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# BMJ Open

## The impact of unit level leadership on physician wellbeing, burnout, professional fulfillment and intent to leave: a multi-center study.

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3 **Title:** The impact of unit level leadership on physician wellbeing, burnout, professional  
4 fulfillment and intent to leave: a multi-center survey study.  
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3 **Author Contributions:** Dr. Mete had full access to all of the study data provided by  
4 PWAC and take responsibility for the integrity and the accuracy of the data analysis.  
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6

7  
8 Concept and design: Marchalik, Mete and Shanafelt.  
9

10  
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12

13  
14 Drafting of the manuscript: Mete, Goldman  
15

16  
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19

20  
21 Statistical analysis: Mete.  
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45 and transparent account of the study being reports; no aspects have been omitted and  
46 all discrepancies have been explained.  
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54 Management Leadership Index and Well-being Index Instruments (Physician Well-being  
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3 Index, Medical Student Well-being Index, Nurse Well-being Index, Well-being Index).

4  
5 Mayo Clinic holds the copyright to these instruments and has licensed them for use

6  
7 outside of Mayo Clinic. Dr Shanafelt receives a portion of any royalties paid to Mayo

8  
9 Clinic. Dr Shanafelt reported receiving honoraria from grand rounds or keynote lecture

10  
11 presentations and advising for health care organizations outside the submitted work.

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13  
14 Other authors report no conflict of interest.

15  
16  
17 **Patient and Public Involvement:** Patients or the public were not involved in the

18  
19 design, conduct or reporting of our research.

**Summary Box:**

- More and more physicians are working in large organization or group practices, increasing the impact of work unit leadership in physician wellness
- Leadership has been identified as a risk factor for burnout and workplace satisfaction in limited previous studies.
- The relationship between leader behavior and physician wellbeing, professional fulfillment and their intent to leave their organizations has not been measured in a multi-center study.
- Physicians who ranked their supervisors in the top tertile of leadership demonstrated 5.8x higher odds of professional fulfillment, 50% less burnout, and 66% lower intention to leave their jobs than those who ranked their supervisors in the lowest tertile.
- Our large multicenter study demonstrates that leadership behavior is strongly associated with physicians' professional fulfillment, burnout and intent to leave their organizations.

**Abstract:**

**Objective:** To examine how perceived leadership behaviors affect burnout, professional fulfillment and intent to leave the organization among physicians.

**Design:** Anonymous cross-sectional survey study from November 2016 to October 2018.

**Setting:** 12,036 attending and resident physicians at eleven healthcare organizations participating in the Physician Wellness Academic Consortium (PWAC) were surveyed to assess burnout and professional fulfillment and their drivers.

**Participants:** A sample of 5416 attending physicians with complete data on gender, specialty, leadership, sleep, burnout and professional fulfillment.

**Main Outcomes and Measures:** The leadership behavior of each physician's supervisor was assessed using the Mayo Clinic Participatory Management Leadership Index and categorized in tertiles. Multivariable logistic regression analyses examined the effect of leadership behavior rating of each physician's supervisor on burnout, professional fulfillment, and intent to leave controlling for sleep impairment, gender, and specialty.

**Results:** The response rate was 45% across 11 institutions. Half of respondents were female. Professional fulfillment increased with increasing tertiles of leadership behavior rating (19%, 34%, 47%  $p < 0.001$ ). The odds of professional fulfillment were 5.8 times higher (95%CI 5.1-6.59) for physicians in the top tertile compared to those in the lowest tertile. Physicians in the top tertile were also 50% less likely to be burned out (95%CI 0.42-0.60) and reported 66% lower intent to leave (95% CI 0.26-0.44). Individuals who rated their supervisor's leadership in upper tertiles relative to lower tertiles exhibited



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3 lower levels of sleep related impairment (24% vs 38% vs 38%  $P<0.001$ ), burnout (18%  
4 vs 35% vs 47%  $p<0.001$ ), and intent to leave (16% vs 24% vs 50%  $p<0.001$ ).  
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7 **Conclusion:** Perceived leadership behaviors have a strong relationship with burnout,  
8 professional fulfillment, and intent to leave among physicians. Organizations should  
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10 consider leadership development as a potential vehicle to improve physician wellness  
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13 and prevent costly physician departures.  
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19 Abstract word count: 290  
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24 Keywords: burnout, leadership, gender, professional fulfillment  
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### 29 **Strengths and Limitations of this Study:**

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31 • First multi-center study to our knowledge of physician well being on professional  
32 fulfillment and intention to leave  
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- 34 • Multi-specialty study of physicians from 11 healthcare organizations  
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- 36 • Validated instruments used to assess burnout professional fulfillment, sleep and  
37 leadership behavior  
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- 39 • Response rate of 45% with possibility for response and recall bias  
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## INTRODUCTION

As the landscape of modern medicine continues to grow and change, physicians are increasingly becoming employed by large organizations.<sup>1</sup> Solo or small practices are becoming less common, and up to two thirds of physicians are now employed by large practice groups and 20% of physicians employed by a practice of greater than 100 physicians.<sup>2</sup> The trend to group medicine exists beyond the boundaries of academic medicine or private practice, including university hospitals, health maintenance organizations, practice groups, and health systems.

Healthcare organizations have increasingly recognized the impact of occupational burnout and physician well-being on their ability to provide high quality healthcare to their communities.<sup>3</sup> The components of burnout include emotional exhaustion (EE), depersonalization, and decreased personal efficacy in the context of the work environment.<sup>4</sup> Concern for physician burnout has gained increasing attention given its implications for patient and provider health. Burnout has previously been associated with worse quality of care,<sup>5-7</sup> physician attrition,<sup>8-10</sup> patient satisfaction,<sup>11-13</sup> cost of care,<sup>3,14-15</sup> and medical errors.<sup>6,16-17</sup> Institutional factors involved in burnout and professional fulfillment act as modifiable factors that can be targeted by organizations.<sup>18-</sup>

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The impact of leadership effectiveness on burnout and workplace satisfaction for physicians is of importance for healthcare organizations.<sup>24-26</sup> A study of 2800 physicians

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3 at the Mayo Clinic demonstrated that average leadership behavior score of physicians  
4 work unit supervisor explained 11% of the variation in burnout and 47% of the variation  
5 in workplace satisfaction across 129 work units when adjusted for other factors.<sup>24</sup> The  
6 leadership behaviors of physicians immediate supervisor have also been found to have  
7 a strong impact on physicians' perception of values alignment with their organization as  
8 a whole.<sup>26</sup> Healthcare leaders face many challenges, balancing costs with ever  
9 changing reimbursements, managing personnel, and addressing dynamic quality  
10 metrics.<sup>27</sup> However, physician training is largely focused on the individual, with an  
11 emphasis on clinical care of patients. Developing leadership skills in physician  
12 supervisors, organizations can make a large impact in the wellbeing of their clinicians  
13 and foster better patient care.<sup>18, 25,28-29</sup> Additionally, by understanding and targeting  
14 leadership, organizations can impact a large number of healthcare professionals and  
15 teams under each leader's supervision. We sought to further evaluate the factors  
16 involved in physician burnout by understanding the relationship between leadership,  
17 burnout, profession fulfillment, and intent to leave.

## 41 METHODS:

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44 The standardized survey administered to participating institutions included the  
45 Professional Fulfillment Index (PFI), the Patient Reported Outcomes Measurement  
46 Information System (PROMIS) Sleep-Related Impairment Scale. Data for this analysis  
47 was collected between November 2016 and October 2018. The dataset was de-  
48 identified by a third-party administrator prior to analysis. The results of the analyses for  
49 this study are based on a sample of 5416 physicians from 11 healthcare organizations

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3 participating in the Physician Wellness Academic Consortium (PWAC-  
4 <https://wellbeingconsortium.org>) who provided complete data on gender, specialty,  
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6 leadership, sleep-related impairment, burnout and professional fulfillment.  
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### 13 Measures

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16 *Leadership Evaluation:* Participants were asked to evaluate their leader using the  
17 organizational leadership subscale based on the revised 9-item Mayo Clinic  
18 Participatory Management Leadership Index (used with permission from Mayo Clinic).<sup>25</sup>  
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20 This instrument was designed to evaluate leadership behaviors associated with team  
21 member engagement, including dimensions related to inclusion (treating everyone with  
22 respect), keeping people informed, soliciting input, empowering team members,  
23 nurturing professional development, and providing feedback and recognition. Each item  
24 is scored on a 5-point scale (0-4) and the scores from the individual items are summed  
25 to compute an aggregate score (with higher scores indicating more favorable ratings).  
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27 The total score was then categorized into tertiles to represent groups of participants'  
28 leadership scores in increasing order.  
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43 *Professional Fulfillment Index:* The PFI was used to measure professional fulfillment  
44 and burnout. The PFI includes 6 items for the assessment of professional fulfillment, 4  
45 items for the assessment of work exhaustion and 6 items to assess interpersonal  
46 disengagement. The burnout score represents the mean of 10 work exhaustion and  
47 interpersonal disengagement items, scored on a Likert scale from 0 (not at all) to 4  
48 (extremely), where 4 indicates the highest burnout score. The professional fulfillment  
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3 scale assesses the degree of intrinsic positive reward the individual derives from their  
4 work, including happiness, meaningfulness, contribution, self-worth, satisfaction, and  
5 feeling in control when dealing with difficult problems at work. Items are measured on a  
6 five-point Likert scale from 0 (not at all true) to 4 (completely true). The mean score  
7 represents the mean of all 6 items and ranges between 0 and 4. Burnout score and  
8 professional fulfillment scores were rescaled to be between 0 and 10 to make  
9 interpretations simpler and consistent with recent reports.<sup>25-26,30</sup> Based on the published  
10 validation studies,<sup>31-32</sup> the established thresholds for burnout and professional fulfillment  
11 on the 0-10 scales are  $\geq 3.25$  and  $\geq 7.5$  respectively.  
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24 *PROMIS Sleep-Related Impairment Scale*: PROMIS short-form Sleep-Related  
25 Impairment (8a) includes 8 items measured on a 5-point Likert scale on perception of  
26 alertness, sleepiness, tiredness and perceived functional impairments during waking  
27 hours associated with sleep problems. The total score ranges between 8 and 40 where  
28 40 indicates highest sleep impairment level. Sleep-related impaired status is considered  
29 to be present when the total score is equal to or higher than 16.<sup>33-34</sup>  
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39 *Intent to Leave*: Participants were asked if they intended to leave their institution within  
40 two years (*What is the likelihood that you will leave your institution within two years?*).  
41 The response choices were none, slight, moderate, likely, and definitely. The responses  
42 were then collapsed to form a binary variable (0=none, 1 otherwise) indicating that the  
43 participants have at least "slight" likelihood of leaving.  
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## 51 **Statistical Analyses**

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Data were summarized for the overall sample (Table 1) and by tertiles of the leadership behavior score using frequencies and percentages for categorical variables (Table 2).

**Table 1. Characteristics of the Respondents**

Total N=5,416	N (%)
Gender	
<i>Female</i>	2710 (50)
Male	2706 (50)
<i>Specialty</i>	
Anesthesiology	407 (7.5)
Dermatology	71 (1.3)
Emergency Medicine	322 (6.0)
Medicine	1671(30.9)
Neurology	195 (3.6)
OB-GYN	248 (4.6)
Pathology	140 (2.6)
Pediatrics	804 (14.9)
Psychiatry	136 (2.5)
Radiation Oncology	77 (1.4)
Radiology	317 (5.9)
Surgery	630 (11.6)
Missing Specialty	398 (7.3)
<i>Occupational Distress and Well-being</i>	
Sleep related impairment	
Mean score (0-10) (SD) <sup>1</sup>	4.4 (1.7)
Sleep-Related Impairment present (yes)	2619 (48)

Professional fulfillment	
Mean score (0-10) (SD) <sup>2</sup>	6.6 (2.1)
Professional Fulfillment Present (yes)	2280 (42)
Burnout	
Mean score (0-10) (SD) <sup>1</sup>	3.0 (1.9)
Burned Out (yes)	2174 (40)
Intent to Leave Current Organization within Two Years	1694 (32)

<sup>1</sup> higher score unfavorable

<sup>2</sup> higher score favorable

**Table 2. Characteristics of the Respondents by the Tertiles of Unit-Level Leadership Ratings**

Total N=5,416	Tertile of Leadership Behavior Score <sup>1</sup>			
	Tertile 1 N (row %)	Tertile 2 N (row %)	Tertile 3 N(row %)	p-value (Chi-square)
Sex				
Female	994 (37)	972 (36)	744 (28)	<0.001
Male	824 (31)	987 (37)	895 (33)	
Specialty				
Anesthesiology	156 (38)	154 (38)	97 (24)	
Dermatology	10 (14)	21 (30)	40 (56)	
Emergency Medicine	66 (21)	144 (45)	112 (35)	

Medicine	625 (37)	593 (36)	453 (27)	<0.001
Neurology	51 (26)	72 (37)	72 (37)	
OB-GYN	98 (40)	83 (34)	67 (27)	
Pathology	32 (23)	51 (36)	57 (41)	
Pediatrics	241 (30)	306 (38)	257 (32)	
Psychiatry	43 (32)	44 (32)	49 (36)	
Radiation Oncology	23 (30)	29 (38)	25 (33)	
Radiology	89 (28)	114 (36)	114 (36)	
Surgery	214 (34)	209 (33)	207 (33)	
Missing Specialty	170 (43)	139 (35)	89 (22)	
Sleep-Related Impairment				
Mean score (0-10) (SD) <sup>2</sup>	4.6 (1.8)	4.4 (1.7)	4.0 (1.5)	<0.001
Sleep-Related Impairment present (yes)	997(38)	990 (38)	632 (24)	<0.001
Professional Fulfillment				
Mean score (0-10) (SD) <sup>3</sup>	5.6 (2.1)	6.7 (1.8)	7.7 (1.8)	<0.001
Professional Fulfillment Present (yes)	438 (19)	779 (34)	1063(47)	<0.001
Burned Out				



Mean score (0-10) (SD) <sup>2</sup>	3.7 (2.0)	3.0 (1.7)	2.2 (1.7)	<0.001
Burned Out (yes)	1010(47)	766 (35)	398 (18)	<0.001
Intent to Leave (yes)	851 (50)	578 (34)	265 (16)	<0.001

<sup>1</sup> higher tertile favorable <sup>2</sup> higher score unfavorable

<sup>3</sup> higher score favorable

The association between leadership behavior score and variables of interests were statistically tested using Chi-square and trend tests presented in Table 2. Linear associations between continuous variables and leadership ratings were examined using correlation coefficients. Internal validity of the organizational leadership scale was assessed using Cronbach's alpha. Multivariable logistic regression analyses were conducted to examine the association between the leadership behavior score of each physician's supervisor and burnout and intent to leave controlling for sleep impairment, gender, professional fulfillment and specialty. The correlation within specialty groups was accounted for using clustering at specialty level (logistic command with cluster option in Stata 15). Estimated odds ratios with 95% confidence intervals and p-values were presented in Table 3. Predictive margins over leadership scale tertiles were computed based on the logistic regression models for male and female physicians and presented in Figures 1 and 2. All statistical analyses were conducted in Stata 15. A p-value of <.05 was considered statistically significant.

### **Table 3. Logistic Regression Models of Professional Fulfillment, Burnout and Intent to Leave**

	Model 1 Professional Fulfillment (yes)  N=5416	Model 2 Burnout Status (yes)  N=5416	Model 3 Intent to Leave (yes)  N=5374
Variables	Odds Ratio (95% CI) (p-val)	Odds Ratio (95% CI) (p- val)	Odds Ratio (95% CI) (p- val)
Female vs Male	0.60 (0.52-0.69) ( $<0.001$ )	1.55 (1.38- 1.74) ( $<0.001$ )	0.70 (0.60- 0.83) ( $<0.001$ )
Leadership Score Tertile 1	Reference	Reference	Reference
Tertile 2	2.07 (1.82-2.36) ( $<0.001$ )	0.51 (0.43- 0.60) ( $<0.001$ )	0.56 (0.48- 0.65) ( $<0.001$ )
Tertile 3	5.40 (4.72-6.19) ( $<0.001$ )	0.29 (0.25- 0.33) ( $<0.001$ )	0.34 (0.26- 0.44) ( $<0.001$ )
Sleep-Related Impairment (yes)	0.36 (0.33-0.38) ( $<0.001$ )	5.68 (4.76- 6.78) ( $<0.001$ )	1.14 (0.93- 1.39) (0.224)
Professional Fulfillment Present (yes)	-----	-----	0.46 (0.40- 0.52) ( $<0.001$ )
Burned out vs Not	-----	-----	2.32 (2.10- 2.56) ( $<0.001$ )
Area under the curve (ROC)	0.75	0.77	0.74

## RESULTS

A total of 12036 attending and resident physicians across 11 institutions were surveyed between November 2016 and October 2018 as part of their membership in the Physician Wellness Academic Consortium. Among these, 5795 attendings completed evaluation of their work unit leader using the 9-item version of the Mayo Clinic Participatory Management Leadership Index. The sample size for the present study was based on the number of attending physicians with complete data on gender, specialty, leadership rating scale, sleep-related impairment, burnout and professional fulfillment. The overall attending physician response rate for the PWAC survey was 45%. The personal and professional characteristics of responders are shown in Table 1. Table 2 presents data on the relationships between specialty distribution, burnout, professional fulfillment, sleep-related impairment, and intent to leave by the tertiles of the scores on the Participatory Management Leadership Index, which showed high internal consistency (Cronbach's  $\alpha=0.95$ ) in this sample.

Female physicians represented 50% (2710/5416) of all participants. The percentage of female physicians who rated their immediate supervisor in the highest tertile of the leaderships scale was significantly lower than male physicians (28% vs 33%  $p<0.001$ ). By specialty, Dermatologists (56%) and Pathologists (41%) had the highest proportion who rated their immediate supervisor in the highest tertile of the leadership behavior. In contrast, Ob-Gyn specialists (40%), Anesthesiologists (38%) and Internal Medicine physicians (31%) were least likely to rate their immediate supervisor in the highest tertile of the leaderships scale.

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3 The leadership behavior rating of each physician's supervisor was negatively  
4 associated with burnout score ( $r=-0.34$ ,  $p<0.001$ ) and positively associated with  
5 professional fulfillment score ( $r=0.44$ ,  $p<0.001$ ). There was a significant positive  
6 association between professional fulfillment and leadership behavior score. Mean  
7 professional fulfillments scores (4.6, 4.4, 4.0,  $p<0.001$ ) and the percentage of those with  
8 professional fulfillment were higher at higher tertiles of leadership behavior scores  
9 (lowest tertile: 19%, middle tertile: 34% and highest tertile: 47%,  $p<0.001$ ). The mean  
10 burnout score (3.7, 3.0, 2.2,  $p<0.001$ ) and percentage of physicians who had a high  
11 burnout score decreased with increasing tertiles of leadership behavior score (47%,  
12 35% and 18%,  $p<0.001$ ). Similarly, the percentage of those who reported an intent to  
13 leave their institution in the next two years decreased with increasing tertiles of  
14 leadership behavior score (50%, 34% and 16%,  $p<0.001$ ). Physicians with sleep related  
15 impairment were less likely to rate their immediate supervisor in the highest tertile of the  
16 leaderships scale (24% vs 38% in lower tertiles,  $p<0.001$ ).

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39 Table 3 presents multivariable logistic regression models of professional fulfillment  
40 (Model 1), burnout status (Model 2) and intent to leave (Model 3) in relation to  
41 leadership behavior rating of physician's supervisor. The strong association between  
42 professional fulfillment and leadership behavior score is demonstrated in Model 1.  
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Physicians who have more favorable evaluations of their leaders were more likely to be  
in the professionally fulfilled category. Specifically, the odds of having high professional  
fulfillment increased by a factor of 2.1 for those who rated their leader in the second  
tertile compared to those in the lowest tertile (OR:2.07, 95% CI: 1.82-2.36) while the

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3 odds increased by a factor of 5.4 for those who are in the top tertile compared to those  
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5 in the lowest tertile (OR:5.40, 95% CI:4.72--6.19, AUC 0.75). This model also  
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7 demonstrates that female physicians were significantly less likely to have high  
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9 professional fulfillment after adjusting for specialty, sleep-related impairment and  
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11 supervisor leadership behavior rating (OR:0.60, 95% CI: 0.52-0.69). Figure 1 illustrates  
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13 the likelihood of having professional fulfillment for leadership behavior tertile of  
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15 physician's supervisor for female and male physicians based on the predicted  
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17 probabilities obtained from Model 1. Non-overlapping confidence intervals at each tertile  
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19 show that the difference between gender groups is maintained across tertiles  
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21 suggesting that the association between of leadership score on professional fulfillment  
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23 is not dependent on gender. This is evidenced by non-significant interaction effects  
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25 between gender and leadership behavior score tertiles in Model 1 when interaction  
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27 terms are included.  
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34 The relationship between organizational leadership and physician burnout is assessed  
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36 in Model 2, which is adjusted by gender, specialty, sleep-related impairment and  
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38 professional fulfillment. Physicians who rated the leader behavior of their supervisor in  
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40 the second tertile were 49% less likely to be burned out compared to those who are in  
41  
42 the first tertile (OR:0.51, 95% CI:0.43-0.60); those who are in the top tertile of leadership  
43  
44 behavior score were 71% less likely to be burned out compared to those who are in the  
45  
46 first tertile (OR:0.29, 95% CI:0.25-0.33). Model 2 also showed that the odds of reporting  
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48 burnout are 55% higher for female physicians (OR:1.55 95% CI: 1.38-1.74), and  
49  
50 approximately 6 times higher for those with sleep-related impairment (OR:5.68, 95%  
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52 CI:3.4.76-6.78, AUC 0.77). The likelihood of burnout derived from Model 2 by the tertiles  
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3 of leadership behavior score of supervisor is illustrated for male and female physicians  
4 in behavior score Figure 2. The gender differences in burnout by increasing tertiles of  
5 leadership behavior score remained similar across tertiles indicated by non-overlapping  
6 confidence intervals at each tertile and non-significant interactions between gender and  
7 leadership behavior score tertiles in Model 2.  
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18 Model 3 estimates the effect of leadership behavior rating of each physician's  
19 supervisor on the likelihood that a physician intent to leave their institution within the  
20 next two years. This model is adjusted by gender, specialty, sleep-related impairment,  
21 burnout and professional fulfillment status as potential confounders of intent to leave.  
22  
23 Physicians who rated the leader behavior of their supervisor in the second tertile were  
24 44% less likely to report an intent to leave compared to those who were in the first tertile  
25 (OR:0.56, 95% CI:0.48-0.65); those who were in the top tertile of supervisor leadership  
26 behavior score are 66% less likely to intend to leave compared to those who were in the  
27 first tertile (OR:0.34, 95% CI:0.26-0.44). Model 3 also shows that the odds of reporting  
28 intent to leave were 30% lower for female physicians (OR:0.70 95% CI: 0.60-0.83) and  
29 54% lower for those with high professional fulfillment (OR:0.46, 95% CI:0.40-0.52). The  
30 area under the ROC curve for this model is 0.74. The likelihood of having intent to leave  
31 for male and female physicians in this model by the tertiles of supervisor leadership  
32 behavior score is shown in Figure 3. Fifty percent (95% CI: 47-53) of male physicians  
33 and 45% (95% CI: 42-48) of female physicians in the lowest tertile of leadership  
34 behavior score reported an intent to leave in two years compared to 17% of male  
35 physicians and 16% of female physicians in the top tertile. The difference between the  
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3 gender groups in the top tertile is significantly narrower compared to that in the lower  
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5 tertile evidenced by a statistically significant interaction term (genderXtertile3, OR=0.70,  
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7 95% CI: 0.52-0.94, p=0.02) when interaction terms are included.  
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## 10 11 12 13 DISCUSSION

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16 This multi-institution study demonstrates a strong relationship between leadership  
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18 evaluations and burnout, professional fulfillment and intent to leave current organization  
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20 among US physicians. These results are consistent with previous single center studies  
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22 which have demonstrated the significant impact of leadership quality on healthcare  
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24 professional burnout and professional fulfillment.<sup>24-26,35</sup> The association between  
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26 leadership and burnout remains strong even when we control for professional fulfillment,  
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28 which has a well-established strong inverse relationship with burnout.<sup>36</sup> Although the  
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30 present study looks at the correlation between individuals' rating of the leadership  
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32 behavior of their supervisor and their own well-being and professional fulfillment,  
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34 previous studies have also found a strong relationship between the composite  
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36 leadership behavior score of a leader (as assessed by all individuals reporting to them)  
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38 and the risk of burnout and professional fulfillment for the members of the team as a  
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40 whole.<sup>24-26</sup> Leader behavior score also had a strong relationship with intent to leave.  
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43 These results are consistent with the notion that physicians who are dissatisfied with  
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45 their supervisor' ability to lead the team are the more likely to consider other  
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48 opportunities. Prior studies demonstrated physicians who report intent to leave are three  
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51 times more likely to actually leave their institution in the next two years.<sup>8,9,37</sup> This is  
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3 especially important as the cost of replacing physicians is significant, and turnover and  
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5 burnout can be associated with lower quality and higher cost care for patients.<sup>3, 48-42</sup>  
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7 Notably, in our study, a lower percentage of female physicians rated the leadership  
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9 behaviors of their supervisor in the top tertile and a higher percentage rated the  
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11 behaviors of their supervisor in the lowest tertile. Previous studies have indicated  
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13 female physicians report greater workplace bullying, harassment, gender  
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15 discrimination, and feelings of isolation.<sup>43-51</sup> While female physicians are no longer a  
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17 minority in the profession as a whole, they are often underrepresented in leadership,  
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19 potentially due to inequality and bias in the opportunity for promotion and reward.<sup>7, 43-46,</sup>  
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24 <sup>52</sup> This also results in fewer female leaders serving as mentors and role models, which  
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26 may be protective against burnout. <sup>44, 47-49, 52</sup>  
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29 Interestingly, in our adjusted analysis controlling for burnout, professional fulfillment,  
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31 and the behavior score of their leader, female physicians reported less intent to leave  
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33 than male physicians (OR 0.7 CI 0.59-0.83 p<0.001). This is in contrast to prior studies  
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35 demonstrating a 8-10% higher attrition rate in female physicians.<sup>37, 45,51</sup> These  
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37 observations are consistent with the possibility that higher attrition rates among women  
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39 physicians may be due to lower satisfaction with their leader and higher rates of  
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41 burnout. Because intention to leave describes a longer-term plan to change jobs, it is  
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43 also possible that female physicians may leave their jobs more suddenly.  
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48 Investing in the leadership development of supervising physicians maybe an important  
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50 strategy to mitigate burnout and promote professional fulfillment in physicians. An  
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52 integrative model of Wellness-Centered Leadership (WCL) incorporating the critical  
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54 skills and leadership behaviors that cultivate engagement and professional fulfillment  
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3 was recently published.<sup>53</sup> When selecting and developing clinician leaders, the  
4 importance of emotional intelligence, social awareness and team communication should  
5 be considered.<sup>27</sup> These are skills that can be developed in physicians in training,  
6 beginning in medical school and continuing through all phases of training, including  
7 communication, mindfulness and reflection.<sup>18, 54-55</sup> Leaders' own well-being impacts  
8 their leadership effectiveness. One recent study demonstrated that 9.8% of the variation  
9 in a leader's leadership behavior scores as assessed by physicians on their team was  
10 related to their own independently assessed degree of burnout.<sup>25</sup> This observation  
11 suggests that burnout among leaders may result in sub-optimal leadership behavior  
12 which in turn increase the risk of burnout in their team members creating a vicious  
13 cycle. This finding suggest that leadership development initiatives should include  
14 attention to the well-being of the leader in addition to cultivation of specific leadership  
15 skills.<sup>53</sup>

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37 Our study has several limitations. First, although relatively high for a physician  
38 survey,<sup>55-58</sup> our response rate was 45% which raises the potential of response bias.<sup>59</sup>  
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40 Second, all physicians surveyed were from healthcare organizations participating in the  
41 PWAC. Although some PWAC institutions are non-academic institutions, most are  
42 academic medical centers, which makes the generalizability of the results to non-  
43 academic settings unclear. Our study also has a number of strengths. It is a large multi-  
44 center study of physicians from 11 healthcare organizations representing all medical  
45 specialties with reasonably high response rate, using validated instruments to assess  
46 burnout, professional fulfillment, sleep, and leadership behavior.

## CONCLUSION

The leadership behaviors of physician supervisors have a strong relationship to their team members' burnout, professional fulfillment, and intent to leave. Female physicians report lower satisfaction with their leaders' leadership behaviors. Greater attention to leader selection, development, and performance evaluation represents a potentially important approach to reducing occupational burnout and promoting professional fulfillment in large healthcare organizations.

**Tables and Figures:**

Table 1. Characteristics of the Respondents

Table 2. Characteristics of the Respondents by the Tertiles of Unit-Level Leadership Ratings

Table 3. Logistic Regression Models of Professional Fulfillment, Burnout and Intent to Leave

Figure 1. Likelihood (% , 95% CI) of Professional Fulfillment Status by the Tertiles of Unit-Level Leadership Behavior Score for Female and Male Physicians

Figure 2. Likelihood (% , 95% CI) of Burnout Status by the Tertiles of Unit-Level Leadership Behavior Score for Female and Male Physicians

Figure 3. Likelihood (% , 95% CI) of Reporting Intent to Leave by the Tertiles of Unit-Level Leadership Behavior Score for Female and Male Physicians

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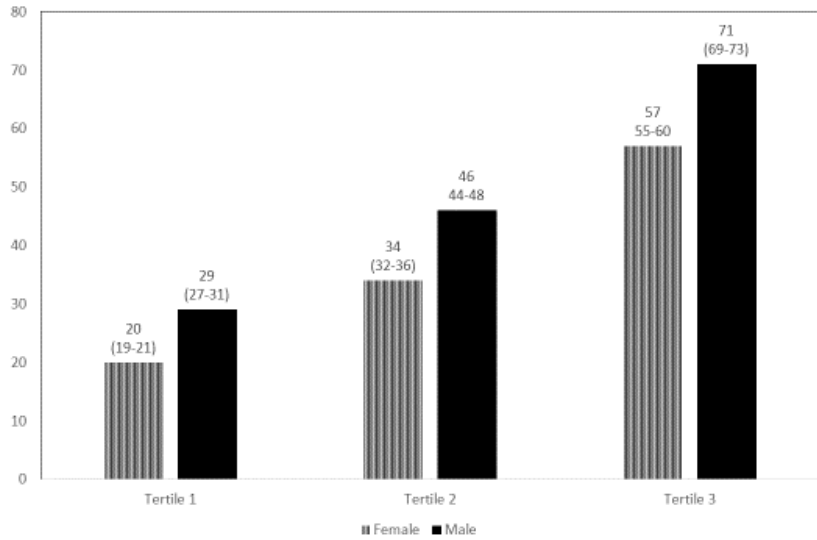
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**Figure 1. Likelihood (% , 95% CI) of Professional Fulfillment Status by the Tertiles of Unit-Level Leadership Behavior Score for Female and Male Physicians**



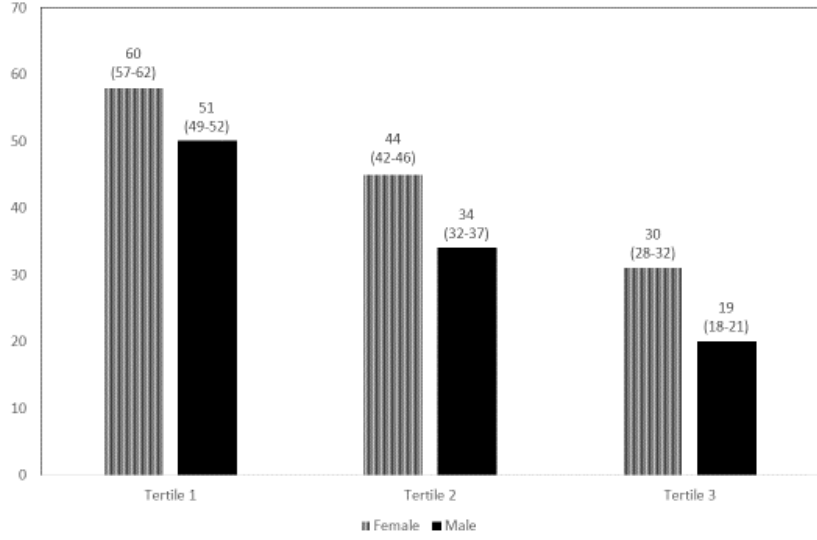
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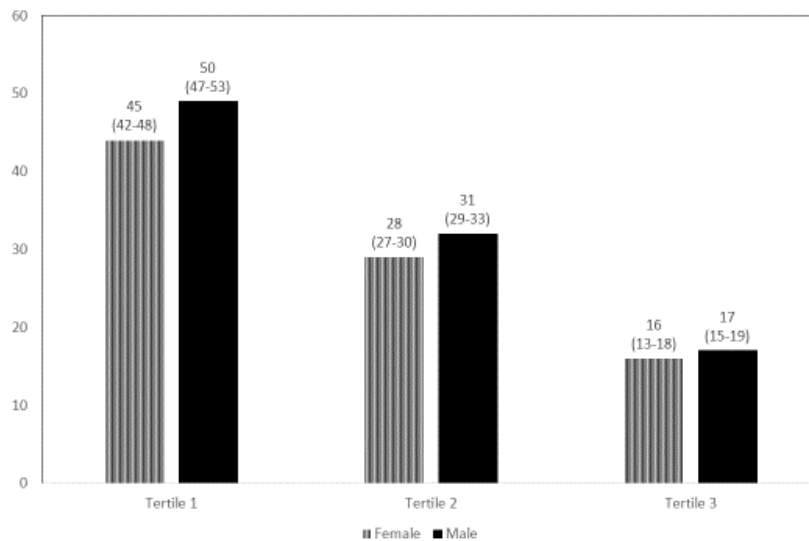
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**Figure 2. Likelihood (% , 95% CI) of Burnout Status by the Tertiles of Unit-Level Leadership Behavior Score for Female and Male Physicians**



Review only

**Figure 3. Likelihood (% , 95% CI) of Reporting Intent to Leave by the Tertiles of Unit-Level Leadership Behavior Score for Female and Male Physicians**



Review only



# BMJ Open

## The impact of leadership behavior on physician wellbeing, burnout, professional fulfillment and intent to leave: a multi-center cross-sectional survey study

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3 **Title:** The impact of leadership behavior on physician wellbeing, burnout, professional  
4 fulfillment and intent to leave: a multi-center cross-sectional survey study  
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54 \*\* Dr. Marchalik and Dr. Shanafelt are shared co-last authors.  
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3 **Author Contributions:** Dr. Mete had full access to all of the study data provided by  
4 PWAC and take responsibility for the integrity and the accuracy of the data analysis.  
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8 Concept and design: Marchalik, Mete and Shanafelt.  
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11 Acquisition, analysis, or interpretation of data: Mete, Marchalik and Shanafelt  
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14 Drafting of the manuscript: Mete, Goldman  
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17 Critical revision of the manuscript for important intellectual content: Shanafelt,  
18 Marchalik, Goldman  
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21 Statistical analysis: Mete.  
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24 Administrative, technical, or material support: Marchalik, Mete  
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45 and transparent account of the study reports; no aspects have been omitted and all  
46 discrepancies have been explained.  
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53 Conflict of Interests: Dr. Shanafelt is coinventor of the Mayo Clinic Participatory  
54 Management Leadership Index and Well-being Index Instruments (Physician Well-being  
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3 Index, Medical Student Well-being Index, Nurse Well-being Index, Well-being Index).

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5 Mayo Clinic holds the copyright to these instruments and has licensed them for use

6  
7 outside of Mayo Clinic. Dr Shanafelt receives a portion of any royalties paid to Mayo

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9 Clinic. Dr Shanafelt reported receiving honoraria from grand rounds or keynote lecture

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11 presentations and advising for health care organizations outside the submitted work.

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14 Other authors report no conflict of interest.  
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**Summary Box:**

- More and more physicians are working in large organization or group practices, increasing the impact of work unit leadership in physician wellness
- Leadership has been identified as a risk factor for burnout and workplace satisfaction in limited previous studies.
- The relationship between leader behavior and physician wellbeing, professional fulfillment and their intent to leave their organizations has not been measured in a multi-center study.
- Physicians who ranked their supervisors in the top tertile of leadership demonstrated 5.8x higher odds of professional fulfillment, 48% less burnout, and 66% lower intent to leave their jobs than those who ranked their supervisors in the lowest tertile.
- Our large multicenter study demonstrates that leadership behavior is strongly associated with physicians' professional fulfillment, burnout and intent to leave their organizations.

**Abstract:**

**Objective:** To examine how perceived leadership behaviors affect burnout, professional fulfillment and intent to leave the organization among physicians.

**Design:** Anonymous cross-sectional survey study from November 2016 to October 2018.

**Setting:** 12,036 attending and resident physicians at eleven healthcare organizations participating in the Physician Wellness Academic Consortium (PWAC) were surveyed to assess burnout and professional fulfillment and their drivers.

**Participants:** A sample of 5416 attending physicians with complete data on gender, specialty, leadership, burnout and professional fulfillment.

**Main Outcomes and Measures:** The leadership behavior of each physician's supervisor was assessed using the Mayo Clinic Participatory Management Leadership Index and categorized in tertiles. Multivariable logistic regression analyses examined the effect of leadership behavior rating of each physician's supervisor on burnout, professional fulfillment, and intent to leave controlling for gender and specialty.

**Results:** The response rate was 45% across 11 institutions. Half of respondents were female. Professional fulfillment increased with increasing tertiles of leadership behavior rating (19%, 34%, 47%  $p < 0.001$ ). The odds of professional fulfillment were 5.8 times higher (OR=5.8, 95%CI 5.1-6.59) for physicians in the top tertile compared to those in the lowest tertile. Physicians in the top tertile were also 48% less likely to be burned out (OR=0.52, 95%CI 0.45-0.61) and reported 66% lower intent to leave (OR=0.34, 95% CI 0.26-0.44). Individuals who rated their supervisor's leadership in upper tertiles relative to

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3 lower tertiles exhibited lower levels of burnout (18% vs 35% vs 47%  $p<0.001$ ), and  
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5 intent to leave (16% vs 24% vs 50%  $p<0.001$ ).  
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8 **Conclusion:** Perceived leadership behaviors have a strong relationship with burnout,  
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10 professional fulfillment, and intent to leave among physicians. Organizations should  
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12 consider leadership development as a potential vehicle to improve physician wellness  
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14 and prevent costly physician departures.  
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19 Abstract word count: 290  
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24 Keywords: burnout, leadership, gender, professional fulfillment  
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### 29 **Strengths and Limitations of this Study:**

- 31 • First multi-center survey that analyzed the effect of supervisor leadership  
32 behaviors on physician wellbeing, professional fulfillment and intent to leave.  
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- 34 • Leadership was evaluated by 5416 physicians representing at least 12  
35 specialties from eleven healthcare organizations.  
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- 37 • Validated instruments were used to assess burnout, professional fulfillment and  
38 leadership behavior.  
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- 40 • Response rate of 45%, although relatively high for a physician survey, may still  
41 contribute to selection bias.  
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- 43 • Respondents are from member institutions of the Physician Wellness Academic  
44 Consortium (PWAC), which may limit generalizability.  
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## INTRODUCTION

As the landscape of modern medicine continues to grow and change, physicians are increasingly becoming employed by large organizations.<sup>1</sup> Solo or small practices are becoming less common, and up to two thirds of physicians are now employed by large practice groups and 20% of physicians employed by a practice of greater than 100 physicians.<sup>2</sup> The trend to group medicine exists beyond the boundaries of academic medicine or private practice, including university hospitals, health maintenance organizations, practice groups, and health systems.

Healthcare organizations have increasingly recognized the impact of occupational burnout and physician well-being on their ability to provide high quality healthcare to their communities.<sup>3</sup> The components of burnout include emotional exhaustion (EE), depersonalization, and decreased personal efficacy in the context of the work environment.<sup>4</sup> Concern for physician burnout has gained increasing attention given its implications for patient and provider health. Burnout has previously been associated with worse quality of care,<sup>5-7</sup> physician attrition,<sup>8-10</sup> patient satisfaction,<sup>11-13</sup> cost of care,<sup>3,14-15</sup> and medical errors.<sup>6,16-17</sup> Institutional factors involved in burnout and professional fulfillment act as modifiable factors that can be targeted by organizations.<sup>18-</sup>

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The impact of leadership effectiveness on burnout and workplace satisfaction for physicians is of importance for healthcare organizations.<sup>24-26</sup> A study of 2800 physicians

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3 at the Mayo Clinic demonstrated that average leadership behavior score of physicians'  
4 work unit supervisor explained 11% of the variation in burnout and 47% of the variation  
5 in workplace satisfaction across 129 work units when adjusted for other factors.<sup>24</sup> The  
6 leadership behaviors of physicians immediate supervisor have also been found to have  
7 a strong impact on physicians' perception of values alignment with their organization as  
8 a whole.<sup>26</sup> Healthcare leaders face many challenges, balancing costs with ever  
9 changing reimbursements, managing personnel, and addressing dynamic quality  
10 metrics.<sup>27</sup> However, physician training is largely focused on the individual, with an  
11 emphasis on clinical care of patients. Developing leadership skills in physician  
12 supervisors, organizations can make a large impact in the wellbeing of their clinicians  
13 and foster better patient care.<sup>18, 25,28-29</sup> Additionally, by understanding and targeting  
14 leadership, organizations can impact a large number of healthcare professionals and  
15 teams under each leader's supervision. We sought to further evaluate the factors  
16 involved in physician burnout by understanding the relationship between leadership,  
17 burnout, profession fulfillment, and intent to leave.

## 41 METHODS:

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44 A cross sectional study of attending physicians in the United States was performed at  
45 eleven healthcare organizations participating in the Physician Wellness Academic  
46 Consortium (PWAC-<https://wellbeingconsortium.org>). A standardized survey was  
47 administered at participating institutions to be distributed to physicians from all available  
48 departments. A total of 12036 attending and resident physicians across 11 institutions  
49 were surveyed between November 2016 and October 2018 as part of their membership

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3 in the Physician Wellness Academic Consortium. Among these, 5795 attendings  
4 completed evaluation of their supervisor using the 9-item version of the Mayo Clinic  
5 Participatory Management Leadership Index. Resident physician data and incomplete  
6 data from attending physicians on gender, specialty, leadership rating scale, burnout or  
7 professional fulfillment were excluded. The dataset was de-identified by a third-party  
8 administrator prior to analysis.  
9

### 19 Patient and Public Involvement

20 Patients or the public were not involved in the design, conduct or reporting of the study.  
21 Given that this was an anonymous deidentified study, the results will be disseminated  
22 by publication of this study without direct contact to participants.  
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### 31 Measures

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34 Supervisor Leadership Behavior Score: Participants were asked to evaluate their leader  
35 using the organizational leadership subscale based on the revised 9-item Mayo Clinic  
36 Participatory Management Leadership Index (included in the Appendix, used with  
37 permission from Mayo Clinic).<sup>25</sup> This instrument was designed to evaluate leadership  
38 behaviors associated with team member engagement, including dimensions related to  
39 inclusion (treating everyone with respect), keeping people informed, soliciting input,  
40 empowering team members, nurturing professional development, and providing  
41 feedback and recognition. Each item is scored on a 5-point scale (0-4) and the scores  
42 from the individual items are summed to compute an aggregate score (with higher  
43 scores indicating more favorable ratings). The total score was then categorized into  
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3 tertiles to represent groups of participants' leadership scores in increasing order  
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5 towards more favorable evaluations.  
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8 *Professional Fulfillment Index*: The PFI was used to measure professional fulfillment  
9 and burnout. The PFI includes 6 items for the assessment of professional fulfillment, 4  
10 items for the assessment of work exhaustion and 6 items to assess interpersonal  
11 disengagement. The burnout score represents the mean of 10 work exhaustion and  
12 interpersonal disengagement items, scored on a Likert scale from 0 (not at all) to 4  
13 (extremely), where 4 indicates the highest burnout score. The professional fulfillment  
14 scale assesses the degree of intrinsic positive reward the individual derives from their  
15 work, including happiness, meaningfulness, contribution, self-worth, satisfaction, and  
16 feeling in control when dealing with difficult problems at work. Items are measured on a  
17 five-point Likert scale from 0 (not at all true) to 4 (completely true). The mean score  
18 represents the mean of all 6 items and ranges between 0 and 4. Burnout score and  
19 professional fulfillment scores were rescaled to be between 0 and 10 to make  
20 interpretations simpler and consistent with recent reports.<sup>25-26,30</sup> Based on the published  
21 validation studies,<sup>31-32</sup> the established thresholds for burnout and professional fulfillment  
22 on the 0-10 scales are  $\geq 3.25$  and  $\geq 7.5$  respectively.  
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43 *Intent to Leave*: Participants were asked if they intended to leave their institution within  
44 two years (*What is the likelihood that you will leave your institution within two years?*).  
45 The response choices were none, slight, moderate, likely, and definitely. The responses  
46 were then collapsed to form a binary variable (0=none, 1 otherwise) indicating that the  
47 participants have at least "slight" likelihood of leaving.  
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## 54 55 56 **Statistical Analyses** 57 58 59 60

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3 Data were summarized for the overall sample (Table 1) and by tertiles of the leadership  
4 behavior score using frequencies and percentages for categorical variables (Table 2).  
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6 The association between leadership behavior score and variables of interests were  
7 statistically tested using Chi-square and trend tests presented in Table 2. Kramer's V  
8 statistic was included in Table 2 to show the degree of associations between categorical  
9 variables. Linear associations between continuous variables and leadership ratings  
10 were examined using correlation coefficients. Internal validity of the organizational  
11 leadership scale was assessed using Cronbach's alpha. Multivariable logistic regression  
12 analyses were conducted to examine the association between the leadership behavior  
13 score of each physician's supervisor and burnout and intent to leave controlling for  
14 gender, professional fulfillment and specialty. The correlation within specialty groups  
15 was accounted for using clustering at specialty level (logistic command with cluster  
16 option in Stata 15). Estimated odds ratios with 95% confidence intervals and p-values  
17 were presented in Table 3. Predictive margins over leadership scale tertiles were  
18 computed based on the logistic regression models for male and female physicians and  
19 presented in Figures 1-3. All statistical analyses were conducted in Stata 15. A p-value  
20 of <.05 was considered statistically significant.  
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## 49 RESULTS

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3 The overall attending physician response rate for the PWAC survey was 45%. Fully  
4 completed surveys from 5416 attending physicians were included in the analysis. The  
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6 personal and professional characteristics of responders are shown in Table 1.  
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10 Table 2 presents data on the relationships between specialty distribution, burnout,  
11 professional fulfillment and intent to leave by the tertiles of the scores on the  
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13 Participatory Management Leadership Index, which showed high internal consistency  
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15 (Cronbach's alpha=0.95) in this sample.  
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20 Female physicians represented 50% (2710/5416) of all participants. The percentage of  
21 female physicians who rated their immediate supervisor in the highest tertile of the  
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23 leaderships scale was significantly lower than male physicians (28% vs 33%  $p<0.001$ ).  
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25 Male physicians rated their leaders more favorably compared to female physicians (2.8  
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27 (1.0) vs 2.6 (1.0),  $p<0.001$ ). By specialty, Dermatologists (56%) and Pathologists (41%)  
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29 had the highest proportion who rated their immediate supervisor in the highest tertile of  
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31 the leadership behavior. In contrast, Ob-Gyn specialists (40%), Anesthesiologists  
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33 (38%) and Internal Medicine physicians (31%) were least likely to rate their immediate  
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35 supervisor in the highest tertile of the leaderships scale.  
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42 The leadership behavior rating of each physician's supervisor was negatively  
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44 associated with burnout score ( $r=-0.34$ ,  $p<0.001$ ) and positively associated with  
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46 professional fulfillment score ( $r=0.44$ ,  $p<0.001$ ). There was a significant positive  
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48 association between professional fulfillment and leadership behavior score. Mean  
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50 professional fulfillments scores (4.6, 4.4, 4.0,  $p<0.001$ ) and the percentage of those with  
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52 professional fulfillment were higher at higher tertiles of leadership behavior scores  
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54 (lowest tertile: 19%, middle tertile: 34% and highest tertile: 47%, Kramer's V:0.33;  
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3 p<0.001). The mean burnout score (3.7, 3.0, 2.2, p<0.001) and percentage of  
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p<0.001). The mean burnout score (3.7, 3.0, 2.2, p<0.001) and percentage of physicians who had a high burnout score decreased with increasing tertiles of leadership behavior score (47%, 35% and 18%, Kramer's V:0.26, p<0.001). Similarly, the percentage of those who reported an intent to leave their institution in the next two years decreased with increasing tertiles of leadership behavior score (50%, 34% and 16%, Kramer's V:0.27, p<0.001).

Table 3 presents multivariable logistic regression models of professional fulfillment (Model 1), burnout status (Model 2) and intent to leave (Model 3) in relation to leadership behavior rating of physician's supervisor. The strong association between professional fulfillment and leadership behavior score is demonstrated in Model 1. Physicians who have more favorable evaluations of their leaders were more likely to be in the professionally fulfilled category. Specifically, the odds of having high professional fulfillment increased by a factor of 2.1 for those who rated their leader in the second tertile compared to those in the lowest tertile (OR:2.10, 95% CI: 1.85-2.37) while the odds increased by a factor of 5.8 for those who are in the top tertile compared to those in the lowest tertile (OR:5.80, 95% CI:5.10-6.59, AUC 0.71). This model also demonstrates that female physicians were significantly less likely to have high professional fulfillment after adjusting for specialty, and supervisor leadership behavior rating (OR:0.58, 95% CI: 0.51-0.66). Figure 1 illustrates the likelihood of having professional fulfillment for each leadership behavior tertile of physician's supervisor for female and male physicians based on the predicted probabilities obtained from Model 1. Non-overlapping confidence intervals at each tertile show that the difference between

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3 gender groups is maintained across tertiles suggesting that the association between of  
4 leadership score on professional fulfillment is not dependent on gender. This is  
5 evidenced by non-significant interaction effects between gender and leadership  
6 behavior score tertiles in Model 1 when interaction terms are included.  
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13 The relationship between organizational leadership and physician burnout is assessed  
14 in Model 2, which is adjusted by gender, specialty and professional fulfillment.  
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17 Physicians who rated the leader behavior of their supervisor in the second tertile were  
18 48% less likely to be burned out compared to those who are in the first tertile (OR:0.52,  
19 95% CI:0.45-0.61); those who are in the top tertile of leadership behavior score were  
20 74% less likely to be burned out compared to those who are in the first tertile (OR:0.26,  
21 95% CI:0.23-0.31). Model 2 also showed that the odds of reporting burnout are 57%  
22 higher for female physicians (OR:1.57 95% CI: 1.41-1.76, AUC 0.77). The likelihood of  
23 burnout derived from Model 2 by the tertiles of leadership behavior score is illustrated  
24 for male and female physicians in Figure 2. The gender differences in burnout by  
25 increasing tertiles of leadership behavior score remained similar across tertiles indicated  
26 by non-overlapping confidence intervals at each tertile and non-significant interactions  
27 between gender and leadership behavior score tertiles in Model 2.  
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47 Model 3 estimates the effect of leadership behavior rating of each physician's  
48 supervisor on the likelihood that a physician intent to leave their institution within the  
49 next two years. This model is adjusted by gender, specialty, burnout and professional  
50 fulfillment status as potential confounders of intent to leave. Physicians who rated the  
51 leader behavior of their supervisor in the second tertile were 44% less likely to report an  
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3 intent to leave compared to those who were in the first tertile (OR:0.56, 95% CI:0.48-  
4 0.65); those who were in the top tertile of supervisor leadership behavior score are 66%  
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6 less likely to intend to leave compared to those who were in the first tertile (OR:0.34,  
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8 95% CI:0.26-0.44). Model 3 also shows that the odds of reporting intent to leave were  
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10 30% lower for female physicians (OR:0.70 95% CI: 0.60-0.83) and 54% lower for those  
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12 with high professional fulfillment (OR:0.46, 95% CI:0.40-0.52). The area under the ROC  
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14 curve for this model is 0.74. The likelihood of having intent to leave for male and female  
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16 physicians in this model by the tertiles of supervisor leadership behavior score is shown  
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18 in Figure 3. Fifty percent (95% CI: 47-53) of male physicians and 45% (95% CI: 42-48)  
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20 of female physicians in the lowest tertile of leadership behavior score reported an intent  
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22 to leave in two years compared to 17% of male physicians and 16% of female  
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24 physicians in the top tertile. The difference between the gender groups in the top tertile  
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26 is significantly narrower compared to that in the lower tertile evidenced by a statistically  
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28 significant interaction term (genderXtertile3, OR=0.70, 95% CI: 0.52-0.94, p=0.02) when  
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30 interaction terms are included.  
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## 41 DISCUSSION

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44 This multi-institution study demonstrates a strong relationship between leadership  
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46 evaluations and burnout, professional fulfillment and intent to leave current organization  
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48 among US physicians. These results are consistent with previous single center studies  
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50 which have demonstrated the significant impact of leadership quality on healthcare  
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52 professional burnout and professional fulfillment.<sup>24-26,33</sup> The association between  
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54 leadership and burnout remains strong even when we control for professional fulfillment,  
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3 which has a well-established strong inverse relationship with burnout.<sup>34</sup> Although the  
4 present study looks at the correlation between individuals' rating of the leadership  
5 behavior of their supervisor and their own well-being and professional fulfillment,  
6 previous studies have also found a strong relationship between the composite  
7 leadership behavior score of a leader (as assessed by all individuals reporting to them)  
8 and the risk of burnout and professional fulfillment for the members of the team as a  
9 whole.<sup>24-26</sup> Leader behavior score also had a strong relationship with intent to leave.  
10 These results are consistent with the notion that physicians who are dissatisfied with  
11 their supervisor' ability to lead the team are the more likely to consider other  
12 opportunities. Prior studies demonstrated physicians who report intent to leave are three  
13 times more likely to leave their institution in the next two years.<sup>8,9,35</sup> This is especially  
14 important as the cost of replacing physicians is significant, and turnover and burnout  
15 can be associated with lower quality and higher cost care for patients.<sup>3, 46-40</sup>  
16 Notably, in our study, a lower percentage of female physicians rated the leadership  
17 behaviors of their supervisor in the top tertile and a higher percentage rated the  
18 behaviors of their supervisor in the lowest tertile. Previous studies have indicated  
19 female physicians report greater workplace bullying, harassment, gender  
20 discrimination, and feelings of isolation.<sup>41-49</sup> While female physicians are no longer a  
21 minority in the profession, they are often underrepresented in leadership, potentially due  
22 to inequality and bias in the opportunity for promotion and reward.<sup>7, 41-44, 50</sup> This also  
23 results in fewer female leaders serving as mentors and role models, which may be  
24 protective against burnout.<sup>42, 45-47, 50</sup>  
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3 Interestingly, in our adjusted analysis controlling for burnout, professional fulfillment,  
4 and the behavior score of their leader, female physicians reported less intent to leave  
5 than male physicians (OR 0.7 CI 0.59-0.83  $p < 0.001$ ). This is in contrast to prior studies  
6 demonstrating a 8-10% higher attrition rate in female physicians.<sup>35, 43,49</sup> These  
7 observations are consistent with the possibility that higher attrition rates among women  
8 physicians may be due to lower satisfaction with their leader and higher rates of  
9 burnout. Because intent to leave describes a longer-term plan to change jobs, it is also  
10 possible that female physicians may leave their jobs more suddenly.

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12 Investing in the leadership development of supervising physicians maybe an important  
13 strategy to mitigate burnout and promote professional fulfillment in physicians. An  
14 integrative model of Wellness-Centered Leadership (WCL) incorporating the critical  
15 skills and leadership behaviors that cultivate engagement and professional fulfillment  
16 was recently published.<sup>51</sup> When selecting and developing clinician leaders, the  
17 importance of emotional intelligence, social awareness and team communication should  
18 be considered.<sup>27</sup> These are skills that can be developed in physicians in training,  
19 beginning in medical school and continuing through all phases of training, including  
20 communication, mindfulness and reflection.<sup>18, 52-53</sup> Leaders' own well-being impacts  
21 their leadership effectiveness. One recent study demonstrated that 9.8% of the variation  
22 in a leader's leadership behavior scores as assessed by physicians on their team was  
23 related to their own independently assessed degree of burnout.<sup>25</sup> This observation  
24 suggests that burnout among leaders may result in sub-optimal leadership behavior  
25 which in turn increase the risk of burnout in their team members creating a vicious  
26 cycle. This finding suggest that leadership development initiatives should include

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3 attention to the well-being of the leader in addition to cultivation of specific leadership  
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5 skills.<sup>51</sup>  
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11 Our study has several limitations. First, although relatively high for a physician  
12 survey,<sup>53-56</sup> our response rate was 45%, which raises the potential for selection bias.<sup>57</sup>  
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14 Second, the cross-sectional and survey-based design of the study allows us only to assess  
15 associations between leadership evaluations and the outcomes. Third, all physicians  
16 surveyed were from healthcare organizations participating in the PWAC. Although  
17 some PWAC institutions are non-academic institutions, most are academic medical  
18 centers, which makes the generalizability of the results to non-academic settings  
19 unclear. Finally, since the age of the respondent along with gender can help reveal the  
20 identity of the physicians in small specialties, it was not made available for the analyses  
21 and remains a limitation of the study. Our study has several strengths. It is a large  
22 multi-center study of physicians from 11 healthcare organizations representing all  
23 medical specialties with reasonably high response rate, using validated instruments to  
24 assess burnout, professional fulfillment, and leadership behavior.  
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## 44 CONCLUSION

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49 The leadership behaviors of physician supervisors have a strong relationship to their  
50 team members' burnout, professional fulfillment, and intent to leave. Female physicians  
51 report lower satisfaction with their leaders' leadership behaviors. Greater attention to  
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3 leader selection, development, and performance evaluation represents a potentially  
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5 important approach to reducing occupational burnout and promoting professional  
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7 fulfillment in large healthcare organizations.  
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3 **Tables and Figures:**  
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6 Table 1. Characteristics of the Respondents  
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Total N=5,416	N (%)
Gender	
<i>Female</i>	2710 (50)
Male	2706 (50)
<i>Specialty</i>	
Anesthesiology	407 (7.5)
Dermatology	71 (1.3)
Emergency Medicine	322 (6.0)
Medicine	1671(30.9)
Neurology	195 (3.6)
OB-GYN	248 (4.6)
Pathology	140 (2.6)
Pediatrics	804 (14.9)
Psychiatry	136 (2.5)
Radiation Oncology	77 (1.4)
Radiology	317 (5.9)
Surgery	630 (11.6)
Missing Specialty	398 (7.3)
Leadership Behavior Mean Score (0-4) (SD)	2.7 (0.7)
<i>Occupational Distress and Well-being</i>	
Professional fulfillment	
Mean score (0-10) (SD) <sup>2</sup>	6.6 (2.1)
Professional Fulfillment Present (yes)	2280 (42)

Burnout	
Mean score (0-10) (SD) <sup>1</sup>	3.0 (1.9)
Burned Out (yes)	2174 (40)
Intent to Leave Current Organization within Two Years	1694 (32)

<sup>1</sup> higher score unfavorable

<sup>2</sup> higher score favorable

Table 2. Characteristics of the Respondents by the Tertiles of Supervisor Leadership Behavior Score (Scores ranked from lowest to highest)

Total N=5,416	Tertiles of Leadership Behavior Score <sup>1</sup>			
	Lowest 1/3 (Low Scores: (0-2.3) N (row %)	Middle 1/3 Medium Scores: (2.4-3.2) N (row %)	Highest 1/3 High Scores: (3.3-4.0) N (row %)	(Kramer's V) Chi-square- p-value
Sex				
Female	994 (37)	972 (36)	744 (28)	(0.07) (<0.001)
Male	824 (31)	987 (37)	895 (33)	
Specialty				
Anesthesiology	156 (38)	154 (38)	97 (24)	(0.11) (<0.001)
Dermatology	10 (14)	21 (30)	40 (56)	
Emergency Medicine	66 (21)	144 (45)	112 (35)	
Medicine	625 (37)	593 (36)	453 (27)	

Neurology	51 (26)	72 (37)	72 (37)	
OB-GYN	98 (40)	83 (34)	67 (27)	
Pathology	32 (23)	51 (36)	57 (41)	
Pediatrics	241 (30)	306 (38)	257 (32)	
Psychiatry	43 (32)	44 (32)	49 (36)	
Radiation Oncology	23 (30)	29 (38)	25 (33)	
Radiology	89 (28)	114 (36)	114 (36)	
Surgery	214 (34)	209 (33)	207 (33)	
Missing Specialty	170 (43)	139 (35)	89 (22)	
Professional Fulfillment				
Mean score (0-10) (SD) <sup>3</sup>	5.6 (2.1)	6.7 (1.8)	7.7 (1.8)	<0.001
Professional Fulfillment Present (yes)	438 (19)	779 (34)	1063(47)	(0.33) (<0.001)
Burned Out				
Mean score (0-10) (SD) <sup>2</sup>	3.7 (2.0)	3.0 (1.7)	2.2 (1.7)	<0.001
Burned Out (yes)	1010(47)	766 (35)	398 (18)	(0.26) (<0.001)
Intent to Leave (yes)	851 (50)	578 (34)	265 (16)	(0.27) (<0.001)

<sup>1</sup> higher tertile favorable <sup>2</sup> higher score unfavorable

<sup>3</sup> higher score favorable



Table 3. Logistic Regression Models of Professional Fulfillment, Burnout and Intent to Leave

	Model 1 Professional Fulfillment (yes)  N=5416	Model 2 Burnout Status (yes)  N=5416	Model 3 Intent to Leave (yes)  N=5374
Variables	Odds Ratio (95% CI) (p-val)	Odds Ratio (95% CI) (p-val)	Odds Ratio (95% CI) (p-val)
Female vs Male	0.58 (0.51-0.66) ( $<0.001$ )	1.57 (1.41- 1.76) ( $<0.001$ )	0.70 (0.60- 0.83) ( $<0.001$ )
<b>Leadership Score</b> Tertile 1 (Lowest 1/3 of All Scores)	Reference	Reference	Reference
Tertile 2 (Middle 1/3 of All Scores)	2.10 (1.85-2.37) ( $<0.001$ )	0.52 (0.45- 0.61) ( $<0.001$ )	0.56 (0.48- 0.65) ( $<0.001$ )
Tertile 3 (Highest 1/3 of All scores)	5.80 (5.10-6.59) ( $<0.001$ )	0.26 (0.23- 0.31) ( $<0.001$ )	0.34 (0.26- 0.44) ( $<0.001$ )
Professional Fulfillment Present (yes)	-----	-----	0.45 (0.40- 0.52) ( $<0.001$ )
Burned out vs Not	-----	-----	2.43 (2.17- 2.71) ( $<0.001$ )
Area under the curve (ROC)	0.71	0.66	0.74

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6 Figure 1. Likelihood (% , 95% CI) of Professional Fulfillment Status by the Tertiles of Supervisor  
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8 Leadership Behavior Score for Female and Male Physicians  
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11 Figure 2. Likelihood (% , 95% CI) of Burnout Status by the Tertiles of Supervisor Leadership  
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13 Behavior Score for Female and Male Physicians  
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15 Figure 3. Likelihood (% , 95% CI) of Reporting Intent to Leave by the Tertiles Supervisor  
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17 Leadership Behavior Score for Female and Male Physicians  
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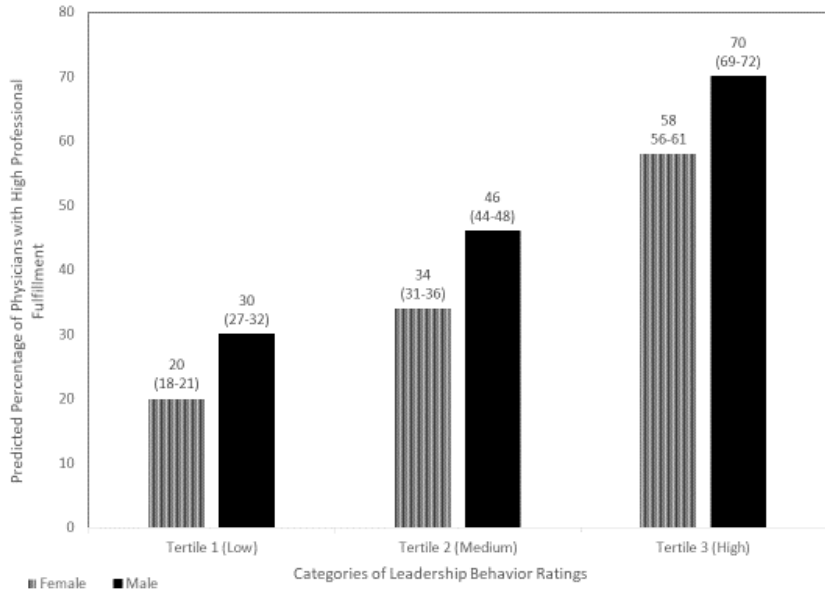
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**Figure 1. Predicted Percentage of Physicians (% , 95% CI) with High Professional Fulfillment by the Tertiles of Supervisor Leadership Behavior Ratings for Female and Male Physicians**

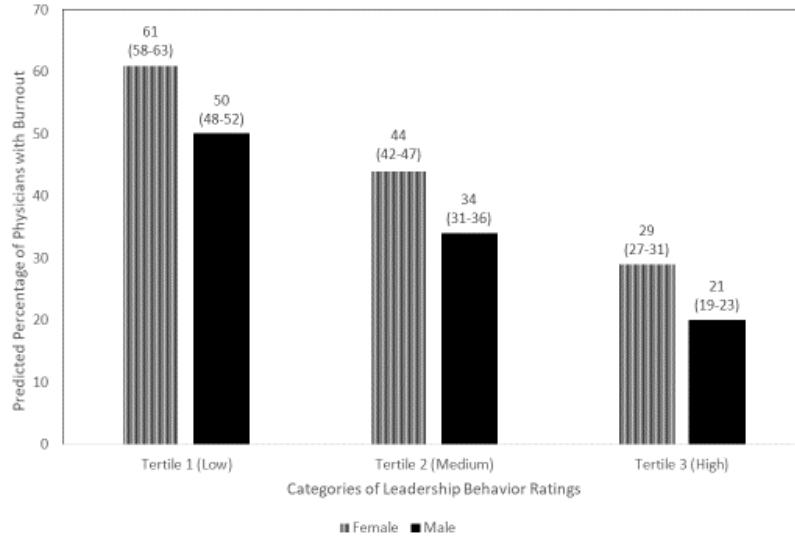


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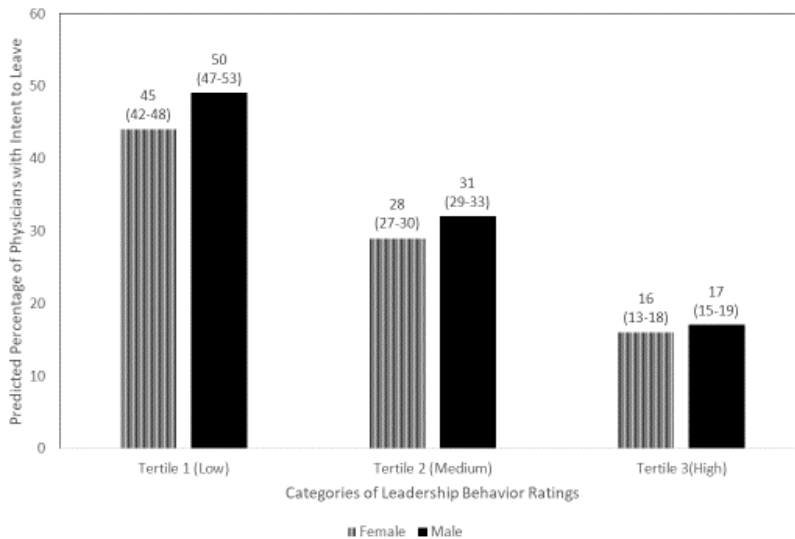
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**Figure 2. Predicted Percentage of Physicians (% , 95% CI) with Burnout by the Tertiles of Supervisor Leadership Behavior Ratings for Female and Male Physicians**



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**Figure 3. Predicted Percentage of Physicians (% , 95% CI) Reporting Intent to Leave by the Tertiles of Supervisor Leadership Behavior Ratings for Female and Male Physicians**



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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
<b>Title and abstract</b>	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	1	
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	5	
<b>Introduction</b>				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	7	
Objectives	3	State specific objectives, including any prespecified hypotheses	8	
<b>Methods</b>				
Study design	4	Present key elements of study design early in the paper	8	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8-9	
Participants	6	(9) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants  (b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case	8-9	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9-10	
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	10	
Bias	9	Describe any efforts to address potential sources of bias	10-11, 16-18	
Study size	10	Explain how the study size was arrived at	8-9, 11	

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2	Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
3			
4	Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding
5			(b) Describe any methods used to examine subgroups and interactions
6			(c) Explain how missing data were addressed
7			(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed
8			<i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed
9			<i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy (Not applicable)
10			(e) Describe any sensitivity analyses (Not applicable)
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15	<b>Results</b>		
16	Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
17			(b) Give reasons for non-participation at each stage
18			(c) Consider use of a flow diagram
19	Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
20			(b) Indicate number of participants with missing data for each variable of interest
21			(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)
22	Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time
23			<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure
24			<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures
25	Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
26			(b) Report category boundaries when continuous variables were categorized
27			(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
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Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	15
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	16
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	18
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17
Generalisability	21	Discuss the generalisability (external validity) of the study results	18
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	2

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).

# BMJ Open

## The impact of leadership behavior on physician wellbeing, burnout, professional fulfillment and intent to leave: a multi-center cross-sectional survey study

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Manuscript ID	bmjopen-2021-057554.R2
Article Type:	Original research
Date Submitted by the Author:	21-Apr-2022
Complete List of Authors:	Mete, Mihriye; MedStar Health Research Institute; Georgetown University Medical Center, Department of Psychiatry Goldman, Charlotte; MedStar Georgetown University Hospital, Shanafelt, Tait ; Stanford University, Medicine Marchalik, Daniel; Georgetown University School of Medicine
<b>Primary Subject Heading</b>:	Health services research
Secondary Subject Heading:	Mental health, Medical education and training, Health services research
Keywords:	Human resource management < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Organisational development < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, Quality in health care < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, HEALTH SERVICES ADMINISTRATION & MANAGEMENT

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3 **Title:** The impact of leadership behavior on physician wellbeing, burnout, professional  
4 fulfillment and intent to leave: a multi-center cross-sectional survey study  
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12 \*Mihriye Mete, PhD<sup>1,2</sup>, Charlotte Goldman, MD<sup>3</sup>, \*\*Tait D. Shanafelt, MD<sup>4</sup>, \*\*Daniel  
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51 Words: 2975/3000  
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54 \*\* Dr. Marchalik and Dr. Shanafelt are shared co-last authors.  
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6 **Abstract:**  
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9 **Objective:** To examine how perceived leadership behaviors affect burnout,  
10 professional fulfillment and intent to leave the organization among physicians.  
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13 **Design:** Anonymous cross-sectional survey study from November 2016 to October  
14 2018.  
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17 **Setting:** 12,036 attending and resident physicians at eleven healthcare organizations  
18 participating in the Physician Wellness Academic Consortium (PWAC) were surveyed to  
19 assess burnout and professional fulfillment and their drivers.  
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22 **Participants:** A sample of 5416 attending physicians with complete data on gender,  
23 specialty, leadership, burnout and professional fulfillment.  
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26 **Main Outcomes and Measures:** The leadership behavior of each physician's  
27 supervisor was assessed using the Mayo Clinic Participatory Management Leadership  
28 Index and categorized in tertiles. Multivariable logistic regression analyses examined  
29 the effect of leadership behavior rating of each physician's supervisor on burnout,  
30 professional fulfillment, and intent to leave controlling for gender and specialty.  
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33 **Results:** The response rate was 45% across 11 institutions. Half of respondents were  
34 female. Professional fulfillment increased with increasing tertiles of leadership behavior  
35 rating (19%, 34%, 47%  $p < 0.001$ ). The odds of professional fulfillment were 5.8 times  
36 higher (OR=5.8, 95%CI 5.1-6.59) for physicians in the top tertile compared to those in  
37 the lowest tertile. Physicians in the top tertile were also 48% less likely to be burned out  
38 (OR=0.52, 95%CI 0.45-0.61) and reported 66% lower intent to leave (OR=0.34, 95% CI  
39 0.26-0.44). Individuals who rated their supervisor's leadership in upper tertiles relative to  
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3 lower tertiles exhibited lower levels of burnout (18% vs 35% vs 47%  $p<0.001$ ), and  
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5 intent to leave (16% vs 24% vs 50%  $p<0.001$ ).  
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8 **Conclusion:** Perceived leadership behaviors have a strong relationship with burnout,  
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10 professional fulfillment, and intent to leave among physicians. Organizations should  
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12 consider leadership development as a potential vehicle to improve physician wellness  
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14 and prevent costly physician departures.  
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19 Abstract word count: 290  
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24 Keywords: burnout, leadership, gender, professional fulfillment  
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### 29 **Strengths and Limitations of this Study:**

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31 • First multi-center survey that analyzed the effect of supervisor leadership  
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33 behaviors on physician wellbeing, professional fulfillment and intent to leave.  
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37 • Leadership was evaluated by 5416 physicians representing at least 12  
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39 specialties from eleven healthcare organizations.  
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42 • Validated instruments were used to assess burnout, professional fulfillment and  
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44 leadership behavior.  
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47 • Response rate of 45%, although relatively high for a physician survey, may still  
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49 contribute to selection bias.  
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- 51  
52 • Respondents are from member institutions of the Physician Wellness Academic  
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54 Consortium (PWAC), which may limit generalizability.  
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## INTRODUCTION

As the landscape of modern medicine continues to grow and change, physicians are increasingly becoming employed by large organizations.<sup>1</sup> Solo or small practices are becoming less common, and up to two thirds of physicians are now employed by large practice groups and 20% of physicians employed by a practice of greater than 100 physicians.<sup>2</sup> The trend to group medicine exists beyond the boundaries of academic medicine or private practice, including university hospitals, health maintenance organizations, practice groups, and health systems.

Healthcare organizations have increasingly recognized the impact of occupational burnout and physician well-being on their ability to provide high quality healthcare to their communities.<sup>3</sup> The components of burnout include emotional exhaustion (EE), depersonalization, and decreased personal efficacy in the context of the work environment.<sup>4</sup> Concern for physician burnout has gained increasing attention given its implications for patient and provider health. Burnout has previously been associated with worse quality of care,<sup>5-7</sup> physician attrition,<sup>8-10</sup> patient satisfaction,<sup>11-13</sup> cost of care,<sup>3,14-15</sup> and medical errors.<sup>6,16-17</sup> Institutional factors involved in burnout and professional fulfillment act as modifiable factors that can be targeted by organizations.<sup>18-</sup>

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The impact of leadership effectiveness on burnout and workplace satisfaction for physicians is of importance for healthcare organizations.<sup>24-26</sup> A study of 2800 physicians

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3 at the Mayo Clinic demonstrated that average leadership behavior score of physicians'  
4 work unit supervisor explained 11% of the variation in burnout and 47% of the variation  
5 in workplace satisfaction across 129 work units when adjusted for other factors.<sup>24</sup> The  
6 leadership behaviors of physicians immediate supervisor have also been found to have  
7 a strong impact on physicians' perception of values alignment with their organization as  
8 a whole.<sup>26</sup> Healthcare leaders face many challenges, balancing costs with ever  
9 changing reimbursements, managing personnel, and addressing dynamic quality  
10 metrics.<sup>27</sup> However, physician training is largely focused on the individual, with an  
11 emphasis on clinical care of patients. Developing leadership skills in physician  
12 supervisors, organizations can make a large impact in the wellbeing of their clinicians  
13 and foster better patient care.<sup>18, 25,28-29</sup> Additionally, by understanding and targeting  
14 leadership, organizations can impact a large number of healthcare professionals and  
15 teams under each leader's supervision. We sought to further evaluate the factors  
16 involved in physician burnout by understanding the relationship between leadership,  
17 burnout, profession fulfillment, and intent to leave.

## 41 METHODS:

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44 A cross sectional study of attending physicians in the United States was performed at  
45 eleven healthcare organizations participating in the Physician Wellness Academic  
46 Consortium (PWAC-<https://wellbeingconsortium.org>). A standardized survey was  
47 administered at participating institutions to be distributed to physicians from all available  
48 departments. A total of 12036 attending and resident physicians across 11 institutions  
49 were surveyed between November 2016 and October 2018 as part of their membership

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3 in the Physician Wellness Academic Consortium. Among these, 5795 attendings  
4 completed evaluation of their supervisor using the 9-item version of the Mayo Clinic  
5 Participatory Management Leadership Index. Resident physician data and incomplete  
6 data from attending physicians on gender, specialty, leadership rating scale, burnout or  
7 professional fulfillment were excluded. The dataset was de-identified by a third-party  
8 administrator prior to analysis.  
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### 16 Patient and Public Involvement

17 Patients or the public were not involved in the design, conduct or reporting of the study.  
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19 Given that this was an anonymous deidentified study, the results will be disseminated  
20 by publication of this study without direct contact to participants.  
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### 31 Measures

32 Supervisor Leadership Behavior Score: Participants were asked to evaluate their leader  
33 using the organizational leadership subscale based on the revised 9-item Mayo Clinic  
34 Participatory Management Leadership Index (included in the Appendix, used with  
35 permission from Mayo Clinic).<sup>25</sup> This instrument was designed to evaluate leadership  
36 behaviors associated with team member engagement, including dimensions related to  
37 inclusion (treating everyone with respect), keeping people informed, soliciting input,  
38 empowering team members, nurturing professional development, and providing  
39 feedback and recognition. Each item is scored on a 5-point scale (0-4) and the scores  
40 from the individual items are summed to compute an aggregate score (with higher  
41 scores indicating more favorable ratings). The total score was then categorized into  
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3 tertiles to represent groups of participants' leadership scores in increasing order  
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5 towards more favorable evaluations.  
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8 *Professional Fulfillment Index*: The PFI was used to measure professional fulfillment  
9 and burnout. The PFI includes 6 items for the assessment of professional fulfillment, 4  
10 items for the assessment of work exhaustion and 6 items to assess interpersonal  
11 disengagement. The burnout score represents the mean of 10 work exhaustion and  
12 interpersonal disengagement items, scored on a Likert scale from 0 (not at all) to 4  
13 (extremely), where 4 indicates the highest burnout score. The professional fulfillment  
14 scale assesses the degree of intrinsic positive reward the individual derives from their  
15 work, including happiness, meaningfulness, contribution, self-worth, satisfaction, and  
16 feeling in control when dealing with difficult problems at work. Items are measured on a  
17 five-point Likert scale from 0 (not at all true) to 4 (completely true). The mean score  
18 represents the mean of all 6 items and ranges between 0 and 4. Burnout score and  
19 professional fulfillment scores were rescaled to be between 0 and 10 to make  
20 interpretations simpler and consistent with recent reports.<sup>25-26,30</sup> Based on the published  
21 validation studies,<sup>31-32</sup> the established thresholds for burnout and professional fulfillment  
22 on the 0-10 scales are  $\geq 3.25$  and  $\geq 7.5$  respectively.  
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43 *Intent to Leave*: Participants were asked if they intended to leave their institution within  
44 two years (*What is the likelihood that you will leave your institution within two years?*).  
45 The response choices were none, slight, moderate, likely, and definitely. The responses  
46 were then collapsed to form a binary variable (0=none, 1 otherwise) indicating that the  
47 participants have at least "slight" likelihood of leaving.  
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## 55 **Statistical Analyses**

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3 Data were summarized for the overall sample (Table 1) and by tertiles of the leadership  
4 behavior score using frequencies and percentages for categorical variables (Table 2).  
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6 The association between leadership behavior score and variables of interests were  
7 statistically tested using Chi-square and trend tests presented in Table 2. Kramer's V  
8 statistic was included in Table 2 to show the degree of associations between categorical  
9 variables. Linear associations between continuous variables and leadership ratings  
10 were examined using correlation coefficients. Internal validity of the organizational  
11 leadership scale was assessed using Cronbach's alpha. Multivariable logistic regression  
12 analyses were conducted to examine the association between the leadership behavior  
13 score of each physician's supervisor and burnout and intent to leave controlling for  
14 gender, professional fulfillment and specialty. The correlation within specialty groups  
15 was accounted for using clustering at specialty level (logistic command with cluster  
16 option in Stata 15). Estimated odds ratios with 95% confidence intervals and p-values  
17 were presented in Table 3. Predictive margins over leadership scale tertiles were  
18 computed based on the logistic regression models for male and female physicians and  
19 presented in Figures 1-3. All statistical analyses were conducted in Stata 15. A p-value  
20 of <.05 was considered statistically significant.  
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## 47 RESULTS

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49 The overall attending physician response rate for the PWAC survey was 45%. Fully  
50 completed surveys from 5416 attending physicians were included in the analysis. The  
51 personal and professional characteristics of responders are shown in Table 1.  
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3 Table 2 presents data on the relationships between specialty distribution, burnout,  
4 professional fulfillment and intent to leave by the tertiles of the scores on the  
5 Participatory Management Leadership Index, which showed high internal consistency  
6 (Cronbach's alpha=0.95) in this sample.  
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13 Female physicians represented 50% (2710/5416) of all participants. The percentage of  
14 female physicians who rated their immediate supervisor in the highest tertile of the  
15 leaderships scale was significantly lower than male physicians (28% vs 33%  $p<0.001$ ).  
16  
17 Male physicians rated their leaders more favorably compared to female physicians (2.8  
18 (1.0) vs 2.6 (1.0),  $p<0.001$ ). By specialty, Dermatologists (56%) and Pathologists (41%)  
19 had the highest proportion who rated their immediate supervisor in the highest tertile of  
20 the leadership behavior. In contrast, Ob-Gyn specialists (40%), Anesthesiologists  
21 (38%) and Internal Medicine physicians (31%) were least likely to rate their immediate  
22 supervisor in the highest tertile of the leaderships scale.  
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34 The leadership behavior rating of each physician's supervisor was negatively  
35 associated with burnout score ( $r=-0.34$ ,  $p<0.001$ ) and positively associated with  
36 professional fulfillment score ( $r=0.44$ ,  $p<0.001$ ). There was a significant positive  
37 association between professional fulfillment and leadership behavior score. Mean  
38 professional fulfillments scores (4.6, 4.4, 4.0,  $p<0.001$ ) and the percentage of those with  
39 professional fulfillment were higher at higher tertiles of leadership behavior scores  
40 (lowest tertile: 19%, middle tertile: 34% and highest tertile: 47%, Kramer's V:0.33;  
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61 The mean burnout score (3.7, 3.0, 2.2,  $p<0.001$ ) and percentage of  
62 physicians who had a high burnout score decreased with increasing tertiles of  
63 leadership behavior score (47%, 35% and 18%, Kramer's V:0.26,  $p<0.001$ ). Similarly,

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3 the percentage of those who reported an intent to leave their institution in the next two  
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5 years decreased with increasing tertiles of leadership behavior score (50%, 34% and  
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7 16%, Kramer's V:0.27,  $p<0.001$ ).  
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13 Table 3 presents multivariable logistic regression models of professional fulfillment  
14 (Model 1), burnout status (Model 2) and intent to leave (Model 3) in relation to  
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16 leadership behavior rating of physician's supervisor. The strong association between  
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18 professional fulfillment and leadership behavior score is demonstrated in Model 1.  
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21 Physicians who have more favorable evaluations of their leaders were more likely to be  
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23 in the professionally fulfilled category. Specifically, the odds of having high professional  
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25 fulfillment increased by a factor of 2.1 for those who rated their leader in the second  
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27 tertile compared to those in the lowest tertile (OR:2.10, 95% CI: 1.85-2.37) while the  
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29 odds increased by a factor of 5.8 for those who are in the top tertile compared to those  
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31 in the lowest tertile (OR:5.80, 95% CI:5.10-6.59, AUC 0.71). This model also  
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33 demonstrates that female physicians were significantly less likely to have high  
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35 professional fulfillment after adjusting for specialty, and supervisor leadership behavior  
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37 rating (OR:0.58, 95% CI: 0.51-0.66). Figure 1 illustrates the likelihood of having  
38  
39 professional fulfillment for each leadership behavior tertile of physician's supervisor for  
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41 female and male physicians based on the predicted probabilities obtained from Model 1.  
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44 Non-overlapping confidence intervals at each tertile show that the difference between  
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46 gender groups is maintained across tertiles suggesting that the association between of  
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48 leadership score on professional fulfillment is not dependent on gender. This is  
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3 evidenced by non-significant interaction effects between gender and leadership  
4 behavior score tertiles in Model 1 when interaction terms are included.  
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8 The relationship between organizational leadership and physician burnout is assessed  
9 in Model 2, which is adjusted by gender, specialty and professional fulfillment.  
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12 Physicians who rated the leader behavior of their supervisor in the second tertile were  
13 48% less likely to be burned out compared to those who are in the first tertile (OR:0.52,  
14 95% CI:0.45-0.61); those who are in the top tertile of leadership behavior score were  
15 74% less likely to be burned out compared to those who are in the first tertile (OR:0.26,  
16 95% CI:0.23-0.31). Model 2 also showed that the odds of reporting burnout are 57%  
17 higher for female physicians (OR:1.57 95% CI: 1.41-1.76, AUC 0.77). The likelihood of  
18 burnout derived from Model 2 by the tertiles of leadership behavior score is illustrated  
19 for male and female physicians in Figure 2. The gender differences in burnout by  
20 increasing tertiles of leadership behavior score remained similar across tertiles indicated  
21 by non-overlapping confidence intervals at each tertile and non-significant interactions  
22 between gender and leadership behavior score tertiles in Model 2.  
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42 Model 3 estimates the effect of leadership behavior rating of each physician's  
43 supervisor on the likelihood that a physician intent to leave their institution within the  
44 next two years. This model is adjusted by gender, specialty, burnout and professional  
45 fulfillment status as potential confounders of intent to leave. Physicians who rated the  
46 leader behavior of their supervisor in the second tertile were 44% less likely to report an  
47 intent to leave compared to those who were in the first tertile (OR:0.56, 95% CI:0.48-  
48 0.65); those who were in the top tertile of supervisor leadership behavior score are 66%  
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3 less likely to intend to leave compared to those who were in the first tertile (OR:0.34,  
4 95% CI:0.26-0.44). Model 3 also shows that the odds of reporting intent to leave were  
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6 30% lower for female physicians (OR:0.70 95% CI: 0.60-0.83) and 54% lower for those  
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8 with high professional fulfillment (OR:0.46, 95% CI:0.40-0.52). The area under the ROC  
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10 curve for this model is 0.74. The likelihood of having intent to leave for male and female  
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12 physicians in this model by the tertiles of supervisor leadership behavior score is shown  
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14 in Figure 3. Fifty percent (95% CI: 47-53) of male physicians and 45% (95% CI: 42-48)  
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16 of female physicians in the lowest tertile of leadership behavior score reported an intent  
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18 to leave in two years compared to 17% of male physicians and 16% of female  
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20 physicians in the top tertile. The difference between the gender groups in the top tertile  
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22 is significantly narrower compared to that in the lower tertile evidenced by a statistically  
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24 significant interaction term (genderXtertile3, OR=0.70, 95% CI: 0.52-0.94, p=0.02) when  
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26 interaction terms are included.  
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## 37 DISCUSSION

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39 This multi-institution study demonstrates a strong relationship between leadership  
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41 evaluations and burnout, professional fulfillment and intent to leave current organization  
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43 among US physicians. These results are consistent with previous single center studies  
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45 which have demonstrated the significant impact of leadership quality on healthcare  
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47 professional burnout and professional fulfillment.<sup>24-26,33</sup> The association between  
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49 leadership and burnout remains strong even when we control for professional fulfillment,  
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51 which has a well-established strong inverse relationship with burnout.<sup>34</sup> Although the  
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53 present study looks at the correlation between individuals' rating of the leadership  
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3 behavior of their supervisor and their own well-being and professional fulfillment,  
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5 previous studies have also found a strong relationship between the composite  
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7 leadership behavior score of a leader (as assessed by all individuals reporting to them)  
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9 and the risk of burnout and professional fulfillment for the members of the team as a  
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11 whole.<sup>24-26</sup> Leader behavior score also had a strong relationship with intent to leave.  
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14 These results are consistent with the notion that physicians who are dissatisfied with  
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16 their supervisor' ability to lead the team are the more likely to consider other  
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18 opportunities. Prior studies demonstrated physicians who report intent to leave are three  
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20 times more likely to leave their institution in the next two years.<sup>8,9,35</sup> This is especially  
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22 important as the cost of replacing physicians is significant, and turnover and burnout  
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24 can be associated with lower quality and higher cost care for patients.<sup>3,36-40</sup>  
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27 Notably, in our study, a lower percentage of female physicians rated the leadership  
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29 behaviors of their supervisor in the top tertile and a higher percentage rated the  
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31 behaviors of their supervisor in the lowest tertile. Previous studies have indicated  
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33 female physicians report greater workplace bullying, harassment, gender  
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35 discrimination, and feelings of isolation.<sup>41-49</sup> While female physicians are no longer a  
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37 minority in the profession, they are often underrepresented in leadership, potentially due  
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39 to inequality and bias in the opportunity for promotion and reward.<sup>7, 41-44, 50</sup> This also  
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41 results in fewer female leaders serving as mentors and role models, which may be  
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43 protective against burnout.<sup>42, 45-47, 50</sup>  
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50 Interestingly, in our adjusted analysis controlling for burnout, professional fulfillment,  
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52 and the behavior score of their leader, female physicians reported less intent to leave  
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54 than male physicians (OR 0.7 CI 0.59-0.83 p<0.001). This is in contrast to prior studies  
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3 demonstrating a 8-10% higher attrition rate in female physicians.<sup>35, 43,49</sup> These  
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5 observations are consistent with the possibility that higher attrition rates among women  
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7 physicians may be due to lower satisfaction with their leader and higher rates of  
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9 burnout. Because intent to leave describes a longer-term plan to change jobs, it is also  
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11 possible that female physicians may leave their jobs more suddenly.  
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15 Investing in the leadership development of supervising physicians maybe an important  
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17 strategy to mitigate burnout and promote professional fulfillment in physicians. An  
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19 integrative model of Wellness-Centered Leadership (WCL) incorporating the critical  
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21 skills and leadership behaviors that cultivate engagement and professional fulfillment  
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23 was recently published.<sup>51</sup> When selecting and developing clinician leaders, the  
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25 importance of emotional intelligence, social awareness and team communication should  
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27 be considered.<sup>27</sup> These are skills that can be developed in physicians in training,  
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29 beginning in medical school and continuing through all phases of training, including  
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31 communication, mindfulness and reflection.<sup>18, 52-53</sup> Leaders' own well-being impacts  
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33 their leadership effectiveness. One recent study demonstrated that 9.8% of the variation  
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35 in a leader's leadership behavior scores as assessed by physicians on their team was  
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37 related to their own independently assessed degree of burnout.<sup>25</sup> This observation  
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39 suggests that burnout among leaders may result in sub-optimal leadership behavior  
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41 which in turn increase the risk of burnout in their team members creating a vicious  
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43 cycle. This finding suggest that leadership development initiatives should include  
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45 attention to the well-being of the leader in addition to cultivation of specific leadership  
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47 skills.<sup>51</sup>  
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3 Our study has several limitations. First, although relatively high for a physician  
4 survey,<sup>53-56</sup> our response rate was 45%, which raises the potential for selection bias.<sup>57</sup>  
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6 Second, the cross-sectional and survey-based design of the study allows us only to assess  
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8 associations between leadership evaluations and the outcomes. Third, all physicians  
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10 surveyed were from healthcare organizations participating in the PWAC. Although  
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12 some PWAC institutions are non-academic institutions, most are academic medical  
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14 centers, which makes the generalizability of the results to non-academic settings  
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16 unclear. Finally, since the age of the respondent along with gender can help reveal the  
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18 identity of the physicians in small specialties, it was not made available for the analyses  
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20 and remains a limitation of the study. Our study has several strengths. It is a large  
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22 multi-center study of physicians from 11 healthcare organizations representing all  
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24 medical specialties with reasonably high response rate, using validated instruments to  
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26 assess burnout, professional fulfillment, and leadership behavior.  
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## 36 CONCLUSION

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41 The leadership behaviors of physician supervisors have a strong relationship to their  
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43 team members' burnout, professional fulfillment, and intent to leave. Female physicians  
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45 report lower satisfaction with their leaders' leadership behaviors. Greater attention to  
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47 leader selection, development, and performance evaluation represents a potentially  
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49 important approach to reducing occupational burnout and promoting professional  
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51 fulfillment in large healthcare organizations.  
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3 **Tables and Figures:**  
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6 Table 1. Characteristics of the Respondents  
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Total N=5,416	N (%)
Gender	
<i>Female</i>	2710 (50)
Male	2706 (50)
<i>Specialty</i>	
Anesthesiology	407 (7.5)
Dermatology	71 (1.3)
Emergency Medicine	322 (6.0)
Medicine	1671(30.9)
Neurology	195 (3.6)
OB-GYN	248 (4.6)
Pathology	140 (2.6)
Pediatrics	804 (14.9)
Psychiatry	136 (2.5)
Radiation Oncology	77 (1.4)
Radiology	317 (5.9)
Surgery	630 (11.6)
Missing Specialty	398 (7.3)
Leadership Behavior Mean Score (0-4) (SD)	2.7 (0.7)
<i>Occupational Distress and Well-being</i>	
Professional fulfillment	
Mean score (0-10) (SD) <sup>2</sup>	6.6 (2.1)
Professional Fulfillment Present (yes)	2280 (42)

Burnout	
Mean score (0-10) (SD) <sup>1</sup>	3.0 (1.9)
Burned Out (yes)	2174 (40)
Intent to Leave Current Organization within Two Years	1694 (32)

<sup>1</sup> higher score unfavorable

<sup>2</sup> higher score favorable

For peer review only

Table 2. Characteristics of the Respondents by the Tertiles of Supervisor Leadership Behavior Score (Scores ranked from lowest to highest)

Total N=5,416	Tertiles of Leadership Behavior Score <sup>1</sup>			
	Lowest 1/3  (Low Scores: (0-2.3) N (row %)	Middle 1/3 Medium Scores: (2.4-3.2) N (row %)	Highest 1/3 High Scores: (3.3-4.0) N (row %)	(Kramer's V) Chi-square- p-value
Sex				
Female	994 (37)	972 (36)	744 (28)	(0.07) (<0.001)
Male	824 (31)	987 (37)	895 (33)	
Specialty				
Anesthesiology	156 (38)	154 (38)	97 (24)	(0.11) (<0.001)
Dermatology	10 (14)	21 (30)	40 (56)	
Emergency Medicine	66 (21)	144 (45)	112 (35)	
Medicine	625 (37)	593 (36)	453 (27)	
Neurology	51 (26)	72 (37)	72 (37)	
OB-GYN	98 (40)	83 (34)	67 (27)	
Pathology	32 (23)	51 (36)	57 (41)	
Pediatrics	241 (30)	306 (38)	257 (32)	
Psychiatry	43 (32)	44 (32)	49 (36)	

Radiation Oncology	23 (30)	29 (38)	25 (33)	
Radiology	89 (28)	114 (36)	114 (36)	
Surgery	214 (34)	209 (33)	207 (33)	
Missing Specialty	170 (43)	139 (35)	89 (22)	
Professional Fulfillment				
Mean score (0-10) (SD) <sup>3</sup>	5.6 (2.1)	6.7 (1.8)	7.7 (1.8)	<0.001
Professional Fulfillment Present (yes)	438 (19)	779 (34)	1063(47)	(0.33) (<0.001)
Burned Out				
Mean score (0-10) (SD) <sup>2</sup>	3.7 (2.0)	3.0 (1.7)	2.2 (1.7)	<0.001
Burned Out (yes)	1010(47)	766 (35)	398 (18)	(0.26) (<0.001)
Intent to Leave (yes)	851 (50)	578 (34)	265 (16)	(0.27) (<0.001)

<sup>1</sup> higher tertile favorable <sup>2</sup> higher score unfavorable

<sup>3</sup> higher score favorable



Table 3. Logistic Regression Models of Professional Fulfillment, Burnout and Intent to Leave

	Model 1 Professional Fulfillment (yes)  N=5416	Model 2 Burnout Status (yes)  N=5416	Model 3 Intent to Leave (yes)  N=5374
Variables	Odds Ratio (95% CI) (p-val)	Odds Ratio (95% CI) (p-val)	Odds Ratio (95% CI) (p-val)
Female vs Male	0.58 (0.51-0.66) ( $<0.001$ )	1.57 (1.41- 1.76) ( $<0.001$ )	0.70 (0.60- 0.83) ( $<0.001$ )
<b>Leadership Score</b> Tertile 1 (Lowest 1/3 of All Scores)	Reference	Reference	Reference
Tertile 2 (Middle 1/3 of All Scores)	2.10 (1.85-2.37) ( $<0.001$ )	0.52 (0.45- 0.61) ( $<0.001$ )	0.56 (0.48- 0.65) ( $<0.001$ )
Tertile 3 (Highest 1/3 of All scores)	5.80 (5.10-6.59) ( $<0.001$ )	0.26 (0.23- 0.31) ( $<0.001$ )	0.34 (0.26- 0.44) ( $<0.001$ )
Professional Fulfillment Present (yes)	-----	-----	0.45 (0.40- 0.52) ( $<0.001$ )
Burned out vs Not	-----	-----	2.43 (2.17- 2.71) ( $<0.001$ )
Area under the curve (ROC)	0.71	0.66	0.74

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3 Figure 1. Likelihood (% , 95% CI) of Professional Fulfillment Status by the Tertiles of Supervisor  
4 Leadership Behavior Score for Female and Male Physicians  
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8 Figure 2. Likelihood (% , 95% CI) of Burnout Status by the Tertiles of Supervisor Leadership  
9 Behavior Score for Female and Male Physicians  
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12 Figure 3. Likelihood (% , 95% CI) of Reporting Intent to Leave by the Tertiles Supervisor  
13 Leadership Behavior Score for Female and Male Physicians  
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22 Author Contributions: Dr. Mete had full access to all of the study data provided by  
23 PWAC and take responsibility for the integrity and the accuracy of the data analysis.  
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25

26  
27 Concept and design: Marchalik, Mete and Shanafelt.  
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29  
30 Acquisition, analysis, or interpretation of data: Mete, Marchalik and Shanafelt  
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33 Drafting of the manuscript: Mete, Goldman  
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35  
36 Critical revision of the manuscript for important intellectual content: Shanafelt,  
37 Marchalik, Goldman  
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40 Statistical analysis: Mete.  
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43 Administrative, technical, or material support: Marchalik, Mete  
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7 Ethical Approval: MedStar Health Research Institute Institutional Review Board  
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9 approved the study (MHRI-IRB 2028:149)  
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12 Transparency statement: Mihriye Mete affirms this manuscript is an honest, accurate  
13  
14 and transparent account of the study reports; no aspects have been omitted and all  
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16 discrepancies have been explained.  
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21  
22 Conflict of Interests: Dr. Shanafelt is coinventor of the Mayo Clinic Participatory  
23  
24 Management Leadership Index and Well-being Index Instruments (Physician Well-being  
25  
26 Index, Medical Student Well-being Index, Nurse Well-being Index, Well-being Index).  
27

28  
29 Mayo Clinic holds the copyright to these instruments and has licensed them for use  
30  
31 outside of Mayo Clinic. Dr Shanafelt receives a portion of any royalties paid to Mayo  
32  
33 Clinic. Dr Shanafelt reported receiving honoraria from grand rounds or keynote lecture  
34  
35 presentations and advising for health care organizations outside the submitted work.  
36

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38 Other authors report no conflict of interest.  
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41 Data availability: No additional data related to the analyses of this study are available.  
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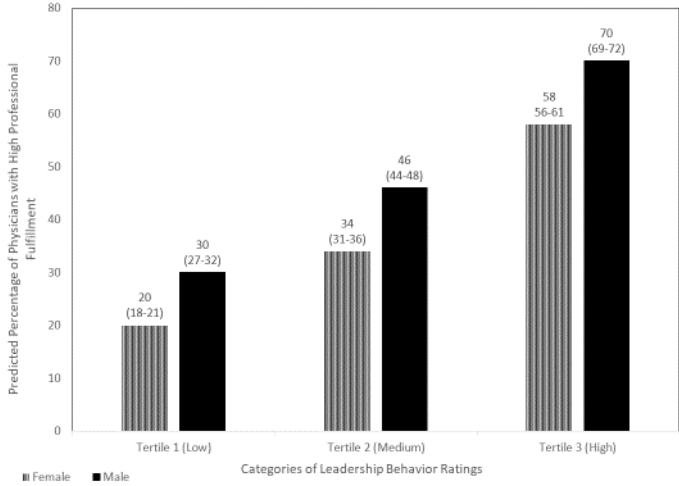
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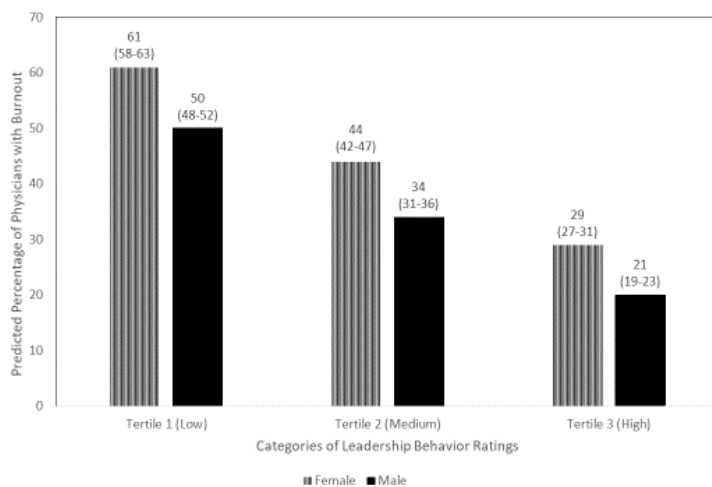
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**Figure 1. Predicted Percentage of Physicians (% , 95% CI) with High Professional Fulfillment by the Tertiles of Supervisor Leadership Behavior Ratings for Female and Male Physicians**



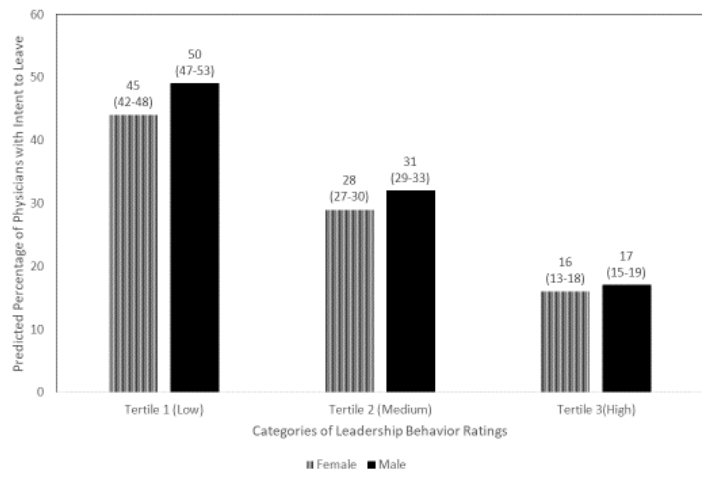
For peer review only

**Figure 2. Predicted Percentage of Physicians (% , 95% CI) with Burnout by the Tertiles of Supervisor Leadership Behavior Ratings for Female and Male Physicians**



peer review only

**Figure 3. Predicted Percentage of Physicians (% , 95% CI) Reporting Intent to Leave by the Tertiles of Supervisor Leadership Behavior Ratings for Female and Male Physicians**



Peer review only

## **Appendix**

### **Revised 9-item Mayo Clinic Participatory Management Leadership Index<sup>1</sup>**

**Please answer the following questions about your experience with the supervisor who is most directly responsible for providing you administrative guidance, feedback, and support.**

**My supervisor...**

1. Holds career development conversations with me
2. Empowers me to do my job
3. Encourages me to suggest ideas for improvement
4. Treats me with respect and dignity
5. Provides helpful feedback and coaching on my performance
6. Recognizes me for a job well done
7. Keeps me informed about changes taking place at (Institution)
8. Encourages me to develop my talents and skills
9. Overall, how satisfied are you with your supervisor?

**Response options:**

**Items 1-8:** 4-strongly agree, 3-agree, 2-neither agree nor disagree, 1-disagree, 0-strongly disagree

**Item 9:** 4-very satisfied, 3-satisfied, 2-neither satisfied nor dissatisfied, 1-dissatisfied, 0-very dissatisfied.

**Scoring:** Each item is scored on a 5-point scale (0-4) and the scores from the individual items are summed to compute an aggregate score (with higher scores indicating more favorable ratings)

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
<b>Title and abstract</b>	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	1	
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	5	
<b>Introduction</b>				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	7	
Objectives	3	State specific objectives, including any prespecified hypotheses	8	
<b>Methods</b>				
Study design	4	Present key elements of study design early in the paper	8	
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8-9	
Participants	6	(9) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants  (b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —For matched studies, give matching criteria and the number of controls per case	8-9	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	9-10	
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	10	
Bias	9	Describe any efforts to address potential sources of bias	10-11, 16-18	
Study size	10	Explain how the study size was arrived at	8-9, 11	

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2	Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
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4	Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding
5			(b) Describe any methods used to examine subgroups and interactions
6			(c) Explain how missing data were addressed
7			(d) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed
8			<i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed
9			<i>Cross-sectional study</i> —If applicable, describe analytical methods taking account of sampling strategy (Not applicable)
10			(e) Describe any sensitivity analyses (Not applicable)
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15	<b>Results</b>		
16	Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
17			(b) Give reasons for non-participation at each stage
18			(c) Consider use of a flow diagram
19	Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
20			(b) Indicate number of participants with missing data for each variable of interest
21			(c) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)
22	Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time
23			<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure
24			<i>Cross-sectional study</i> —Report numbers of outcome events or summary measures
25	Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
26			(b) Report category boundaries when continuous variables were categorized
27			(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
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separately)

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Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	15
<b>Discussion</b>			
Key results	18	Summarise key results with reference to study objectives	16
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	18
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17
Generalisability	21	Discuss the generalisability (external validity) of the study results	18
<b>Other information</b>			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	2

\*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

**Note:** An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at [www.strobe-statement.org](http://www.strobe-statement.org).