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Article type : Original Research

What is the association between student well-being and high-stakes examination scores?

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This is the author manuscript accepted for publication and has undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the [Version of Record](#). Please cite this article as [doi: 10.1111/MEDU.14460](https://doi.org/10.1111/MEDU.14460)

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ABSTRACT

Introduction:

As educators seek to improve medical student well-being, it is essential to understand the interplay between distress and important outcomes. Performance on Step 1 of the United States Medical Licensing Examination has played a significant role in selection for postgraduate residency positions in the U.S., and consequently is a source of great stress for medical students. The purpose of this study was to examine whether student well-being correlates with performance on a high stakes licensing examination.

Methods:

Between 2014-2016, three sequential cohorts of medical students at (name redacted) Medical School completed the Medical Student Well-Being Index (MSWBI) at the end of their 2nd year coursework, shortly before taking Step 1. Associations between well-being and Step 1 scores were investigated while adjusting for MCAT scores and cumulative second-year course scores.

Results:

In total, 354 students were included in the analysis (68.1% of potential responders). On bivariate analysis, poor student well-being (0=low distress [high well-being], 7=high distress [poor well-being]) was associated with lower Step 1 examination scores (slope = -2.10, $p < 0.01$), and well-being accounted for 5% of overall Step 1 score variability ($R^2=0.05$). However, after adjustment for MCAT scores and cumulative GPA (full model $R^2=0.51$), the relationship between well-being and Step 1 score was no longer significant (slope = -0.70, p -value = 0.06).

Conclusions:

When controlling for metrics of academic performance, student well-being prior to taking Step 1 was not associated with how well students performed on Step 1 for the study sample.

Introduction

The focus on medical student well-being has risen in recent years, following increased recognition that many students experience significant psychological distress during medical school.¹⁻³ For some students, this distress progresses into depression, anxiety, and suicidal ideation at rates higher than their age-matched peers.^{1, 4, 5} A narrative review of studies between 1990-2015 found that 35-55% of medical students had emotional exhaustion, depersonalization, and symptoms of burnout.⁶ High levels of distress are associated with frequent illness, burnout, poor performance, lower empathy, unprofessionalism, and dropping out of school.^{2, 7-10} It has become an increasing imperative to understand and address contributors to and outcomes from distress and poor well-being.¹¹

One time point associated with great stress/distress for United States (U.S.) medical students is the period preceding the United State Medical Licensing Examination (USMLE) Step 1. Other medical education systems have similar high stakes examinations; the United Kingdom, for example, is planning to institute a Medical Licensing Assessment in the near future.¹² The Step 1 examination was developed as part of the U.S. physician licensure process, and was not designed to stratify individuals. However, a secondary and unintended use of the scores has been to determine who is granted residency interviews in the U.S., creating tremendous pressure for students to achieve high scores.¹⁴ As a result, students devote significant time and financial resources to preparation, and medical schools allot dedicated curricular time to prepare for the exam.

Step 1 study time typically occurs at the culmination of a rigorous curricular year (often at the end of the 2nd year of study). In addition, the majority of students start studying for Step 1 during the preclinical phase before the dedicated study time.¹⁵ During the Step 1 study period, students study on average 11 hours a day for multiple weeks at a time.^{13, 15 16} Studying for Step 1 is a time period high in *depleting factors* (long hours studying, sleep deprivation, isolation from peers, stress) and low in *replenishing factors* (social connections, exercise, healthy eating).¹⁷ Not surprisingly, the time frame preceding Step 1 is noted to be one of the most stressful periods during medical school, and students are at high risk for development of distress and burnout.¹⁸⁻²¹

However, the association between heightened student distress and actual performance on Step 1 (and similar high stakes assessments) warrants further study. Previous studies of the association between well-being and Step 1 performance have varied substantially in the timing of

when students were surveyed, the scales used, and metrics controlled. Haight et al used a number of scales to assess health and wellness at the end of students' third year (a year after they took Step 1) and found no significant association.²² Tucker et al studied students' self-reported stress, quality of life, and perceived health using a variety of scales before and after curriculum revision, and found no correlation with Step 1 performance; however, these measures were collected 9 months before students took Step 1.²³ A series of studies from 1987-1992 found that anxiety levels measured 2 months before taking NBME part 1 (the precursor to Step 1) accounted for 13% of performance variance, but worry and emotionality measured the morning of the exam accounted for only 7% and 3% respectively.^{24,25} However, these studies did not control for prior academic performance.

Without a rich understanding of the association between student distress and performance, it is difficult to predict outcomes of (or lobby for resources for) institutional/individual strategies implemented to mitigate distress and improve wellness. Given the high stakes associated with Step 1, we sought to more thoroughly explore the relationship between student well-being and Step 1 performance. Our research question was: does student well-being, as measured prior to preparing for Step 1, correlate with subsequent performance on Step 1? We hypothesized that poor well-being would be associated with lower Step 1 scores.

Methods

Study population and setting:

All second-year medical students at the (name redacted) medical school in three sequential entry cohorts during 2014-2016 were included in this study. These students had all taken the Medical College Admission Test (MCAT) prior to matriculation. During this timeframe, the integrated organ system preclinical curriculum was 19 months long, spread across two academic years (M1 and M2), with a 10-week summer break after the first year. Upon completion of the preclinical curriculum, students immediately began a self-directed study period of up to six weeks, during which time they took Step 1. Students were required to successfully pass Step 1 before entering the clinical learning environment (clerkships).

Instrument and Variables:

The Medical School Well-Being Index (MSWBI) is a 7-question instrument that sought to evaluate multiple dimensions of distress (burnout, depression, fatigue, stress, and quality of life) utilizing a single, simple scale; possible scores range from 0-7, with higher scores indicating

higher distress/poorer well-being.²⁶ The MSWBI has been used extensively and has strong validity evidence for assessing well-being and distress, having been developed specifically for medical students, and combining multiple dimensions²⁶⁻²⁸ Scores ≥ 4 have been associated with a 3-fold higher risk of burnout, and a 2-fold higher risk of severe fatigue, poor mental quality of life, seriously considering dropping out of medical school, and suicidal ideation.²⁶

The primary variable of interest was Step 1 score. Covariates included performance on the three subdomains of the MCAT (which were verbal, biological and physical sciences at the time of the study) and the M2 cumulative performance. These two academic assessments have been associated with Step 1 performance at our and other institutions.^{15, 16} We also chose these as co-variables that could influence the coping reservoir for all students (poor prior academic performance may lead to self-doubt and thus affect distress entering the Step 1 study period).¹⁷

Data and analysis:

During the years of 2014, 2015, and 2016, as part of routine program evaluation, students were administered a series of scales (the [name redacted] Learning Environment Study), including the MSWBI in March of the M2 year, immediately before entering the dedicated Step 1 study period. Response was expected of all students but voluntary. Bivariate associations between the MSWBI and Step 1 scores were investigated using simple linear regression. We then ran multiple linear regression to adjust for MCAT scores and M2 cumulative scores. A non-linear relationship between the well-being index and Step 1 scores was explored using polynomial regression and spline modeling.

The REG and TRANSREG procedures in the SAS statistical software (version 9.4) were used for analysis. This study was determined to be exempt from ongoing review by the University of Michigan Institutional Review Board (HUM00147688).

Results

Of 520 students eligible to take the MSWBI before entering their Step 1 study period, 367 students completed the survey. 354 (68.1%) students had complete data sets and were included in the analysis. Demographics of respondents and non-respondents are provided in Table 1. The overall mean Step 1 score was 234.8 (SD = 17.7, 95% CI: 233.0, 236.7). The mean MSWBI score was 2.6 (SD = 1.8, 95% CI: 2.4, 2.7). Cronbach's alpha estimate for MSWBI in our dataset was 0.82 (95% CI: 0.79, 0.85.)

On bivariate linear regression, poor medical student well-being was significantly associated with lower Step 1 scores ($F(1,364)=17.4$, $p\text{-value} < 0.0001$), with the MSWBI accounting for 5% of the overall score variability. There was a negative association (slope = -2.10, $SE = 0.50$, $p\text{-value} < 0.01$), suggesting that as the MSWBI increased by one unit (indicating worse well-being), the expected Step 1 score decreased by slightly over two points. The scatter plot showing this linear relationship and the regression fit is provided in Figure 1.

In the multivariate analysis, scores from the biological and physical sciences sections of the MCAT and M2 cumulative scores had significant and positive relationships with Step 1 scores (Supplemental Table 1). After adding MCAT and M2 cumulative scores to the model, well-being scores were no longer statistically significantly associated with Step 1 scores (slope -0.70, $SD = 0.37$, $p=.06$). This fully adjusted model explained 51% of the variation in Step 1 scores ($R^2=0.51$).

Discussion

This study of three consecutive classes of medical students at one medical school found that lower well-being prior to taking a high stakes medical knowledge assessment (USMLE Step 1) is not associated with lower Step 1 performance, when controlling for metrics of academic performance (pre-matriculation MCAT scores and pre-Step 1 second year course scores). These results have relevance to numerous stakeholders, including students, counselors and advisors, administrators, researchers, and decision-making bodies.

Given our understanding of the relationship between emotion and learning,²⁹ it is necessary to explore educational outcomes that result from poor well-being. A number of studies have demonstrated that assessment is associated with heightened distress in students, but far fewer look at the impact of heightened stress on assessment performance, with great variation in study design and assessment focus.³⁰ Our study adds to the corpus of research by 1) studying the association between well-being and a high stakes summative national licensing exam 2) in a large number of medical students across several years 3) using a scale specifically designed to assess medical student well-being 4) while controlling for metrics of academic performance known to be associated with Step 1 performance.

Our empirical findings are relevant to educational theories that explicitly or implicitly influence approaches to addressing test anxiety. The Yerkes-Dodson rule states that performance

increases with pressure (psychological/physiologic arousal) to a certain point, after which time performance decreases.³¹The results of our study do not support this theory; increasing amounts of student distress did not have a statistically significant effect on students' academic performance after controlling for previous test performance. Test anxiety can drive students to request extensions or delays on exams hoping to feel more confident about the chances of passing, or to improve their performance, leading them to fall behind in their progression through medical school. Our findings provide some reassurance that the degree of stress or well-being a student is experiencing before an upcoming high stakes assessment is not in and of itself indicative of future poor performance, nor should it be the sole reason for considering a delay in taking the assessment. In combination with research showing that longer delays before taking another licensure exam (USMLE Step 2) are associated with worse performance³² our findings have implications for medical students navigating their approach to licensure exams, as well as their counselors and coaches. Counselors may use these findings to advise students who are worried about the impact of their well-being on their STEP 1 score; particularly that anxiety is common before a high-stakes assessment, and poor well-being at the beginning of their STEP 1 study period is not likely to adversely affect their STEP 1 performance. Coaches can encourage students to review past performance on assessments and facilitate goal development and help-seeking for both study and self-care. Additionally, our findings can inform policy decisions around high stakes and/or licensure exams made by educational administrators.

In recent years there has been much debate regarding the impact of USMLE Step 1 on many aspects of medical student education.³³ The USMLE announced that Step 1 will be reported as pass/fail only, without numeric scores, in January 2022.³⁴ Among the reasons for this change was recognition that the use of Step 1 scores for residency selection was causing students significant distress.³⁴ We anticipate that the switch to pass/fail scoring will reduce student distress about what score they achieve on Step 1 (although distress may shift towards other metrics important in residency selection). However, our findings may still have implications for the approach taken and counseling received by students who are at genuine risk of not passing their licensing exam based on prior academic metrics. In these instances, students and counselors should carefully assess academic metrics when making decisions about exam timing.

While our study suggests that distress does not significantly impact performance on Step 1, this does not negate the impact of heightened distress on many other variables of interest^{2,7-}

¹⁰Studying for high-stakes assessments is a stressful experience for students, enriched in depleting factors with limited opportunities for replenishment concentrated over a very short time-frame, rendering it a high-risk time for poor well-being. It is important to provide data-driven guidance to students experiencing distress related to preparing for high stress timeframes and assessments. Working with students from the beginning of medical school to create habits to build resiliency such as stress reduction, exercise, organized study plans, and supportive relationships may provide them with strategies to combat distress throughout medical training. More importantly, a careful review of institutional factors that could influence student well-being around times of higher stress and advocating for systems-level initiatives to address wide-spread burnout among medical trainees is also needed.³⁵

There are limitations to this study, which include its single-site design and mean Step 1 score above national average, which limit generalizability. Whether the findings of this study remain the same in different curricula or learning environments is not known. The response rate was acceptable but absence of input from non-respondents (although demographically similar) may still have created response bias. The MSWBI, although a robust measure of medical student well-being, is only one of many scales that assess different components of well-being. The goal of our study was to broadly assess the association between well-being and performance on a standardized assessment; as a result, we did not break down our analysis to specific demographic factors. Finally, we were only able to assess well-being at one point in time shortly before students took Step 1. Well-being is not a static phenomenon, and it is possible that changes in responses could have occurred closer to taking the test.

Future study could examine whether these findings hold true across different student demographics (gender, race, socioeconomic status, etc).^{33 34} Future research could also explore whether student well-being at various timepoints leading up to high stakes examinations is associated with examination performance."^{16, 32, 36,37,}

Conclusion

As other countries seek to incorporate licensing exams as part of their undergraduate medical degree program expectations, it is important to understand factors that are associated with performance on such high stakes assessments.^{12, 38-39} We sought to explore the relationship between student self-reported well-being shortly before starting the dedicated Step 1 study period

and subsequent performance on the USMLE Step 1 examination. Our findings demonstrate that after controlling for standardized and institutional exam performance, there is not an association between student well-being prior to studying for and taking Step 1 (as measured by the MSWBI) and how well students performed on Step 1. We hope that this work and discussion of evidence-based risk factors associated with decreased high stakes assessment performance will be used to inform approaches to optimize well-being, both at the level of institutional policy, support services, and in conversations between medical students and their advisors.

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Figure and Table Legends

New Table 1: Demographics of M2 students who completed the MSWBI between 2014-2016, [name redacted] medical school

Figure 1: Scatter plot depicting linear relationship and the regression fit between Medical School Well-Being Index score and Step 1 examination score ($R^2 = 0.05$; p -value < 0.0005). Responses from 354 2nd year medical students at the [name redacted] Medical School between 2014 and 2016.

New Figure 2: Coping reservoir model depicting specific factors leading to burnout vs resiliency around the Step 1 study period (based on Dunn et al.'s framework for well-being¹²).

Supplemental Table Figures and Legends

Supplemental Table 1:

Multivariable regression on Step 1 Examination scores from 366 second-year medical students, University of Michigan Medical School, 2014-2016

Supplemental Table 2: Multivariable regression on Step 1 Examination scores from 366 second-year medical students using dichotomized MSWBI, University of Michigan Medical School, 2014-2016

Supplemental Figure 1: Box plot comparing Step 1 performance between students with low and high MSWBI scores.

Table 1: Demographics of M2 students who completed the MSWBI between 2014-2016, [name redacted] medical school

	Completed MSWBI (N = 367)	Did not complete MSWBI (N = 157)	Entire cohort (N = 524)
Gender	N (%)	N (%)	N (%)
Female	193 (53%)	74 (47%)	267 (51%)
Male	174 (47%)	83 (53%)	257 (49%)
Race			
White	257 (75%)	89 (57%)	346 (66%)
Black	17 (5%)	8 (5%)	25 (5%)
Hispanic	6 (2%)	6 (4%)	12 (2%)
Asian	61 (17%)	36 (23%)	97 (19%)
Native American	-	1 (1%)	1 (0%)
Other/ Not Answered	26 (7%)	17 (11%)	43 (8%)
	Completed MSWBI	Did not complete MSWBI	Entire cohort
Academic metrics	Score (N)	Score (N)	Score (N)
MCAT Biol (mean)	12.1 (358)	12.0 (154)	12.0 (512)
MCAT Phys (mean)	11.8 (358)	12.0 (154)	11.9 (512)
MCAT Verb (mean)	10.8 (358)	10.7 (154)	10.8 (512)
M2 cumulative score (%)	90.3 (364)	90 (152)	90 (516)
Step 1 score (mean)	235 (366)	234 (152)	234 (518)

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Figure 1

