

## Medical students, mental health and the role of resilience – a cross-sectional study

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## Supplementary Materials

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Supplementary Table 1. Linear Correlation coefficients for the pairwise relationships between the outcome variables.

	<b>Depression</b>	<b>Anxiety</b>	<b>Personal Burnout</b>	<b>College Burnout</b>	<b>Resilience</b>
<b>Depression</b>	1	-	-	-	-
<b>Anxiety</b>	<b>0.77</b>	1	-	-	-
<b>Personal Burnout</b>	<b>0.70</b>	<b>0.69</b>	1	-	-
<b>College Burnout</b>	<b>0.57</b>	<b>0.57</b>	<b>0.66</b>	1	-
<b>Resilience</b>	<b>-0.48</b>	<b>-0.46</b>	<b>-0.46</b>	<b>-0.40</b>	1

Emboldened values denote variables with a  $p < .05$ . Analysis weighted for sampling bias.

Supplementary Table 2. The correlation coefficients for the relationship between resilience with the outcome variables when stratified by demographics.

	Outcomes				
	Depression	Anxiety	Personal Burnout	College Burnout	Comorbidity <sup>a</sup>
<b>Overall (n=521)</b>	<b>-0.48</b>	<b>-0.46</b>	<b>-0.46</b>	<b>-0.40</b>	<b>-0.33</b>
<b>Gender %</b>					
Female (n=302)	<b>-0.48</b>	<b>-0.41</b>	<b>-0.41</b>	<b>-0.32</b>	<b>-0.33</b>
Male (n=213)	<b>-0.51</b>	<b>-0.54</b>	<b>-0.50</b>	<b>-0.47</b>	<b>-0.35</b>
N-B/O (n=6)	0.60	0.40	0.14	<b>-0.84</b>	-0.28
<b>Medical Training Year %</b>					
DEM1 (n=165)	<b>-0.36</b>	<b>-0.39</b>	<b>-0.46</b>	<b>-0.35</b>	<b>-0.30</b>
DEM2 (n=146)	<b>-0.49</b>	<b>-0.45</b>	<b>-0.45</b>	<b>-0.47</b>	<b>-0.30</b>
DEM3 (n=131)	<b>-0.49</b>	<b>-0.44</b>	<b>-0.43</b>	<b>-0.29</b>	<b>-0.30</b>
GEM1 (n=36)	-0.25	<b>-0.44</b>	<b>-0.46</b>	<b>-0.35</b>	<b>-0.30</b>
GEM2 (n=43)	<b>-0.51</b>	<b>-0.48</b>	-0.25	-0.22	<b>-0.46</b>
<b>Region %</b>					
Irish (n=88)	<b>-0.48</b>	<b>-0.56</b>	<b>-0.46</b>	<b>-0.49</b>	<b>-0.39</b>
Malaysian (n=75)	<b>-0.44</b>	<b>-0.32</b>	<b>-0.44</b>	<b>-0.31</b>	<b>-0.33</b>
Middle Eastern (n=136)	<b>-0.52</b>	<b>-0.41</b>	<b>-0.40</b>	<b>-0.31</b>	<b>-0.25</b>
North American (n=108)	<b>-0.51</b>	<b>-0.46</b>	<b>-0.43</b>	<b>-0.42</b>	<b>-0.35</b>
Other (n=114)	<b>-0.41</b>	<b>-0.51</b>	<b>-0.53</b>	<b>-0.44</b>	<b>-0.35</b>

Emboldened values denote variables with a  $p < .05$ . Analysis weighted for sampling bias. This will differ from the raw number of individuals in the data. <sup>a</sup>: Assessed using Kendall's tau.

Supplementary Table 3. Demographic and predictive examination of those who took part in Part B and those who did not.

Predictor	Did Not Complete Mean/%	Completed Mean/%	Univariate OR 95%ile CI	Multivariable OR 95%ile CI
Age	21.3 (2.23)	21.8 (3.35)	<b>1.06</b> (1.02-1.11)	<b>1.06</b> (1.00-1.11)
Gender (%)				
Male (ref)	62.0	38.0	-	-
Female	48.8	51.2	<b>1.71</b> (1.35-2.18)	<b>1.66</b> (1.27-2.17)
N-B/O	58.8	41.2	1.14 (0.43-3.05)	1.07 (0.41-2.81)
Medical Training Year				
DEM1 (ref)	48.3	51.7	-	-
DEM2	64.5	35.5	<b>0.51</b> (0.38-0.68)	<b>0.44</b> (0.32-0.61)
DEM3	57.5	42.5	<b>0.69</b> (0.51-0.94)	<b>0.60</b> (0.43-0.85)
GEM1	34.6	65.4	<b>1.77</b> (1.07-2.93)	1.00 (0.55-1.82)
GEM2	51.7	48.3	0.87 (0.54-1.39)	<b>0.53</b> (0.29-0.99)
Region				
Irish (ref)	35.6	64.4	-	-
Malaysian	49.4	50.6	<b>0.57</b> (0.37-0.87)	0.68 (0.42-1.09)
Middle Eastern	67.4	32.6	<b>0.27</b> (0.18-0.39)	<b>0.32</b> (0.21-0.50)
North American	55.3	44.7	<b>0.45</b> (0.30-0.66)	<b>0.45</b> (0.29-0.69)
Other	55.5	45.5	<b>0.44</b> (0.30-0.65)	<b>0.48</b> (0.32-0.72)
Brief Resilience Scale	3.25 (0.66)	3.28 (0.65)	1.07 (0.91-1.29)	1.06 (0.84-1.34)
EPOCH Engagement	2.65 (0.72)	2.62 (0.69)	0.95 (0.80-1.12)	1.09 (0.89-1.34)
EPOCH Perseverance	3.12 (0.79)	3.22 (0.77)	<b>1.17</b> (1.01-1.37)	1.08 (0.89-1.31)
EPOCH Optimism	3.12 (0.85)	3.04 (0.84)	0.89 (0.77-1.01)	0.95 (0.76-1.18)
EPOCH Connectedness	3.80 (0.96)	3.89 (0.96)	1.10 (0.98-1.25)	1.07 (0.91-1.26)
EPOCH Happiness	3.09 (0.85)	2.99 (0.78)	0.87 (0.76-1.00)	<b>0.72</b> (0.57-0.91)

NHS Leadership	1.40	1.47	<b>1.82</b>	<b>2.05</b>
Personal Qualities	(1.36)	(1.35)	(1.31-2.54)	(1.30-3.24)
NHS Leadership	1.57	1.59	<b>1.20</b>	0.76
Working with others	(1.35)	(1.32)	(0.85-1.69)	(0.49-1.20)
Professional Self Identity	1.80	1.50	<b>0.83</b>	<b>0.89</b>
	(1.34)	(1.22)	(0.76-0.91)	(0.81-0.99)

Note: Emboldened statistics denote a significant difference from the reference category (ref).

Supplementary Table 4. Comparison of the main results with and without the probability weight applied to the analysis.

<b>Outcome</b>	<b>Unweighted</b>	<b>Weighted</b>	<b>Difference</b>
Depression score M (SD)	7.60 (5.87)	7.92 (6.02)	0.31
Depression incidence (15+) %	13.3	14.7	1.33
Anxiety Score M (SD)	7.52 (5.62)	7.67 (5.68)	0.16
Anxiety Incidence (15+) %	13.8	14.3	0.53
Personal Burnout Score M (SD)	12.47 (4.54)	12.53 (4.55)	0.59
Personal Burnout Quartile %	17.75	18.20	0.45
College-Related Burnout Score M (SD)	13.76 (5.40)	14.16 (5.48)	0.40
College-Related Burnout Quartile %	24.62	27.15	2.53
Cumulative Comorbidity Difficulties <sup>a</sup> %			
None	51.78	48.71	-3.07
One	17.39	19.88	2.49
Two	12.65	12.52	-0.13
Three	9.88	9.94	0.06
Four	8.30	8.89	0.59

Note: <sup>a</sup>: Total sample for cumulative comorbidity is 503 as all participants will have to have completed all questionnaires.

Supplementary Table 5. Linear Correlation coefficients for the pairwise relationships between the outcome variables and the other scales used in PILLAR Part A.

	Depression	Anxiety	Personal Burnout	College Burnout	Resilience
<b>EPOCH Engagement</b>	-0.04	-0.06	<b>-0.09</b>	-0.07	<b>0.16</b>
<b>EPOCH Perseverance</b>	<b>-0.24</b>	<b>-0.10</b>	<b>-0.17</b>	<b>-0.16</b>	<b>0.28</b>
<b>EPOCH Optimism</b>	<b>-0.42</b>	<b>-0.36</b>	<b>-0.41</b>	<b>-0.28</b>	<b>0.40</b>
<b>EPOCH Connectedness</b>	<b>-0.31</b>	<b>-0.28</b>	<b>-0.26</b>	<b>-0.17</b>	<b>0.23</b>
<b>EPOCH Happiness</b>	<b>-0.50</b>	<b>-0.48</b>	<b>-0.49</b>	<b>-0.33</b>	<b>0.45</b>
<b>Professional Self Identity</b>	0.07	<b>0.11</b>	0.04	0.08	<b>0.09</b>
<b>NHS Leadership Personal Qualities</b>	<b>-0.19</b>	<b>-0.11</b>	<b>-0.14</b>	<b>-0.21</b>	<b>0.38</b>
<b>NHS Leadership Working with others</b>	-0.01	0.02	-0.01	<b>-0.13</b>	<b>0.20</b>

Emboldened values denote variables with a  $p < .05$ . Analysis weighted for sampling bias.



## **Supplementary Methods.**

*Depression.* The Patient Health Questionnaire-9 (PHQ-9) screening tool was used to estimate the incidence of depression (Kroenke et al., 2001). This consists of a 9-item questionnaire which assesses symptoms such as low mood, anhedonia, thoughts of death, sleep changes, weight changes and fatigue. Within the study, depression is reported as a continuous and categorical measure using a threshold cut-off of  $\geq 10$ . A score  $\geq 10$  had a sensitivity of 88% and a specificity of 88% and a Likelihood ratio of 7.0 for major depression (Kroenke et al., 2001). In addition, based on the additional 10<sup>th</sup> item from the PHQ-9, we report the difficulties these symptoms have posed for home, work or relationships using a conservative threshold (“very or extremely difficult”). The reliability coefficient of the measure within this sample is  $\alpha = .88$ .

*Anxiety:* The Generalised Anxiety Disorder-7 (GAD-7) screening tool was used to estimate the incidence of anxiety (Spitzer et al., 2006). This consists of a 7-item questionnaire which assesses symptoms such as feeling nervous/anxious, uncontrollable worry, difficulty relaxing and feeling restless. Similar to depression, anxiety was reported as both a continuous and categorical measure using a threshold cut-off score of  $\geq 10$ . A score  $\geq 10$  had a sensitivity of 89% and a specificity of 92% and a Likelihood ratio of 5.1 for generalised anxiety (Spitzer et al., 2006). Using the additional 8<sup>th</sup> item from the GAD-7, we report the difficulties these symptoms have posed for home, work or relationships using a conservative threshold (“very or extremely difficult”). The reliability coefficient of the measure within this sample is  $\alpha = .91$ .

*Burnout:* Burnout was measured using two sub-scales of the Copenhagen Burnout Inventory: Personal Burnout and Work-Related/Professional Burnout (Kristensen et al., 2005). Personal Burnout was measured using a 6-item 5-response Likert scale with scores ranging from “Always” (scored as 4) to “Never” (scored as 0). The personal burnout measure examines

phenomena such as physical exhaustion, emotional exhaustion, feeling worn out and feeling susceptible to illness. The reliability coefficient of the measure in this sample was  $\alpha = .85$ . The work-related/professional burnout scale was modified so that the content related to college work rather than employment (for example, “*are you exhausted in the morning at the thought of another day at work?*” was replaced with “*are you exhausted in the morning at the thought of another day at college?*”). Similar to the personal burnout measure, College-related Burnout was measured using a 7-item 5-response Likert scale with scores ranging from “Always” (scored as 4) to “Never” (scored as 0). One item was reverse coded. This measure examined phenomena such as feeling worn out by college, exhaustion at the thoughts of college, not having enough energy for leisure time due to college, and feeling frustrated with college. The reliability coefficient of the measure in this sample was  $\alpha = .87$ . Both burnout variables were reported as a continuous and categorical measure. In line with Kristensen et al. (2005), “High” burnout was defined as a score within the top quartile.

*Resilience.* Resilience was measured using the Brief Resilience Scale (Smith et al., 2008), a 6-item 5-response Likert scale with responses ranging from “Strongly Disagree” to “Strongly Agree”. This measure examined the student’s ability to positively respond to difficult circumstances with items such as “It does not take me long to recover from stressful events”. Three items are reverse coded. The reliability coefficient of the measure in this sample was  $\alpha = .81$ .

### **Sampling Bias and weighing**

Given the difference in response rates between PILLAR Parts A (93%) and B (45%), variables from the compulsory PILLAR assessment were used to weight the sample to account for sampling bias using inverse probability weighting. These included demographic and educational

characteristics, specifically age, gender, geographical region of origin and year of medical training, as well as key measures of the PILLAR assessment with proximity to our outcome variables, specifically the EPOCH Measure of Well-being (Kern et al., 2016); the Brief Resilience Scale (Smith et al., 2008); the NHS Leadership Framework Self-Assessment Tool (NHS Leadership Academy, 2012); and the Professional Self Identity Questionnaire (Crossley & Vivekananda-Schmidt, 2009). We used inverse probability weighting to adjust sampling bias. This approach assigns a weight to each student in the analysis so that they represent both themselves as well as students with similar demographic, educational and PILLAR characteristics as themselves but who did not complete Part B of the study (see Hernán, Hernández & Robins, 2004). The predicted probability of completion of Part B was calculated using multi-variable logistic regression. Completion of Part B was used as the binary outcome variable (yes or no). All auxiliary variables were used as exposures. The inverse of this probability ( $1/\text{probability}$ ) was calculated for all students. All subsequent analyses have been weighted by this inverse probability to account for sampling bias.

## **Statistical Analysis**

We report descriptive statistics for the overall sample and when stratified by medical training year. We examined the mean score and incidence of depression, anxiety, personal burnout, college-related burnout, and resilience. We examined the relationship between gender, age, geographical region of origin (Region) and year of medical training with each outcome using univariable logistic regression for binary variables. Odds ratios and beta coefficients with their corresponding 95<sup>th</sup> percentile confidence intervals (%CIs) are reported respectively. Region and medical training year were treated as nominal variables. A supplementary analysis was conducted treating the outcomes as continuous variables using linear modelling. We examined

the relationship between each continuous outcome score using linear correlation as well as report the rates of comorbidity using dichotomised outcome variables. We used uni-variable negative binomial regression to examine the relationship between gender, age, region of origin and year of medical training with the number of difficulties endorsed (co/multi-morbidity). For this analysis we report incidence risk ratios (IRR) and 95<sup>th</sup> %CIs. We examined the correlation between resilience with each of the outcome variables using Pearson's linear correlation (depression, anxiety and burnout) and Kendall's rank correlation (comorbidity). Finally, we descriptively examined any differences in findings between the weighted analyses and unweighted analyses. We report the discrepancy between these analyses in mean scores and incidence on the outcome variables. All analyses were conducted in Stata 15.

## Supplementary Analysis

*Method and Procedure.* We ran additional analyses investigating the relationship between demographic and educational characteristics with each outcome difficulty when it is measured as a continuous variable. This was conducted using uni-variable linear regression analyses and we report the beta coefficients and the 95<sup>th</sup> percentile confidence intervals. Means, standard deviations and beta coefficients for each analyses are reported in supplementary table 5.

*Depression.* The mean depression score was 7.92 (SD:6.02). Similar to the main analysis, years of education was significantly associated with depression scores such that, relative to direct entry year 1, students in direct entry years 2 & 3 had higher depression scores. Additionally graduate entry year 1 students had significantly lower depression scores. Neither gender, age nor region of origin were significantly associated with depression scores.

*Anxiety.* The mean anxiety scores was 7.67 (SD:5.68). Similar to the main analysis female medical students had higher anxiety scores than their male counter-parts. Students in direct entry years 2 and 3 had significantly higher anxiety scores than those in direct entry year 1. Neither age nor region of origin were associated with anxiety scores.

*Personal Burnout.* Similar to the main analysis female student had higher personal burnout scores than male students. Non-binary or student who preferred not to specify their gender also reported higher personal burnout scores, however these findings should be interpreted with caution as we had limited sample size within this group (n=6). Years of education was significantly associated with personal burnout scores such that, relative to direct entry year 1, students in direct entry years 2 & 3 had higher personal burnout scores. Additionally graduate

entry year 1 students had significantly lower personal burnout scores. Neither age nor region of origin were associated with personal burnout scores.

*College-Related Burnout.* Female student had higher college-related burnout scores than male students. Non-binary or student who preferred not to specify their gender also reported higher college-related burnout scores. Years of education was significantly associated with college-related burnout scores such that, relative to direct entry year 1, students in direct entry years 2 & 3 had higher personal burnout scores. Additionally graduate entry year 1 students had significantly lower college-related burnout scores. Students from Malaysia and the middle east had significantly higher college-related burnout score relative to their Irish peers.

Conclusion. These results suggest that the method of analysis (binary compared with continuous outcome) had limited impact on the interpretation of the results.

Supplementary Table 6. Descriptive statistics for the demographic and educational characteristics when stratified by the outcomes variables and the coefficient  $\beta$  and 95%ileCIs for the association between each variable with the outcome.

	Depression		Anxiety		Personal Burnout		College-related Burnout	
	$\bar{x}$ (SD)	$\beta$ (CI)	$\bar{x}$ (SD)	$\beta$ (CI)	$\bar{x}$ (SD)	$\beta$ (CI)	$\bar{x}$ (SD)	$\beta$ (CI)
<b>Gender</b>								
Female	8.2 (6.1)	0.7 (-0.5 -2.0)	8.2 (5.7)	<b>1.4</b> (0.2 -2.5)	13.0 (4.6)	<b>1.3</b> (0.4 -2.2)	14.6 (5.5)	<b>1.1</b> (0.4 -2.2)
Male (ref)	7.5 (5.8)	-	6.9 (5.5)	-	11.7 (4.4)	-	13.5 (5.4)	-
N-B/O	10.0 (5.5)	2.6 (-1.6 - 6.8)	7.4 (6.4)	0.5 (-4.2 - 5.3)	14.8 (2.4)	<b>3.0</b> (1.0 - 5.1)	16.9 (4.0)	<b>3.5</b> (0.1 - 6.8)
<b>Medical Training Year</b>								
DEM1 (ref)	5.8 (5.0)	-	5.9 (4.8)	-	11.2 (4.1)	-	12.1 (4.9)	-
DEM2	11.0 (6.6)	<b>5.2</b> (3.7 - 6.8)	9.9 (6.4)	<b>4.0</b> (2.6 - 5.5)	14.5 (4.4)	<b>3.3</b> (2.2 - 4.3)	16.8 (5.1)	<b>4.7</b> (3.4 - 5.9)
DEM3	8.6 (5.7)	<b>2.8</b> (1.5 - 4.2)	8.4 (5.5)	<b>2.5</b> (1.3 - 3.7)	12.8 (4.5)	<b>1.5</b> (0.5 - 2.6)	15.3 (5.6)	<b>3.3</b> (2.0 - 4.5)
GEM1	4.5 (3.3)	<b>-1.4</b> (-2.5 to -0.2)	4.7 (3.9)	-1.2 (-2.5 - 0.1)	9.9 (4.1)	<b>-1.4</b> (-2.6 to -0.1)	10.4 (4.0)	<b>-1.7</b> (-3.0 to -0.4)
GEM2	6.6 (5.0)	0.7 (-0.9 -2.5)	7.0 (5.2)	1.1 (-0.7 - 2.9)	12.3 (4.6)	1.0 (-0.7 - 2.7)	13.1 (4.7)	1.1 (-0.7 - 2.9)
<b>Region</b>								
Irish (ref)	7.6 (6.1)	-	7.4 (5.7)	-	12.3 (4.6)	-	13.1 (5.2)	-
Malaysian	7.9 (4.6)	0.3 (-1.9 - 1.9)	7.2 (5.1)	-0.3 (-1.8 - 1.3)	13.2 (3.7)	1.0 (-0.2 - 2.1)	14.9 (4.8)	<b>1.7</b> (0.3 - 3.2)
Middle Eastern	9.1 (6.6)	1.6 (-0.3 - 3.5)	9.0 (5.7)	1.6 (-0.1 - 3.2)	12.8 (4.8)	0.5 (-0.8 - 1.8)	15.4 (6.0)	<b>2.2</b> (0.6 - 3.8)
North American	7.4 (5.9)	-0.2 (-1.8 - 1.5)	6.9 (5.7)	-0.5 (-2.1 - 1.0)	11.8 (5.0)	-0.4 (-1.7 - 0.8)	14.0 (5.4)	0.8 (-0.6 - 2.3)
Other	7.2 (5.9)	-0.3 (-1.9 - 1.3)	7.4 (5.8)	-0.1 (-1.6 - 1.5)	12.7 (4.4)	0.4 (-0.8 - 1.6)	13.2 (5.3)	0.1 (-1.3 - 1.5)

Note: Emboldened statistics denote a significant difference from the reference category (ref). CI: 95 percentile confidence interval.

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