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The importance of physical and mental health in explaining health-related academic role impairment among college students

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ABSTRACT

Research consistently documents high rates of mental health problems among college students and strong associations of these problems with academic role impairment. Less is known, though, about prevalence and effects of physical health problems in relation to mental health problems. The current report investigates this by examining associations of summary physical and mental health scores from the widely-used Short-Form 12 (SF-12) Health Survey with self-reported academic role functioning in a self-report survey of 3,855 first-year students from five universities in the northeastern United States (US; mean age 18.5; 53.0% female). The mean SF-12 physical component summary (PCS) score (55.1) was half a standard deviation above the benchmark US adult population mean. The mean SF-12 mental component summary (MCS) score (38.2) was more than a full standard deviation below the US adult population mean. Two-thirds of students (67.1%) reported at least mild and 10.5% severe health-related academic role impairment on a modified version of the Sheehan Disability Scale. Both PCS and MCS scores were significantly and inversely related to these impairment scores, but with nonlinearities and interactions and much stronger associations involving MCS than PCS. Simulation suggests that an intervention that improved the mental health of all students with scores below the MCS median to be at the median would result in a 61.3% reduction in the proportion of students who experienced severe health-related academic role impairment. Although low-cost scalable interventions exist to address student mental health problems, pragmatic trials are needed to evaluate the effectiveness of these interventions in reducing academic role impairment.

1. Introduction

Epidemiological research consistently finds high rates of mental health problems among college students in the United States (US; Cho et al., 2015; Hunt and Eisenberg, 2010; Kendler et al., 2015) and across the world (Auerbach et al., 2016, 2018, 2019) as well as significant associations of these problems with decrements in academic role performance (Alonso et al., 2018, 2019; Bruffaerts et al., 2018), and discontinuing college (Arria et al., 2013; Eisenberg et al., 2009). Specific mental health problems such as Attention Deficit Hyperactivity Disorder (ADHD), depression, and sleep disturbances are typically found to be the most important mental disorders in these studies (Merkt and Gawrilow, 2016; Gormley et al., 2019; Hysenbegasi et al., 2005; Gaultney, 2010).

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Research has also shown that physical health problems are associated with decrements in academic role performance among college students (Dryer et al., 2016; Ruthig et al., 2011; El Ansari and Stock, 2010). This research is much less extensive and fine-grained than the research on mental health problems, presumably based on the fact that the vast majority of college students are in good physical health. As a result of this fact, a single yes-no measure is often used of either any disability or any chronic condition physical health problem in studying associations between physical health problems and academic performance, whereas more complex multivariate models assessing the joint effects of diverse conditions on academic performance are often used in studies of mental disorders.

Normative data suggest that the prevalence of mental and physical health problems might be more comparable among college students than suggested by the different approaches used to examine their associations with academic performance. Specifically, inspection of the Physical Component Summary (PCS) and Mental Component Summary (MCS) subscales in the Medical Expenditures Panel Survey (MEPs; Cohen et al., 2009), an annual nationally representative sample of the US Civilian non-institutionalized population, shows that mean physical health component scores are only slightly higher than mean mental health component scores among the youngest respondents (ages 20–29) (Hanmer and Kaplan, 2016). Furthermore, the majority of primary care visits on college campuses are for physical health problems rather than mental health problems (Turner and Keller, 2015), although college students tend to underuse psychological services even when they endorse symptoms of a psychiatric disorder (Bruffaerts et al., 2019). Based on these findings, it is plausible to think that physical health problems might be more important relative to mental health problems in affecting the academic performance of college students than implied by the literature. We are unaware, though, of any research that has investigated this issue systematically by comparing either relative prevalence or relative importance of these two sets of health problems in accounting for decrements in the academic performance of college students.

We carried out such an investigation by examining the associations of SF-12 PCS and MCS scores with reports about health-related academic role impairments in a self-report survey of first-year college students from five universities in the northeast US. The students were surveyed as part of the first phase of the WHO World Mental Health Surveys International College Student (WMH-ICS) Initiative (Cuijpers et al., 2019). Prior cross-national WMH-ICS reports documented high lifetime and 12-month prevalence of mental disorders in the US as well as other participating countries (Auerbach et al., 2018) along with academic role impairment associated strongly with these disorders (Alonso et al., 2019). Building on this earlier work, we examine the more highly aggregated MCS score rather than measures of specific mental disorders in order to make an even-handed comparison with the single summary measure of physical disorder available in the survey. Both these measures are used to predict student reports of health-related academic role impairment.

2. Methods

2.1. Sample

All incoming first year students in the five participating colleges and universities (n = 20,583) were invited to participate in a web-based self-report health survey between October 2017 and March 2019. All but one school invited first year students to participate in October with the other school inviting first year students in March. A total of 3,855 students completed the survey (18.7% response rate). Participants were excluded from analysis if they were under age 18 (n = 7), older than age 22 (n = 68), were currently or previously married (n = 27), and either had a child, were pregnant, or had a pregnant partner (n = 9) based on the rarity of these characteristics in the sample. The final analysis sample included 3,761 respondents. All participants provided written informed consent prior to participation. All study procedures were approved by the human subjects boards of all involved organizations. The investigation was carried out in accordance with the latest version of the Declaration of Helsinki.

2.2. Measures

2.2.1. Physical and mental health

Physical and mental health in the four weeks before the survey was assessed with the SF-12, a widely-used 12-question self-report scale designed to assess perceived health (Ware et al., 1996). Separate physical health component and mental health component summary scores were constructed from SF-12 responses. The PCS and MCS both have a theoretical range of 0–100, with higher scores indicating better health, and have been normed to have a mean of 50 and a standard deviation of 10 in the total US population (Gandek et al., 1998; Ware et al., 1995, 1996). The SF-12 is an abbreviated measure of the SF-36 and the SF-12 achieved strong R-squares with the original SF-36 on both the PCS (0.91) and MCS (0.94) (Ware et al., 1996). The SF-36, in turn, has been shown to have good construct validity in that the two broad dimensions of physical and mental health found in much previous research was replicated in dimensional analyses of the SF-36 and these dimensional scales were shown to have similar patterns of association as clinician measures of physical and mental health with a wide range of correlates (McHorney et al., 1993). In addition, PCS scores are correlated strongly with objective disorder severity measures among patients with a wide range of physical disorders, whereas MCS scores are correlated strongly with objective disorder severity measures among patients with a wide range of mental disorders (Coons et al., 2000).

2.2.2. Health-related academic role impairment

Health-related role impairments in the 30 days before the interview was assessed with a revised version of the Sheehan Disability Scale (SDS; Sheehan et al., 1996), a short self-report visual analogue scale of impairments in functioning across multiple role domains. The revised SDS asked respondents to rate on a 0–10 scale the extent to which problems with their health impaired their functioning in each of a series of life domains (e.g., quality of school work, social life, close personal relationships), using a rating system in which a score of 0 was labeled *no impairment*, scores in the range 1–3 were labeled *mild impairment*, 4–6 *moderate impairment*, 7–9 *severe impairment*, and 10 *very severe impairment*. We modified the original SDS wording, which combined work and school, to ask separately about each. We focused here on responses to the academic role impairment question, collapsing responses into nested categories of any (1–10 versus 0) and severe (7–10 versus 0–6) in the total sample and subsample estimates of more than mild among those with any health-related academic role impairment (4–10 versus 1–3) and severe among those with more than mild impairment (7–10 versus 4–6). No data as yet exist on the validity of these reports compared to objective academic performance measures, such as grade point average, but comparable studies of objective work performance measures among employed people show that the SDS is one of the most valid self-report scales of work performance (Mateen et al., 2017). Ongoing WMH-ICS methodological studies are collecting comparable data for college students, but results are not yet available.

2.2.3. Control variables

All models included dummy control variables for schools along with controls for the following socio-demographic variables: age (continuous); gender (male, female, and self-reported "other"); race/ethnicity (Hispanic, Non-Hispanic Black, Non-Hispanic White, other); nativity (nested categories of the student being foreign-born, at least one parent being foreign-born, at least one grandparent being foreign-born, and all grandparents being native-born); and highest parental education (high school or less, some college, college graduate, some postbaccalaureate education, doctorate or other professional degree).

2.3. Analysis methods

The survey data from each college were post-stratified to match the distribution of the entire first-year class on the cross-classification of sex and race/ethnicity in order to adjust for discrepancies between the sample and the population on these variables. These were the only post-stratification variables available across all schools. Item-level missing data were then multiply imputed (MI) using the fully conditional specification method with 20 imputations per respondent (van Buuren, 2007). MI logistic regression analysis was used to estimate the associations of PCS and MCS scores with the four dichotomous measures described above of health-related academic role impairment, controlling for the socio-demographic variables described above. Eight nested logistic models were estimated for each outcome: Separate linear and nonlinear models for PCS predicting the outcome (M1-M2); comparable models for MCS (M3-M4); models for the linear additive (M5) and interactive (M6) associations of PCS and MCS with the outcome; and models for the nonlinear additive (M7) and interactive (M8) associations of PCS and MCS with the outcome. Nonlinearities were modeled as incremental regression splines for the lowest and highest quartiles of the PCS and MCS distributions in addition to linear terms. Differences in comparative model fit were evaluated with MI-adjusted likelihood ratio χ^2 tests. The logits and logits + /-two standard errors of best-fitting models were exponentiated and presented as odds-ratios (ORs) with 95% confidence intervals (95% CIs). Statistical significance was evaluated consistently using 0.05-level two-sided MI-adjusted tests.

To aid in the interpretation of the interactive spline models, we calculated population attributable risk proportions (PARPs; Greenland and Drescher, 1993) for best-fitting models to estimate the effects of hypothetical interventions to improve respondent scores on either the PCS or MCS while holding the other score constant. Such estimates assume provisionally that PCS and MCS scores are causal risk factors for academic impairment and that the effects of hypothetical interventions to increase these scores are captured by the logistic regression coefficients. These simulations were carried out for six hypothetical interventions that: improved the MCS scores of students in the bottom quartile of the distribution to equal either the observed 25th percentile score or the median; improved the MCS scores of students in the bottom half of the distribution to equal the median; and improved the PCS scores in the same three ways. Each scenario improved only one of the two SF-12 scores while holding the other score constant. Population attributed risk proportions (PARPs) in academic role impairment due to these hypothetical interventions were calculated by dividing the difference between observed and predicted proportions by observed proportions. The jackknife repeated replication (JRR) simulation method (Rust and Rao, 1996) was used to estimate standard errors of PARPs using colleges as strata and random subsamples of respondents within colleges as sampling error calculation units. All analyses were carried out in SAS Version 9.4 (SAS Institute Inc, 2014).

3. Results

3.1. Sample description

Item-level missing data ranged between 0.1% (age) and 1.7% (race/ethnicity) across the variables considered here. The 3,761 students in the analysis sample had a mean age of 18.5 and were 53.0% female, 13.9% Hispanic, 9.3% Non-Hispanic Black, 43.0% Non-Hispanic White, and 33.7% defined themselves as Non-Hispanics of "other" races that we did not ask them to specify (Table 1). More than one-fourth of students (26.3%) were not born in the US, whereas 26.9% were first generation, 16.0% second generation, and the remaining 30.7% third or later generation. No data were collected to disaggregate students not born in the U.S. to distinguish immigrants from international students. Most students (83%) came from families in which at least one parent was a college graduate and a majority had at least one parent with either a masters (31.3%) or doctoral/professional (27.5%) degree. Additional demographic characteristics of the sample are summarized in Appendix Table 1.

The PCS mean in the sample is 55.1 (SE = 0.1), which is about half a standard deviation better than the mean of 50 in the overall US adult population. The PCS standard deviation is 6.1 compared to 10 in the general population. The MCS mean, 38.2 (SE = 0.2), is significantly lower than the PCS mean and is over a full standard deviation worse than the mean in the overall US adult population. The MCS standard deviation is 12.9 compared to 10 in the general population. There is a small, albeit statistically significant, negative correlation between MCS and PCS scores ($r = -0.24$, $p < .001$).

Roughly two-thirds of the sample (67.1%) reported health-related academic role impairment, including 36.0% mild, 20.6% moderate, and 10.5% severe. Among individuals with any health-related academic role impairment, 46.4% reported that the impairment was more than mild and 33.7% of those with more than mild academic role impairment reported that it was severe.

3.2. Associations of PCS and MCS scores with health-related academic role impairment

3.2.1. Comparative model fit

Inspection of comparative model fit shows that M8 (the model with all nonlinearities and the interaction between PCS and MCS) is the best model predicting severe health-related academic role impairment and more than mild academic role impairment among students with any academic role impairment, whereas M7 (the model with all terms other than the interaction) is the best model predicting the other outcomes (Table 2). The interaction is not significant in predicting any of the outcomes when we assume linear marginal effects (i.e., M6 vs. M5; $\chi^2_1 = 0.2–2.8$, $p = .89-.09$), but emerges as significant in predicting severe impairment and more than mild impairment among students with any impairment when we allow for nonlinear marginal effects (i.e., M8 vs. M7; $\chi^2_1 = 5.1–18.5$, $p = .020- < 0.001$).

3.2.2. Model coefficients

Examination of model coefficients shows that the ORs of PCS and MCS are consistently less than 1.0, indicating that improvements in both physical and mental health are associated with reductions in academic role impairment (Table 3). This broad pattern is consistent with the gross associations between quartiles of the PCS and MCS distributions with the outcomes (Appendix Table 2). With the exception of the model predicting any impairment, the ORs of PCS with impairment increase monotonically with increasing mental health. Similarly, with the exception of the model predicting any impairment, the ORs of MCS with impairment increase monotonically with increasing physical health. But the significant PCS × MCS interactions are consistently greater than 1.0, indicating that the generally negative associations between each type of health and impairment weaken with decreases in the other type of health.

3.2.3. Population attributable risk proportions

The simulations estimate that each of the six hypothetical interventions would result in a significant reduction in each of the three components of academic role impairment (i.e., any impairment, more than mild impairment among students with any, severe impairment among students with more than mild impairment) as well in the overall proportion of students with severe academic role impairment (Table 4). Comparisons of the three pairs of interventions to improve MCS and PCS in similar ways across these four outcomes show that the estimated effects would be significantly different in 11 out of 12 cases, in 10 of which the intervention to improve mental health would lead to a significantly greater decrease in academic role impairment than the

Table 1
Student characteristics by sex and in total.

	Total		Male		Female		Other		F-test
	(n = 3,761)		(n = 1,739)		(n = 1,995)		(n = 27)		
	Est	(SE)	Est	(SE)	Est	(SE)	Est	(SE)	$F_{num\ df,\ dem\ df}$
I. Socio-demographics									
Age (Mean)	18.5	(0.0)	18.6	(0.0)	18.4	(0.0)	18.3	(0.1)	2, 13871420.4 = 40.4***
Race (%)									
Hispanic	13.9	(0.6)	13.4	(1.0)	14.3	(0.8)	12.6	(5.6)	2, 869390 = 0.3
Non-Hispanic Black	9.3	(0.6)	8.8	(0.9)	9.8	(0.7)	12.2	(6.8)	2, 11178.4 = 0.7
Non-Hispanic Other	33.7	(0.9)	33.7	(1.6)	33.9	(1.1)	28.3	(9.0)	2, 14271.8 = 0.2
Non-Hispanic White	43.0	(0.9)	44.1	(1.6)	42.0	(1.1)	46.8	(9.2)	2, 19340.5 = 0.9
Nativity (%)									
Respondent not born in US	26.3	(0.8)	26.6	(1.4)	26.2	(1.0)	10.7	(6.1)	2, 27870421.8 = 1.6
Respondent born in US but at least 1 parent not	27.0	(0.8)	25.2	(1.4)	28.7	(1.0)	8.2	(4.9)	2, 42789669.7 = 5.0**
Respondent and both parents born in US, but at least 1 grandparent not	16.0	(0.6)	15.7	(1.0)	16.2	(0.8)	27.0	(7.8)	2, 11491047.6 = 1.2
Respondent and both and all 4 grandparents born in US	30.7	(0.9)	32.4	(1.5)	28.9	(1.0)	54.1	(9.2)	2, 52901755.7 = 5.8**
Parental education (%)									
High school or less	8.3	(0.5)	8.0	(0.7)	8.6	(0.6)	3.8	(3.1)	2, 6583957.3 = 0.5
Some college	8.7	(0.5)	8.1	(0.8)	9.1	(0.6)	17.4	(7.4)	2, 14109191.1 = 1.7
Bachelor's degree	24.2	(0.8)	24.2	(1.4)	24.1	(1.0)	28.8	(8.5)	2, 23819798.2 = 0.2
Master's degree	31.4	(0.9)	31.8	(1.5)	30.9	(1.0)	35.8	(8.9)	2, 26708709.1 = 0.3
Doctorate/Professional degree	27.5	(0.8)	27.8	(1.3)	27.3	(1.0)	14.2	(6.3)	2, 137430111.3 = 1.2
II. Perceived health and health-related academic role impairment									
PCS (Mean)	55.1	(0.1)	55.3	(0.2)	54.9	(0.1)	50.7	(1.8)	2, 2252502.3 = 9.0***
MCS (Mean)	38.2	(0.2)	40.4	(0.3)	36.3	(0.2)	30.4	(2.1)	2, 5649358.3 = 72.7***
Modified Sheehan Scale (%)									
None	32.9	(0.9)	40.8	(1.6)	26.3	(1.0)	11.1	(5.7)	2, 2547120.8 = 46.1***
Mild	36.0	(0.9)	33.6	(1.4)	38.2	(1.1)	24.1	(8.2)	2, 8933099.6 = 5.1**
Moderate	20.6	(0.7)	16.9	(1.1)	23.6	(0.9)	40.3	(9.3)	2, 3759109.1 = 15.4***
Severe	10.5	(0.5)	8.7	(0.8)	11.9	(0.7)	24.6	(7.6)	2, 35559164.1 = 7.7***
More than mild/Any	46.4	(1.1)	43.2	(1.8)	48.1	(1.3)	72.9	(9.1)	2, 12290775.6 = 6.0**
Severe/More than mild	33.7	(1.5)	33.9	(2.7)	33.6	(1.8)	37.9	(10.9)	2, 13001475.9 = 0.1

*p < .05; **p < .01; ***p < .001.
Abbreviations: MCS, Mental Component Summary; PCS, Physical Component Summary; SE, standard error; US, United States.

Table 2
Comparisons of fit across nested models (MI-adjusted likelihood ratio χ^2 tests)[a].

	Parameters	df	Any impairment	More than mild impairment/ Any	Severe impairment/More than mild	Severe impairment
I. Models (χ^2_{LR})						
Model 1	PCS[b]	1	4552.0	3345.4	1457.7	2402.6
Model 2	PCS, PCSs1,[c] PCSs3[d]	3	4273.2	3304.9	1453.9	2352.8
Model 3	MCS[e]	1	3388.9	3064.9	1388.0	1996.9
Model 4	MCS, MCSs1,[f] MCSs3[g]	3	3347.1	3039.4	1358.2	1989.6
Model 5	PCS, MCS	2	3228.4	2872.9	1355.1	1864.1
Model 6	PCS, MCS, PCS*MCS	3	3226.2	2871.7	1352.3	1864.1
Model 7	PCS, PCSs1, PCSs3, MCS, MCSs1, MCSs3	6	3180.5	2849.1	1320.3	1852.9
Model 8	PCS, PCSs1, PCSs3, MCS, MCSs1, MCSs3, PCS*MCS	7	3177.1	2843.9	1301.9	1851.2
II. Model comparisons (χ^2_{LR} difference)						
Model 5 vs 1	MCS	1	1323.6***	472.6***	102.6***	538.5***
Model 5 vs 3	PCS	1	160.6***	192.1***	33.0***	132.8***
Model 2 vs 1	PCSs1, PCSs3	2	278.8***	40.5***	3.7	49.7***
Model 4 vs 3	MCSs1, MCSs3	2	41.8***	25.5***	29.8***	7.3*
Model 7 vs 5	PCSs1, PCSs3, MCSs1, MCSs3	4	47.8***	23.8***	34.7***	11.2**
Model 7 vs 4	PCS, PCSs1, PCSs3	3	166.6***	190.4***	37.9***	136.7***
Model 7 vs 2	MCS, MCSs1, MCSs3	3	1092.6***	455.9***	133.6***	499.9***
Model 6 vs 5	PCS*MCS	1	2.2	1.2	2.8	0.02
Model 8 vs 7	PCS*MCS	1	3.4	5.1*	18.5***	1.8

*p < .05; **p < .01; ***p < .001.
Abbreviations: df, degrees of freedom.
[a] All models adjusted for age, gender, school, nativity, parent education and race/ethnicity.
[b] PCS = SF-12 Physical Component Summary.
[c] PCSs1 = SF-12 Physical Component Summary spline (< 25^{th}percentile).
[d] PCSs3 = SF-12 Physical Component Summary spline (> 75^{th}percentile).
[e] MCS = SF-12 Mental Component Summary.
[f] MCSs1 = SF-12 Mental Component Summary spline (< 25^{th}percentile).
[g] MCSs3 = SF-12 Mental Component Summary spline (> 75^{th}percentile).

Table 3
Best model associations of Physical and Mental Health Component Summaries predicting academic role impairment.

	Any impairment		More than mild impairment/Any		Severe impairment/More than mild		Severe impairment	
	OR	(95%CI)	OR	(95%CI)	OR	(95%CI)	OR	(95%CI)
I. SF-12 PCS splines								
0–25th percentile	0.9***	(0.8–0.9)	0.8***	(0.7–0.9)	0.8***	(0.7–0.9)	0.9***	(0.9–1.0)
25th–75th percentile	0.9*	(0.9–1.0)	0.8***	(0.8–0.9)	0.8***	(0.8–0.9)	0.9***	(0.8–0.9)
> 75th percentile	1.0	(0.8–1.1)	0.9*	(0.8–1.0)	0.9*	(0.8–1.0)	0.9	(0.8–1.0)
χ^2_3	166.6***		27.2***		37.7***		136.7***	
II. SF-12 MCS splines								
0–25th percentile	1.0*	(0.9–1.0)	0.8***	(0.6–0.9)	0.7***	(0.6–0.8)	0.8***	(0.8–0.9)
25th–75th percentile	0.8***	(0.8–0.8)	0.8***	(0.7–0.9)	0.7***	(0.6–0.8)	0.9***	(0.8–0.9)
> 75th percentile	0.9***	(0.9–1.0)	0.8*	(0.8–1.0)	0.8*	(0.7–0.9)	1.0	(0.9–1.0)
χ^2_3	1,092.6***		30.7***		60.2***		499.9***	
PCS × MCS interaction	–		1.3*	(1.0–1.6)	1.6***	(1.3–2.1)	–	

*p < .05; **p < .01; ***p < .001.
Abbreviations: CI, confidence interval; MCS, Mental Component Summary; OR odds ratio; PCS, Physical Component Summary.

comparable intervention to improve physical health.

The largest estimated effect in the simulations is for the intervention to improve the mental health of students with scores below the MCS median to be at the median. Such an intervention would be expected to result in a 61.3% reduction in the proportion of students who experience severe health-related academic role impairment. The estimated effects of a comparable intervention to improve student physical health is a 24.6% reduction in severe health-related academic role impairment. Decomposition of the MCS effect suggests that nearly two-thirds of the total effect on severe role impairment would be due to increasing the mental health of students with scores below the 25th percentile to the 25th percentile (63%; 38.7/61.3), whereas the remainder would be due to increasing the mental health of these same students to the median (24%; [53.5–38.7]/61.3) and increasing the mental health of students with scores between the 25th and 50th percentiles to the median (13%; [61.3–53.5]/61.3). Although these improvements in mental health would be associated with significant reductions in health-related academic role impairments across the range of impairment levels, the largest proportional reductions in all cases would be in severe role impairment among students with more than mild role impairment.

A decomposition of the total comparable PCS effect suggests that about half of the effect on severe role impairment would be due to increasing the physical health of students below the 25th percentile to the 25th percentile (50%; 12.2/24.5), whereas the remainder would be due to increasing the physical health of these same students to the median (38%; [21.6–12.2]/24.5) and increasing the physical health of students with scores between the 25th and 50th percentiles to the median (12%; [24.5–21.6]/24.5). Unlike the situation with a mental health intervention, where the largest proportional reductions in severe academic role impairment would be due to reducing severe impairment among students with more than mild impairment, the major effect of a physical health intervention would be in reducing more than mild impairment among students with any impairment.

4. Discussion

To the best of our knowledge, this is the first study to examine the relative importance of physical and mental health in accounting for health-related academic role impairment among college students. Results indicate that college students have significantly better physical health and significantly worse mental health than the overall US adult population, that most students have at least mild health-related academic role impairment, that physical and mental health are both significantly and inversely associated with this impairment, and that these

Table 4
Population Attributable Risk Proportions for best-fitting models simulating the effects of intervening on either SF-12 Physical Component Summary scores or Mental Component Summary scores in reducing academic role impairment.[a].

	Any impairment[b]				More than mild impairment/Any[c]				Severe impairment/More than mild[c]				Severe impairment[b]			
	PARP	(SE)	T	(SE)[d]	PARP	(SE)	T	(SE)[d]	PARP	(SE)	T	(SE)[d]	PARP	(SE)	T	(SE)[d]
I. SF-12 PCS																
If below Q1, shift to Q1	3.9	(0.5)			5.6	(1.2)			4.4	(1.5)			12.2	(2.2)		
If below Q1, shift to Median	5.4	(0.6)			11.5	(1.1)			8.2	(1.5)			21.6	(3.1)		
If below Median, shift to Median	6.1	(0.9)			14.3	(1.7)			10.4	(1.9)			24.6	(3.3)		
II. SF-12 MCS																
If below Q1, shift to Q1	0.7	(0.3)	−3.2	(0.2)***	9.0	(1.1)	3.4	(1.3)*	11.0	(3.1)	6.6	(5.9)	38.7	(3.2)	26.5	(7.5)*
If below Q1, shift to Median	7.9	(0.8)	2.5	(0.5)***	17.5	(1.4)	6.0	(1.6)*	22.1	(2.1)	13.9	(3.3)***	53.5	(4.3)	31.9	(14.1)*
If below Median, shift to Median	12.1	(1.1)	6.0	(1.0)***	21.7	(1.7)	7.4	(2.9)*	27.3	(2.4)	16.9	(4.7)*	61.3	(5.1)	36.7	(18.4)*

*p < .05; **p < .01; ***p < .001.
Abbreviations: MCS, Mental Component Summary; PARP, Population Attributable Risk Proportion; PCS, Physical Component Summary; SE, standard error.
[a] All models adjusted for continuous age, male gender, school, nativity, parent education and race/ethnicity.
[b] Model for PARP includes adjusting variables and SF-12 MCS splines (at the 25th, 50th and 75th percentiles) and SF-12 PCS splines (at the 25th, 50th and 75th percentiles).
[c] Model for PARP includes adjusting variables and SF-12 MCS splines (at the 25th, 50th and 75th percentiles), SF-12 PCS splines (at the 25th, 50th and 75th percentiles), and interaction between SF-12 MCS and PCS.
[d] T-tests compare the impact of congruous shifts in SF-12 MCS vs SF-12 PCS scores.

associations are for the most part a good deal stronger for mental than physical health. The latter result suggests that successful interventions to increase student mental health would lead to considerably greater improvements in academic role performance than would successful interventions to increase student physical health.

The finding that mean PCS scores are higher than in the adult general population is not surprising given the young age of the sample. The finding that mean MCS scores are lower than in the adult general population was also expected given evidence of high Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) disorder prevalence in other recent surveys of college students (Cho et al., 2015; Hunt and Eisenberg, 2010; Kendler et al., 2015). However, we were nonetheless surprised to find that the mean MCS score was more than a full standard deviation below the mean in the adult general population. However, these results are quite different from those in the MEP survey reviewed in the introduction (Cohen et al., 2009; Hanmer and Kaplan, 2016). It is noteworthy that the MEPS reported results by age and sex but not in a way that distinguished college students from other young adults, making it impossible for us to know if the results found in the current study are idiosyncratic to this sample or generalize to all college students in the US. We are exploring these possibilities in a series of surveys in a larger sample of institutions that include non-respondent follow-up assessments.

We were surprised to see that PCS and MCS scores were negatively (albeit modestly) correlated given other data suggesting positive correlations between the two types of problems in the general population (Scott et al., 2007). This might reflect both the fact that physical health problems in this age range are typically not severe enough to influence mental health and that the effects of mental disorders on chronic physical disorders take more time to emerge (Scott et al., 2016), although both of these possibilities imply the existence of specifications that need to be investigated in epidemiological samples with broader age ranges to see if they are confirmed.

Our analysis of nonlinear associations and interactions suggests that identifying and successfully treating students with the worst mental health would have the most impact on academic performance. However, it would presumably be more difficult to treat these students than to treat students with milder emotional problems. Pragmatic trials are needed to investigate this issue. Given that there are 22 million college students in the US and our results suggest that many of them experience mental health problems sufficiently severe to be associated with impaired academic performance, scalable interventions will have to be centrally involved in addressing this enormous problem of unmet need for treatment (Harrer et al., 2019). Existing research suggests that guided online interventions can be as effective as face-to-face psychotherapy in treating mild-moderate common mental disorders (Carlbring et al., 2018), but it is not known if this is equally true among college students. A challenge in answering this question is that college students have a number of psychological barriers to seeking treatment for emotional problems such as embarrassment, cost, and inconvenience of treatment that will have to be overcome before broad-based interventions can be implemented (Ebert et al., 2019a). Interventions delivered through computational software offer a scalable way of addressing some of these concerns because they can be delivered privately via computer or smart phone in the student's home or dorm room at a relatively low cost and at times that are convenient for the student. Interventions offered to everyone emphasizing mind health and optimal performance rather than need for treatment or offered as a course in psychological skills training could potentially avoid the inherent stigma associated with seeking help for psychological problems (Cuijpers et al., 2009). In addition to these possibilities, we are exploring a number of other innovative ways of increasing treatment uptake and retention (Ebert et al., 2019b) and expanding group psychoeducational intervention program to be delivered in a variety of settings and mediums. The next phase of WMH-ICS will involve carrying out a series of pragmatic trials to determine whether these interventions are successful in improving college student mental health (Cuijpers et al., 2019).

The results should be interpreted within the context of several limitations. First, the response rate was low and the sample might be biased in the direction of students with psychological problems having a higher probability of participation than other students. Future college health surveys need to develop methods to improve response rates. Second, the sample consisted only of first year students from five northeastern universities, limiting generalizability of findings. Third, both academic role impairment and health functioning were assessed using self-report questionnaires rather than objective assessments (e.g., physical examinations, administrative reports of grade point average), although both the SF-12 and SDS have been shown to have high concordance with clinician ratings (Salyers et al., 2000; Sheehan et al., 1996). Relatedly, the SF-12 measures are summary scores that provide no insights into the specific physical and mental disorders that should be the focus of clinical attention in order to reduce academic role impairments. Fourth, substance use disorders are not included in these measures even though substance problems are known to be common among college students and to influence academic role performance (Auerbach et al., 2018; Bruffaerts et al., 2018). Future research needs to determine which specific mental disorders account for the strong associations documented here between SF-12 MCS scores and academic functioning as well as to include information about alcohol and drug use disorders. Fifth, all but one of the surveys were carried out in October. This limits the external validity of results because the mental health of first-year college students is known to decrease over the course of the school year (Pritchard et al., 2007; Sax et al., 2004). Future WMH-ICS surveys are being implemented in random replicates across the entire academic year to address this problem.

5. Conclusions

Within the context of these limitations, the results suggest that mental health problems account for a much higher proportion of academic role impairment than physical health problems among university students. As universities begin to grapple with the growing recognition of the important role mental health plays in student success, more attention will need to be placed on broad-based interventions designed to improve the mental health of the student body. Given the magnitude of the problem, scalable solutions are needed. More research is needed to evaluate the effects of innovative scalable mental health interventions and develop methods to triage college students in need of treatment into the least expensive interventions.

Author contributions

Chelsey R. Wilks contributed to the concept and design of the study; interpretation of data; drafting of the manuscript; critical revision of manuscript; provided supervision. Randy P. Auerbach, Jordi Alonso, Corina Benjet, Ronny Bruffaerts, Pim Cuijpers, David D. Ebert, Jennifer G. Green, Claude A. Mellins, and Philippe Mortier contributed to the critical revision of manuscript; provided supervision. Ekaterina Sadikova conducted statistical analyses and contributed to drafting of the manuscript. Nancy A. Sampson and Ronald C. Kessler contributed to acquisition, analysis, or interpretation of data; critical revision of manuscript; provided supervision. Additionally, NAS contributed administrative, technical, or material support. Ronald C. Kessler contributed to concept and design of study; acquisition, analysis, or interpretation of data; critical revision of manuscript; statistical analysis; provided supervision. All authors have approved the final version of this manuscript.

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Declaration of competing interest

Dr. Ebert reports to have received consultancy fees/served on the scientific advisory board for Sanofi, Novartis, Minddistrict, Lantern, Schoen Kliniken, and two German health insurance companies (BARMER, Techniker Krankenkasse). He is also a stakeholder in the Institute for health training online (GET.ON), which aims to implement scientific findings related to digital health interventions into routine care. In the past 3 years, Dr. Kessler received support for his epidemiological studies from Sanofi Aventis; was a consultant for Datastat, Inc., Johnson & Johnson Wellness and Prevention, Sage Pharmaceuticals, Shire, Takeda; and served on an advisory board for the Johnson & Johnson Services Inc. Lake Nona Life Project. The remaining authors have no conflicts to declare.

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Appendix A. Supplementary data

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