience
24 and grit. Clinical performance was determined by faculty and peer evaluations and the
25 standardized Mini Clinical Evaluation Examination (Mini-CEX). (49, 50) The Mini-CEX
26 evaluates core clinical skills by trainees, namely medical interviewing, physical
27 examination, informed decision-making/counseling, and clinical judgment/reasoning.
28 The Mini-CEX has demonstrated validity evidence among internal medicine residents.
29 (49-52) The mini-CEX used at Mayo Clinic Rochester incorporates a 5-point scale.
30 Multisource assessments of residents' clinical performance at Mayo Clinic Rochester
31 are completed by faculty, peers and senior medical residents. Items within these clinical
32 performance assessments have shown multi-dimensionality and excellent internal
33 consistency reliability. (53, 54) The clinical performance evaluations (peer evaluations,
34 faculty evaluations, and mini-CEX ratings) are administered by the residency evaluation
35 platform, MedHub[®]. Aggregate reports of evaluations can be obtained by timeframe of
36 interest, with all assessments standardized to a score in the range of 0-10.
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44 **Data Analysis**

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46 Participants' demographics were summarized using descriptive statistics. Continuous
47 variables such as age were summarized as mean (standard deviation). Nominal
48 variables, such as gender, were reported using a count (percent of total). A threshold of
49 $p < 0.05$ was used to determine statistical significance. Statistical analyses were
50 conducted using SAS version 9.4 (SAS Institute, Inc., Cary, NC).
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53 **Validation of the CD-RISC 10 and Grit-S Scales among Internal Medicine** 54 **Residents**

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3 It has been recommended to re-examine the validity of assessments when applying
4 them to specific contexts and educational settings. (55) Therefore, we evaluated the
5 internal structure validity of the CD-RISC 10 and Grit-S for this study as follows:
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- 8 1. Factor analyses of the CD-RISC 10 & Grit-S instruments were done using
9 principal components analysis with a minimum eigenvalue of 1 criterion. An
10 orthogonal Varimax rotation was used to estimate item loadings. Items with factor
11 loadings of 0.48 or more were retained. (56) Internal consistency reliabilities for
12 items comprising each factor and overall were determined using Cronbach alpha,
13 where alpha >0.7 was considered acceptable. (56) Scale values were reversed
14 for the 'Consistency of Interest' factor items of Grit-S (1, 3, 5, and 6) so that
15 1=very much like me, 2=mostly like me, 3=somewhat like me, 4=not much like
16 me, 5=not like me at all, so that higher item scores reflect increased 'Grit'.
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- 21 2. Criterion validity (relations to other variables): Unadjusted bivariate associative
22 analyses used generalized linear models with normal response distributions and
23 identity link functions estimated via generalized estimating equations (GEEs) with
24 an exchangeable covariance matrix. The CD-RISC 10 and Grit-S scores were
25 treated as the explanatory variables, and residency performance in the various
26 metrics during the subsequent 6 months were the outcome variables.
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30 **Patient and public involvement:**

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32 Patients and the public were not involved in this research study.
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34 **RESULTS**

35 **Sample Characteristics**

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37 From a total of 253 eligible IM residents training at Mayo Clinic Rochester between July
38 2017 and June 2019, 213 (84.2%) completed at least 1 IMWELL survey, resulting in
39 468 completed CD-RISC 10 and 472 Grit-S surveys from a total of 801 possible
40 surveys. A total of 461 IMWELL surveys included complete responses for both scales.
41 There were 193 ITE percentiles and 358 mini-CEX evaluations available for the same
42 time period. The demographic characteristics of the participants are shown in Table 1.
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47 **Medical Knowledge, Clinical Performance, and Professionalism Metrics**

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49 The ITE score percentiles among residents in our study (N=193) ranged from 18-100,
50 with a mean (SD) of 83.3 (15.5). Clinical performance, as reflected by faculty
51 evaluations (N=429), peer evaluations (N=362), and mini-CEX (N=358) showed mean
52 (SD) scores of 7.84 (0.69), 8.09 (0.83), and 8.19 (1.59), respectively. Performance
53 measure summaries are shown in Table 2.
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Validity Analyses of the CD-RISC 10 and GRIT-S Instruments

Regarding the internal structure validity evidence for the scales among IM residents, the CD-RISC 10 index demonstrated a single dimension of resilience while the GRIT-S index demonstrated two dimensions of grittiness. The internal consistency reliability for both scales overall, and for the GRIT subscales, was high (Cronbach α 's>0.7, Tables 3 and 4).

The 468 completed CD-RISC 10 scales showed mean scores for individual items ranging from 2.74 (not easily discouraged by failure) to 3.34 (can achieve goals despite obstacles) on the 0-4 scale [Table 3]. The overall mean summed (SD) CD-RISC score was 31.5 (6.1). The 472 completed GRIT-S scales showed individual-item mean scores ranging from 2.99 (new ideas and projects sometimes distract me from previous ones) to 4.48 (I am a hard worker) on the 1-5 scale [Table 4]. The overall mean (SD) GRIT-S score was 3.72 (0.59).

Regarding relations to other variables (i.e., criterion) validity evidence, the CD-RISC 10 overall summed scores correlated negatively with medical knowledge acquisition as measured by ITE score percentile ($\beta = -0.34$, 95% CI: -0.62 to -0.05, $P=0.02$). The CD-RISC 10 overall summed scores also correlated negatively with clinical performance as measured by the mini-CEX ($\beta = -0.02$, 95% CI: -0.05 to -0.002, $P=0.03$) (Table 5).

The GRIT-S overall mean score correlated positively with evaluation completion percentage ($\beta = 2.51$, 95% CI: 0.35 to 4.67, $P=0.02$) and in-person conference attendance ($\beta = 2.70$, 95% CI: 0.11 to 5.29, $P=0.04$) (Table 5), which are measures of the dutifulness aspect of professionalism.

DISCUSSION

The CD-RISC 10 and GRIT-S instruments have strong validity in measuring resilience and grit in several populations (20, 23, 45, 57) and there have been studies of grit in surgical (28, 29, 58) and emergency medicine residents. (30) However, to our knowledge, this is the first validity study of the CD-RISC 10 and GRIT-S among IM residents. Both instruments showed excellent internal consistency reliability, statistically significant associations with previously validated measures of resident physician performance, and dimensionality characteristics that are consistent with previous research.

We identified a negative association between residents' CD-RISC 10 scores and measures of clinical performance (mini-CEX) and medical knowledge (ITE). This finding might reflect resilient residents' abilities to thrive within a high-pressured IM training environment, despite performing less favorably on standardized assessments within this setting. In other words, whether a resident thrives was not determined by their

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3 performance on one of these measures, but rather, on their overall standing within our
4 rigorous training environment. This finding may be supported by the residents' highest
5 score on the item, "achieve goals despite obstacles." We also identified a positive
6 association between GRIT-S scores and evaluation completion, which is a dutifulness
7 aspect of professionalism. (22, 59) These findings suggest that, as expected, residents
8 with grittiness tend to finish tasks. Additionally, these findings correspond to residents'
9 highest score on the item, "I am a hard worker." Overall, our research should inform
10 future interventions to improve resident performance and well-being by using the CD-
11 RISC 10 and GRIT-S as roadmaps for curricular interventions.
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16 Compared to the general U.S. population included in the original validation studies, (43,
17 57, 60) the overall mean (SD) resilience score in our sample was comparable [31.5
18 (6.1) versus 32.1 (5.8) and 31.8 (5.4)]. However, compared to the reference group
19 aged 25-34 years in the original validation study, the overall mean (SD) GRIT-S score in
20 our sample was higher [3.72 (0.59) versus 3.2 (0.7)]. (23) Our study participants noted
21 strong perseverance as reflected by their highest GRIT-S score on the item "I am a hard
22 worker." Additionally, the dimensionalities for the GRIT-S and CD-RISC 10 scales in our
23 study were consistent with findings from research in different populations. (61, 62)
24 However, despite having higher grit and comparable resilience as compared to the
25 general population, burnout rates among physicians and physicians-in-training appear
26 to be greater than that of the U.S. working population. (3, 8) This suggests that the
27 medical profession selects gritty and resilient individuals, yet still manages to burn them
28 out. Furthermore, research shows that wellbeing indicators are highest upon
29 matriculation to medical school, and subsequently wane throughout medical training.
30 (63) Consequently, future research should examine the interactions between burnout,
31 empathy, resilience, and grit.
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38 This study has several limitations. First, it was observational, which constrains the ability
39 to draw causal inferences about the relationships that were identified. Second, the
40 analysis did not adjust for age, gender, and international versus U.S. medical
41 graduation status. Nonetheless, these are non-modifiable variables that would not
42 facilitate efforts at professional development or enhancing residency curricula. Third,
43 this study involved IM residents at a large academic medical center, which may limit
44 generalization to some other specialties and settings. Fourth, although we implicate
45 potential, counterbalancing interactions between grit and wellness with burnout, this
46 remains speculative until there is further research that actually examines interactions
47 between performance on these scales among internal medicine residents. Fifth,
48 residents' self-selection to participate in the study introduces the potential for selection
49 and response biases, though it is noteworthy that the response/participation rate for this
50 study was high.
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3 Resilience and grit may lessen burnout, yet these relationships remain unclear among
4 physicians in training. Thus, research on resilience and grit could assist interventions to
5 mitigate physician burnout (64, 65) and provide a deeper understanding of dynamics
6 between the issues at play. (66) Findings from this study support use of the CD-RISC
7 10 and GRIT-S among internal medicine residents and should serve as a foundation for
8 future research on resilience and grit in medical learners. This research should examine
9 associations among IM residents between CD-RISC 10 and GRIT-S, with validated
10 measures of burnout and well-being. It is noteworthy that burnout is prevalent within
11 current medical education and training systems and may be an indicator of
12 organizational health. (67, 68) Therefore, improved understanding of resilience and grit
13 may enhance graduate medical education curricula (36, 69-72) and the wellbeing of
14 physicians.

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16 There have been ample investigations on physician burnout and depression, yet there
17 has been less research on positive aspects of physician wellness including resilience
18 and grit among internal medicine residents. Especially during this era of the COVID
19 pandemic, it is necessary to better understand characteristics of physicians that allow
20 them to surmount adversity and thrive. Since high resiliency and grit have been
21 correlated with positive attributes in other populations, we are hopeful that further study
22 of these traits in residents' will help to improve their quality of life. (27, 58, 73)

23 24 25 **Author contributions:**

26 Idea conception: TJB, FA, CPW, VMM

27 Study design and methodology: FA, TJB, AJH

28 Data management and analysis: AJH, JNM

29 Interpretation of the data: FA, AJH, TJB, MHM, BEV

30 Manuscript drafting: FA

31 Supervision: TJB

32 Revising, editing, and final approval of manuscript: all authors.

33 34 35 **Disclosure:**

36 No conflicts of interest, financial or other, to declare by any of the authors.

37 Dissemination of study results to study participants is not applicable.

38 No additional data available.

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40 publication of this article.

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Table 1. Baseline Characteristics of Internal Medicine Resident Physicians

Variable	Level	Total (N=253)	≥1 Survey (N=213)	No Survey (N=40)	P value
Sex	Male	165 (65.2%)	137 (64.3%)	28 (70.0%)	0.59
	Female	88 (34.8%)	76 (35.7%)	12 (30%)	
Program	Categorical	196 (77.5%)	170 (79.8%)	26 (65.0%)	0.06
	Preliminary	57 (22.5%)	43 (20.2%)	14 (35.0%)	
Match Year	2015	50 (19.8%)	40 (18.8%)	10 (25.0%)	0.40
	2016	47 (18.6%)	39 (18.3%)	8 (20.0%)	
	2017	78 (30.8%)	70 (32.9%)	8 (20.0%)	
	2018	78 (30.8%)	64 (30.1%)	14 (35.0%)	
Age	Mean (SD)	27.72 (2.62)	27.69 (2.66)	27.90 (2.43)	0.62
Possible Surveys	Mean (SD)	3.17 (1.17)	3.20 (1.17)	3.00 (1.18)	0.33
Completed Surveys	Mean (SD)	-	2.16 (1.08)	-	-

Notes: Baseline Characteristics of 253 Survey Eligible IM Resident Physicians from July 2017 Through June 2019 (213 [84.2%] IM Resident Physicians Completed 461 [57.6%] CD-RISC 10 / Grit-S Surveys out of 801 possible)

Table 2. Medical Knowledge, Professionalism, and Clinical Performance Measures for 210 IM Resident Physicians Providing Data from July 2017 to June 2019 (N=429)

Variable	Metric (scale)	n (Eligible)	n (Responses)	Mean (SD)	Range
Medical Knowledge	IM-ITE, percentile	353	193	83.3 (15.5)	18-100
Professionalism	Conference Attendance, number	705	429	53.8 (14.3)	6-95
	Evaluation Completion, %	705	429	77.3 (11.5)	22-100
Clinical Performance	Faculty Evaluations (0-10)	705	429	7.84 (0.69)	4.49-9.37
	Peer Evaluations (0-10)	705	362	8.09 (0.83)	4.13-10
	Mini-CEX (0-10)	705	358	8.19 (1.59)	4.00-10

Table 3. IM Resident Physicians' Mean Scores on, Factor Loadings of, and Internal Consistency Reliability of the CD-RISC 10 (N=468)

Item	Mean Score (SD)	Item Loading	Cronbach α
CD-RISC 10 overall (0-40)	31.5 (6.1)		0.93
1. Able to adapt to change	3.29 (0.68)	0.80	
2. Can deal with whatever comes	3.18 (0.74)	0.82	
3. Tries to see humorous side of problems	3.19 (0.79)	0.71	
4. Coping with stress can strengthen me	3.11 (0.79)	0.72	
5. Tend to bounce back after illness or hardship	3.25 (0.76)	0.83	
6. Can achieve goals despite obstacles	3.34 (0.71)	0.82	
7. Can stay focused under pressure	3.03 (0.78)	0.81	
8. Not easily discouraged by failure	2.74 (0.91)	0.75	
9. Thinks of self as strong person	3.20 (0.78)	0.83	
10. Can handle unpleasant feeling	3.19 (0.73)	0.81	

Table 4. IM Resident Physicians' Mean Scores on, Factor Loadings of, and Internal Consistency Reliability of the Grit-S (N=472)

Item	Mean Score (SD)	Item Loading		Cronbach α
		Consistency of Interest	Perseverance of Effort	
Consistency of Interest (reverse-scored)				0.84
1. New ideas and projects sometimes distract me from previous ones.	2.99 (0.95)	0.83	0.002	
3. I have been obsessed with a certain idea or project for a short time but later lost interest.	3.39 (0.95)	0.84	0.11	
5. I often set a goal but later choose to pursue a different one.	3.63 (0.88)	0.80	0.26	
6. I have difficulty maintaining my focus on projects that take more than a few months to complete.	3.56 (1.03)	0.76	0.29	
Overall Consistency of Interest mean	3.39 (0.79)			
Perseverance of Effort				0.71
2. Setbacks don't discourage me.	3.40 (0.94)	0.08	0.49	
4. I am a hard worker.	4.48 (0.70)	0.05	0.86	
7. I finish whatever I begin.	3.95 (0.84)	0.47	0.63	

8. I am diligent.	4.33 (0.72)	0.17	0.87	
Overall Perseverance of Effort mean	4.04 (0.59)			
Grit-S Overall (1-5)	3.72 (0.59)			0.82

Table 5. Associations of Performance Measures with CD-RISC 10 and Grit-S

Variable	Metric (scale)	CD-RISC 10 (0-40)			Grit-S (1-5)		
		β	95% CI	p-value	β	95% CI	p-value
Medical Knowledge	IM-ITE, percentile	-0.34	-0.62, -0.05	0.02	0.42	-3.29, 4.12	0.83
Professionalism	Conference Attendance, number	-0.07	-0.31, 0.18	0.59	2.70	0.11, 5.29	0.04
	Evaluation Completion, %	0.19	-0.05, 0.43	0.13	2.51	0.35, 4.67	0.02
Clinical Performance	Faculty Evaluations (0-10)	0.0002	-0.01, 0.01	0.98	0.06	-0.08, 0.20	0.38
	Peer Evaluations (0-10)	0.02	-0.0006, 0.03	0.06	0.09	-0.09, 0.26	0.33
	Mini-CEX (0-10)	-0.02	-0.05, -0.002	0.03	-0.20	-0.47, 0.06	0.13

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How Do We Assess Resilience and Grit among Internal Medicine Residents at the Mayo Clinic? A Longitudinal Validity Study Including Correlations with Medical Knowledge, Professionalism, and Clinical Performance

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Abstract

Background: There has been limited research on the positive aspects of physician wellness and to our knowledge there have been no validity studies on measures of resilience and grit among internal medicine (IM) residents.

Objectives: To investigate the validity of resilience (CD-RISC 10) and grit (GRIT-S) scores among IM residents at a large academic center, and assess potential associations with previously validated measures of medical knowledge, clinical performance, and professionalism.

Methods: We evaluated CD-RISC 10 and GRIT-S instrument scores among IM residents at the Mayo Clinic Rochester, Minnesota between July 2017 and June 2019. We analyzed dimensionality, internal consistency reliability, and criterion validity in terms of relationships between resilience and grit, with standardized measures of residents' medical knowledge (in-training examination [ITE]), clinical performance (faculty and peer evaluations and mini-clinical evaluation exercise [mini-CEX]), and professionalism/dutifulness (conference attendance and evaluation completion).

Results: A total of 213 out of 253 (84.2%) survey-eligible IM residents provided both CD-RISC 10 and GRIT-S survey responses. Internal consistency reliability (Cronbach alpha) was excellent for CD-RISC 10 (0.93) and GRIT-S (0.82) overall, and for the GRIT subscales of consistency of interest (0.84) and perseverance of effort (0.71). CD-RISC 10 scores were negatively associated with ITE percentile ($\beta = -3.4$, 95% CI: -6.2 to -0.5, $P=0.02$) and mini-CEX ($\beta = -0.2$, 95% CI: -0.5 to -0.02, $P=0.03$). GRIT-S scores were positively associated with evaluation completion percentage ($\beta = 2.51$, 95% CI: 0.35 to 4.67, $P=0.02$) and conference attendance ($\beta = 2.70$, 95% CI: 0.11 to 5.29, $P=0.04$).

Conclusions: This study revealed favorable validity evidence for CD-RISC 10 and GRIT-S among IM residents. Residents demonstrated resilience within a competitive training environment despite less favorable test performance and grittiness that was manifested by completing tasks. This initial validity study provides a foundation for further research on resilience and grit among physicians-in-training.

Strengths and limitations of this study

- This is the first validity study of CD-RISC 10 and Grit-S scores among IM residents for resilience and grit respectively, and was completed at a large academic center in the U.S.
- This study evaluated the dimensionality, internal consistency reliability, and the criterion validity of these two measures among IM residents.

- This study provides a foundation for further research on resilience and grit among physicians in training.
- This was an observational study, which limits the ability to draw causal inferences about the relationships found.
- The analysis did not adjust for resident age, gender, or international versus U.S. medical graduation status, as they are non-modifiable variables in terms of career development and enhancing residency curricula.

For peer review only

BACKGROUND

The prevalence of physician burnout in the US is estimated to be approximately 50% among physicians-in-training (1-4) and practicing physicians. (5-7) Notably, burnout rates are higher for physicians than other professionals even after adjusting for work hours. (8, 9) It is unclear why burnout rates are higher in certain residency programs and among particular individuals within the same clinical settings. (10) Since burnout seems to begin during medical school, (3, 11) tackling this problem at earlier stages could help mitigate its consequences later. Furthermore, although there has been much research on correlates of burnout, (12) there is limited research on the positive aspects of physician wellness and very little known about resilience and grit among internal medicine residents.

The American Psychological Association (APA) describes resilience as adapting effectively to stressors such as relationship problems, serious health issues, or workplace and financial challenges. (13) That is, resilience is the capacity to respond to adversity such that goals are achieved at minimal psychological and physical cost. Essentially, resilient individuals "bounce back" after challenges while also growing stronger. (14) Although several models of resilience have evolved over the years, (15) the dominant paradigm of resilience is dynamic, linking neurobiology, behavior, and environmental conditions. (16) Resilience is considered essential for enhancing quality of medical care, empathy for patients, and sustainability of the healthcare workforce as a whole. (14) Moreover, low resilience may impair brain function, even resulting in posttraumatic stress disorder (PTSD), depression, and other psychiatric disorders. (17) Yet, most people do not develop such conditions after experiencing difficult life events and are thus considered to be "resilient". Resilience as a successful adaptation relies on effective responses to environmental challenges and, ultimately, resistance to the harmful effects of stress. (18) Therefore, a greater understanding of the factors that promote resilience is critical. (19)

The most widely used assessment of resilience is the Connor-Davidson Resilience Scale (CD-RISC). Use of the CD-RISC has shown that resilience is modifiable and can be improved. A shorter version of this scale, which has similar psychometric properties, is the CD-RISC 10. (20) Evidence based on the use of this assessment measure suggests that resilience can be promoted in healthcare workplaces, (21) although research on physicians is scarce.

Grit is defined as the perseverance and passion for long-term goals. (22-24) Rather than avoidance and shying away, grit means working towards achieving specific outcomes despite difficulty, failure, or adversity. (25) Individuals who remain focused on a goal or task and see it through to satisfactory completion would be described as "gritty". (26) Grit is a predictor of success in stressful, high-achievement fields including,

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3 but not limited to, surgical residency, (27-29) emergency residency,(30) military, (23)
4 and pharmacy. (31) The original Grit Scale (Grit-O) consists of 12 items, each rated on
5 a 5-point scale, (1-5) classified under two main domains: 1) consistency of interest, and
6 2) perseverance of effort, with six elements each. (22) Subsequently, an abbreviated (8-
7 question) scale with improved psychometric properties was developed by the same
8 investigators to measure trait-level perseverance and passion for long-term goals (Grit-
9 S), (23)
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13 Although there has been ample research on relationships between burnout and various
14 aspects of professionalism and clinical performance among resident physicians, (32-36)
15 to our knowledge the CD-RISC 10 and Grit-S scales have not been previously validated
16 in U.S. internal medicine residents. Furthermore, there remains the need for further
17 research on positive aspects of physician wellness – such as resilience and grit – which
18 may serve to counterbalance burnout.
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22 In this study we assessed the validity of CD-RISC 10 and Grit-S scores among internal
23 medicine (IM) residents at a large academic medical center. Additionally, we examined
24 associations between resident resilience and grit based on CD-RISC 10 and Grit-S
25 scores, respectively, with previously standardized measures of medical knowledge (the
26 in-training examination), professionalism (dutifulness based on conference attendance
27 and evaluation completion), and clinical performance (validated, multisource, clinical
28 performance evaluations).
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32 **METHODS**

33 **Study Design and Sample**

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35 This was a longitudinal cohort study of IM residents training at Mayo Clinic Rochester
36 between July 2017 and June 2019 who were invited to participate in the Mayo Internal
37 Medicine Well-Being (IMWELL) Study. We used existing survey data from the IMWELL
38 study in addition to administrative data collected routinely on IM residents at Mayo Clinic
39 in Rochester, MN. This study was deemed exempt by the Mayo Institutional Review
40 Board.
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45 **The Mayo IMWELL Study**

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47 The prospective, longitudinal, Mayo IMWELL study was initiated in 2003 to evaluate IM
48 residents' burnout, quality of life, and empathy, along with other measures of well-being
49 (37-40). Enrollment is voluntary and is offered during the orientation of all new interns
50 (categorical and preliminary) in the IM residency program. Incentives were not given.
51 For the time frame between July 2017 to June 2019, 253 residents were eligible to be
52 enrolled as participants and were surveyed twice per year. An additional survey was
53 sent each spring to graduating categorical residents. Identities of participants were
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3 anonymized during data collection and before analysis using numerical codes. The CD-
4 RISC 10 and Grit-S instruments were added to the IMWELL study surveys starting July
5 2017. The CD-RISC 10 and Grit-S scores from the IMWELL study for each resident
6 were merged with each resident's residency performance metrics during the
7 subsequent 6 months (July to December or January to June) on the other relevant
8 instruments described below.
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11 **Validity Evidence**

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14 The validity argument for this study was based on a modern approach to validity which
15 states that all validity is construct validity, and that validity evidence is gathered from the
16 categories of content, internal structure, relations to other variables, response process,
17 and consequences. (41) Content refers to relationships between an assessment's
18 wording and the construct that it purportedly measures. Internal structure refers to the
19 degree to which instrument items fit the underlying construct and is often reported in
20 terms of dimensionality and reliability. Relations to other variables evidence is the
21 relationship between scores and other variables relevant to the construct being
22 measured, such that the relationships may be positive or negative depending on the
23 constructs being measured. (42) Notably, research has indicated that commonly
24 reported categories of validity evidence among education research studies come from
25 the categories of content, internal structure, and relations to other variables. (42)
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31 **Instruments and Scales Used**

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33 Short Grit Scale (Grit-S): An 8-item assessment, each rated on a 5-point scale (1=Not
34 like me at all, 2=Not much like me, 3=Somewhat like me, 4=Mostly like me, 5=Very
35 much like me), covering two factors, (23) that measures trait-level perseverance and
36 passion for long-term goals. It has 4 fewer items than the original grit scale (Grit-O) (22)
37 with improved psychometric properties. The Short Grit (Grit-S) scale is a brief version of
38 the original 12-item Grit-O scale. Previous studies have shown that it has predictive
39 validity, consensual validity, and test-retest stability. Factor analysis, and later
40 confirmatory factor analysis, has supported a 2-factor structure of the scale reflecting
41 "consistency of interest" and "perseverance of effort". Both factors showed adequate
42 internal consistency reliability. (23)
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47 10 item Connor-Davidson Resilience Scale (CD-RISC 10): An assessment consisting of
48 10 items, rated on a 5-point scales (0=Not true at all, 1=Rarely true, 2=Sometimes true,
49 3=Often true, 4=True nearly all of the time), with higher scores indicating greater
50 resilience. (43) It has ability to distinguish between those with greater and lesser
51 resilience levels, and to demonstrate that resilience is modifiable and can be improved.
52 The reliability and validity of the Connor-Davidson Resilience scale (CD-RISC) were
53 previously evaluated and performed well in other settings. Factor analysis revealed five
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3 factors for the CD-RISC scale. (43) CD-RISC 10 is a 10-item version of this scale with
4 good internal consistency and evidence to support construct validity. (20) Further
5 validation studies have shown excellent performance of the CD-RISC 10 among the
6 general population (44) and trainees in the United States Air Force. (45)
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9 Knowledge measures: This included In-Training Exam (ITE) score percentiles. The ITE
10 is administered to all U.S. IM residents annually. Residents in this study were
11 administered the ITE annually each fall. Validity of the ITE scores has been established
12 in several studies. (46, 47)
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15 Professionalism and dutifulness measures: This included conference attendance and
16 evaluation completion, which were reported as relations to variables validity evidence in
17 our previous studies of residents at the Mayo Clinic. (48) Conference attendance was
18 assessed using in-person card-swipe data. Evaluation completion percentage was
19 determined from the MedHub[®] residency evaluation system for our study's time frame.
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23 Clinical performance: We selected clinical performance measures as association
24 variables for this study, because we believed that standardized assessments of
25 performance are among the most rigorous challenges for testing residents' resilience
26 and grit. Clinical performance was determined by faculty and peer evaluations and the
27 standardized Mini Clinical Evaluation Examination (Mini-CEX). (49, 50) The Mini-CEX
28 evaluates core clinical skills by trainees, namely medical interviewing, physical
29 examination, informed decision-making/counseling, and clinical judgment/reasoning.
30 The Mini-CEX has demonstrated validity evidence among internal medicine residents.
31 (49-52) The mini-CEX used at Mayo Clinic Rochester incorporates a 5-point scale.
32 Multisource assessments of residents' clinical performance at Mayo Clinic Rochester
33 are completed by faculty, peers and senior medical residents. Items within these clinical
34 performance assessments have shown multi-dimensionality and excellent internal
35 consistency reliability. (53, 54) The clinical performance evaluations (peer evaluations,
36 faculty evaluations, and mini-CEX ratings) are administered by the residency evaluation
37 platform, MedHub[®]. Aggregate reports of evaluations can be obtained by timeframe of
38 interest, with all assessments standardized to a score in the range of 0-10.
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45 **Data Analysis**

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47 Participants' demographics were summarized using descriptive statistics. Continuous
48 variables such as age were summarized as mean (standard deviation). Nominal
49 variables, such as gender, were reported using a count (percent of total). Only fully
50 completed Grit-S and CD-RISC 10 instruments were included in the analysis. A
51 threshold of $p < 0.05$ was used to determine statistical significance. Statistical analyses
52 were conducted using SAS version 9.4 (SAS Institute, Inc., Cary, NC).
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Validation of the CD-RISC 10 and Grit-S Scales among Internal Medicine Residents

It has been recommended to re-examine the validity of assessments when applying them to new contexts and educational settings. (55) Therefore, we evaluated the internal structure validity of the CD-RISC 10 and Grit-S for this study as follows:

1. Factor analyses of the CD-RISC 10 & Grit-S instruments were done using principal components analysis with a minimum eigenvalue of 1 criterion. An orthogonal Varimax rotation was used to estimate item loadings. Items with factor loadings of 0.48 or more were retained. (56) Internal consistency reliabilities for items comprising each factor and overall were determined using Cronbach alpha, where $\alpha > 0.7$ was considered acceptable. (56) Scale values were reversed for the 'Consistency of Interest' factor items of Grit-S (1, 3, 5, and 6) so that 1=very much like me, 2=mostly like me, 3=somewhat like me, 4=not much like me, 5=not like me at all, so that higher item scores reflect increased 'Grit'.
2. Criterion validity (relations to other variables): Unadjusted bivariate associative analyses used generalized linear models with normal response distributions and identity link functions estimated via generalized estimating equations (GEEs) with an exchangeable covariance matrix. The CD-RISC 10 and Grit-S scores were treated as the explanatory variables, and residency performance in the various metrics during the subsequent 6 months were the outcome variables.

Patient and public involvement:

Patients and the public were not involved in this research study.

RESULTS

Sample Characteristics

From a total of 253 eligible IM residents training at Mayo Clinic Rochester between July 2017 and June 2019, 213 (84.2%) completed at least 1 IMWELL survey, resulting in 468 completed CD-RISC 10 and 472 Grit-S surveys from a total of 801 possible surveys. A total of 461 IMWELL surveys included complete responses for both scales. The distributions of overall scores were assessed visually, with Grit-S appearing approximately normal and CD-RISC 10 displaying some left-skewness. There were 193 ITE percentiles and 358 mini-CEX evaluations available for the same time period. The demographic characteristics of the participants are shown in Table 1.

Medical Knowledge, Clinical Performance, and Professionalism Metrics

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3 The ITE score percentiles among residents in our study (N=193) ranged from 18-100,
4 with a mean (SD) of 83.3 (15.5). Clinical performance, as reflected by faculty
5 evaluations (N=429), peer evaluations (N=362), and mini-CEX (N=358) showed mean
6 (SD) scores of 7.84 (0.69), 8.09 (0.83), and 8.19 (1.59), respectively. Performance
7 measure summaries are shown in Table 2.
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10 **Validity Analyses of the CD-RISC 10 and GRIT-S Instruments**

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12 Regarding the internal structure validity evidence for the scales among IM residents, the
13 CD-RISC 10 index demonstrated a single dimension of resilience while the GRIT-S
14 index demonstrated two dimensions of grittiness. The internal consistency reliability for
15 both scales overall, and for the GRIT subscales, was high (Cronbach α 's>0.7, Tables 3
16 and 4).
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20 The 468 completed CD-RISC 10 scales showed mean scores for individual items
21 ranging from 2.74 (not easily discouraged by failure) to 3.34 (can achieve goals despite
22 obstacles) on the 0-4 scale [Table 3]. The overall mean summed (SD) CD-RISC score
23 was 31.5 (6.1). The 472 completed GRIT-S scales showed individual-item mean scores
24 ranging from 2.99 (new ideas and projects sometimes distract me from previous ones)
25 to 4.48 (I am a hard worker) on the 1-5 scale [Table 4]. The overall mean (SD) GRIT-S
26 score was 3.72 (0.59).
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30 Regarding relations to other variables (i.e., criterion) validity evidence, the CD-RISC 10
31 overall summed scores correlated negatively with medical knowledge acquisition as
32 measured by ITE score percentile ($\beta = -0.34$, 95% CI: -0.62 to -0.05, $P=0.02$). The CD-
33 RISC 10 overall summed scores also correlated negatively with clinical performance as
34 measured by the mini-CEX ($\beta = -0.02$, 95% CI: -0.05 to -0.002, $P=0.03$) (Table 5).
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38 The GRIT-S overall mean score correlated positively with evaluation completion
39 percentage ($\beta = 2.51$, 95% CI: 0.35 to 4.67, $P=0.02$) and in-person conference
40 attendance ($\beta = 2.70$, 95% CI: 0.11 to 5.29, $P=0.04$) (Table 5), which are measures of
41 the dutifulness aspect of professionalism.
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44 **DISCUSSION**

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46 The CD-RISC 10 and GRIT-S instruments have strong validity in measuring resilience
47 and grit in several populations (20, 23, 45, 57) and there have been studies of grit in
48 surgical (28, 29, 58) and emergency medicine residents. (30) However, to our
49 knowledge, this is the first validity study of the CD-RISC 10 and GRIT-S among IM
50 residents. Both instruments showed excellent internal consistency reliability, statistically
51 significant associations with previously validated measures of resident physician
52 performance, and dimensionality characteristics that are consistent with previous
53 research.
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3 We identified a negative association between residents' CD-RISC 10 scores and
4 measures of clinical performance (mini-CEX) and medical knowledge (ITE). This finding
5 might reflect resilient residents' abilities to thrive within a high-pressured IM training
6 environment, despite performing less favorably on standardized assessments within this
7 setting. Notably, whether a resident thrives is not determined by their performance on
8 one of these measures, but rather, by their overall standing within our rigorous training
9 environment. This finding may be supported by the residents' highest score on the item,
10 "achieve goals despite obstacles." We also identified a positive association between
11 GRIT-S scores and evaluation completion, which is a dutifulness aspect of
12 professionalism. (22, 59) This finding suggests that, as expected, residents with
13 grittiness tend to finish tasks. Additionally, this finding corresponds to residents' highest
14 score on the item, "I am a hard worker." Overall, our research should inform future
15 interventions to improve resident performance and well-being by using the CD-RISC 10
16 and GRIT-S as roadmaps for curricular interventions.
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22 Compared to the general U.S. population included in the original validation studies, (43,
23 57, 60) the overall mean (SD) resilience score in our sample was comparable [31.5
24 (6.1) versus 32.1 (5.8) and 31.8 (5.4)]. However, compared to the reference group
25 aged 25-34 years in the original validation study, the overall mean (SD) GRIT-S score in
26 our sample was higher [3.72 (0.59) versus 3.2 (0.7)]. (23) Our study participants noted
27 strong perseverance as reflected by their highest GRIT-S score on the item "I am a hard
28 worker." Additionally, the dimensionalities for the GRIT-S and CD-RISC 10 scales in our
29 study were consistent with findings from research in different populations. (61, 62)
30 However, despite having higher grit and comparable resilience as compared to the
31 general population, burnout rates among physicians and physicians-in-training appear
32 to be greater than that of the U.S. working population. (3, 8) This suggests that the
33 medical profession selects gritty and resilient individuals, yet still manages to burn them
34 out. Furthermore, research shows that wellbeing indicators are highest upon
35 matriculation to medical school, and subsequently wane throughout medical training.
36 (63) Consequently, future research should examine the interactions between burnout,
37 empathy, resilience, and grit.
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44 This study has several limitations. First, it was observational, which constrains the ability
45 to draw causal inferences about the relationships that were identified. Second, the
46 analysis did not adjust for age, gender, and international versus U.S. medical
47 graduation status. Nonetheless, these are non-modifiable variables that would not
48 facilitate efforts at professional development or enhancing residency curricula. Third,
49 this study involved IM residents at a large academic medical center, which may limit
50 generalization to some other specialties and settings. Fourth, although we implicate
51 potential, counterbalancing interactions between grit and wellness with burnout, this
52 remains speculative until there is further research that actually examines interactions
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3 between performance on these scales among internal medicine residents. Fifth,
4 residents' self-selection to participate in the study introduces the potential for selection
5 and response biases, though it is noteworthy that the response/participation rate for this
6 study was high.
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9 Resilience and grit may lessen burnout, yet these relationships remain unclear among
10 physicians in training. Thus, research on resilience and grit could assist interventions to
11 mitigate physician burnout (64, 65) and provide a deeper understanding of dynamics
12 between the issues at play. (66) Findings from this study support use of the CD-RISC
13 10 and GRIT-S among internal medicine residents and should serve as a foundation for
14 future research on resilience and grit in medical learners. This research should examine
15 associations among IM residents between CD-RISC 10 and GRIT-S, with validated
16 measures of burnout and well-being. It is noteworthy that burnout is prevalent within
17 current medical education and training systems and may be an indicator of
18 organizational health. (67, 68) Therefore, improved understanding of resilience and grit
19 may enhance graduate medical education curricula (36, 69-72) and the wellbeing of
20 physicians.
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26 There have been ample investigations on physician burnout and depression, yet there
27 has been less research on positive aspects of physician wellness including resilience
28 and grit among internal medicine residents. Especially during this era of the COVID
29 pandemic, it is necessary to better understand characteristics of physicians that allow
30 them to surmount adversity and thrive. Since high resiliency and grit have been
31 correlated with positive attributes in other populations, we are hopeful that further study
32 of these traits in residents' will help to improve their quality of life. (27, 58, 73)
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36 **Author contributions:**

37 Idea conception: TJB, FA, CPW, VMM

38 Study design and methodology: FA, TJB, AJH

39 Data management and analysis: AJH, JNM

40 Interpretation of the data: FA, AJH, TJB, MHM, BEV

41 Manuscript drafting: FA

42 Supervision: TJB

43 Revising, editing, and final approval of manuscript: all authors.
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48 **Disclosure:**

49 No conflicts of interest, financial or other, to declare by any of the authors.
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52 Dissemination of study results to study participants is not applicable.
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54 No additional data available.
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Table 1. Baseline Characteristics of Internal Medicine Resident Physicians

Variable	Level	Total (N=253)	≥1 Survey (N=213)	No Survey (N=40)	P value
Sex	Male	165 (65.2%)	137 (64.3%)	28 (70.0%)	0.59
	Female	88 (34.8%)	76 (35.7%)	12 (30%)	
Program	Categorical	196 (77.5%)	170 (79.8%)	26 (65.0%)	0.06
	Preliminary	57 (22.5%)	43 (20.2%)	14 (35.0%)	
Match Year	2015	50 (19.8%)	40 (18.8%)	10 (25.0%)	0.40
	2016	47 (18.6%)	39 (18.3%)	8 (20.0%)	
	2017	78 (30.8%)	70 (32.9%)	8 (20.0%)	
	2018	78 (30.8%)	64 (30.1%)	14 (35.0%)	
Age	Mean (SD)	27.72 (2.62)	27.69 (2.66)	27.90 (2.43)	0.62
Possible Surveys	Mean (SD)	3.17 (1.17)	3.20 (1.17)	3.00 (1.18)	0.33
Completed Surveys	Mean (SD)	-	2.16 (1.08)	-	-
Notes: Baseline Characteristics of 253 Survey Eligible IM Resident Physicians from July 2017 Through June 2019 (213 [84.2%] IM Resident Physicians Completed 461 [57.6%] CD-RISC 10 / Grit-S Surveys out of 801 possible)					

Table 2. Medical Knowledge, Professionalism, and Clinical Performance Measures for 210 IM Resident Physicians Providing Data from July 2017 to June 2019 (N=429)

Variable	Metric (scale)	n (Eligible)	n (Responses)	Mean (SD)	Range
Medical Knowledge	IM-ITE, percentile	353	193	83.3 (15.5)	18-100
Professionalism	Conference Attendance, number	705	429	53.8 (14.3)	6-95
	Evaluation Completion, %	705	429	77.3 (11.5)	22-100
Clinical Performance	Faculty Evaluations (0-10)	705	429	7.84 (0.69)	4.49-9.37
	Peer Evaluations (0-10)	705	362	8.09 (0.83)	4.13-10
	Mini-CEX (0-10)	705	358	8.19 (1.59)	4.00-10

Table 3. IM Resident Physicians' Mean Scores on, Factor Loadings of, and Internal Consistency Reliability of the CD-RISC 10 (N=468)

Item	Mean Score (SD)	Item Loading	Cronbach α
CD-RISC 10 overall (0-40)	31.5 (6.1)		0.93
1. Able to adapt to change	3.29 (0.68)	0.80	
2. Can deal with whatever comes	3.18 (0.74)	0.82	
3. Tries to see humorous side of problems	3.19 (0.79)	0.71	
4. Coping with stress can strengthen me	3.11 (0.79)	0.72	
5. Tend to bounce back after illness or hardship	3.25 (0.76)	0.83	
6. Can achieve goals despite obstacles	3.34 (0.71)	0.82	
7. Can stay focused under pressure	3.03 (0.78)	0.81	
8. Not easily discouraged by failure	2.74 (0.91)	0.75	
9. Thinks of self as strong person	3.20 (0.78)	0.83	
10. Can handle unpleasant feeling	3.19 (0.73)	0.81	

Table 4. IM Resident Physicians' Mean Scores on, Factor Loadings of, and Internal Consistency Reliability of the Grit-S (N=472)

Item	Mean Score (SD)	Item Loading		Cronbach α
		Consistency of Interest	Perseverance of Effort	
Consistency of Interest (reverse-scored)				0.84
1. New ideas and projects sometimes distract me from previous ones.	2.99 (0.95)	0.83	0.002	
3. I have been obsessed with a certain idea or project for a short time but later lost interest.	3.39 (0.95)	0.84	0.11	
5. I often set a goal but later choose to pursue a different one.	3.63 (0.88)	0.80	0.26	
6. I have difficulty maintaining my focus on projects that take more than a few months to complete.	3.56 (1.03)	0.76	0.29	
Overall Consistency of Interest mean	3.39 (0.79)			
Perseverance of Effort				0.71
2. Setbacks don't discourage me.	3.40 (0.94)	0.08	0.49	
4. I am a hard worker.	4.48 (0.70)	0.05	0.86	
7. I finish whatever I begin.	3.95 (0.84)	0.47	0.63	
8. I am diligent.	4.33 (0.72)	0.17	0.87	
Overall Perseverance of Effort mean	4.04 (0.59)			
Grit-S Overall (1-5)	3.72 (0.59)			0.82

Table 5. Associations of Performance Measures with CD-RISC 10 and Grit-S

Variable	Metric (scale)	CD-RISC 10 (0-40)			Grit-S (1-5)		
		β	95% CI	p-value	β	95% CI	p-value
Medical Knowledge	IM-ITE, percentile	-0.34	-0.62, -0.05	0.02	0.42	-3.29, 4.12	0.83
Professionalism	Conference Attendance, number	-0.07	-0.31, 0.18	0.59	2.70	0.11, 5.29	0.04
	Evaluation Completion, %	0.19	-0.05, 0.43	0.13	2.51	0.35, 4.67	0.02
Clinical Performance	Faculty Evaluations (0-10)	0.0002	-0.01, 0.01	0.98	0.06	-0.08, 0.20	0.38
	Peer Evaluations (0-10)	0.02	-0.0006, 0.03	0.06	0.09	-0.09, 0.26	0.33
	Mini-CEX (0-10)	-0.02	-0.05, -0.002	0.03	-0.20	-0.47, 0.06	0.13