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Physician Task Load and the Risk of Burnout Among US Physicians in a National Survey

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Background: Cognitive task load can affect providers' ability to perform their job well and may contribute to burnout.

Methods: The researchers evaluated whether task load, measured by the National Aeronautics and Space Administration (NASA) Task Load Index (TLX), correlated with burnout scores in a large national study of US physicians between October 2017 and March 2018 with a 17.1% response rate. Burnout was measured using the Emotional Exhaustion and Depersonalization scales of the Maslach Burnout Inventory, and a high score on either score was considered a manifestation of professional burnout. The NASA-TLX was chosen to evaluate physician task load (PTL) due to its robust validation and use across many industries, including health care, over the past 30 years. The domains included in the PTL were mental, physical, and temporal demands, and perception of effort.

Results: Mean score in task load dimension varied by specialty. In aggregate, high emotional exhaustion, depersonalization, and one symptom of burnout was seen in 38.8%, 27.4%, and 44.0% of participants, respectively. The mean PTL score was 260.9/400 (standard deviation = 71.4). The specialties with the highest PTL score were emergency medicine, urology, anesthesiology, general surgery subspecialties, radiology, and internal medicine subspecialties. A dose response relationship between PTL and burnout was observed. For every 40-point (10%) decrease in PTL there was 33% lower odds of experiencing burnout (odds ratio = 0.67, 95% confidence interval = 0.65–0.70, $p < 0.0001$).

Conclusion: The relationship between PTL and burnout may suggest areas of particular focus to improve the practice environment and reduce physician burnout.

Health care is an intrinsically complex field, and in the wake of policy changes, an aging population with increasingly complex comorbidities, health care reform, advances in medical knowledge, and electronic health record adoption, it has been cited as one of the most complex industries ever created.[1,2] This complexity is increasing at an alarming pace and directly affects the day-to-day work of physicians as they care for patients. There is no centralized process to monitor the volume and impact of the increasing administrative and cognitive burden on physicians,[3] and the mounting complexity of their work may contribute to the increased risk of burnout in physicians relative to workers in other fields.[4–7] The Quadruple Aim of health care seeks to improve the work life of health care providers and enable professional fulfillment and meaning in work. Despite this, and the evidence that workload stressors increase burnout and intent to leave, little formal measurement has been done to evaluate the degree and impact of this increasing complexity and resultant cognitive workload, although informal and colloquial discussions related to workload and burnout have been described.[8–11]

In 1973 Daniel Kahneman, the Nobel Prize–winning psychologist known for his work in judgment, decision making, and behavioral economics, posited that human beings have limited cognitive resources available for attention.[12] Cognitive load theory, popularized by Australian psychologist Jonathan Sweller, added to this framework by identifying limitations in working memory that humans depend on to perform cognitive tasks.[13] Working memory, a fundamentally limited cognitive resource, is attenuated in the presence of physiologic or emotional stress.[14–16] The availability of working memory depends on external physiologic or emotional stressors, the type of information being processed, and the method of information delivery.

Cognitive load refers to the amount of working memory used and has three components: intrinsic load, extraneous load, and germane load (Figure 1). *Intrinsic load* refers to the inherent complexity of the task. With the ever-increasing complexity of patient care, this load is increasing. This load is immutable. *Extraneous load* refers to the load imposed by the way in which information is presented. Information presented in a disorganized, redundant, or incomplete manner presents high extraneous load and uses more working memory. In contrast, standardization, lack of redundancy, and synthesizing all pertinent data pieces to one location and type of presentation reduces extraneous load. *Germane load* is the workload of making mental models or learning.

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Figure 1: Working memory is the available awareness necessary to complete any cognitive task. It is reversibly depleted by three types of cognitive load: intrinsic, germane, and extraneous.

This is the working memory devoted to synthesizing novel information and expanding current mental models to incorporate new information. The workload imposed by germane load is highest for learners and those early in their career, although it remains a critical feature for all lifelong learners in the age of ever-evolving medical knowledge. Understanding these types of loads as well as the impact of stressors on available working memory is critical because when cognitive resources are overwhelmed, new information cannot be acquired or integrated, and critical data can be lost.[17]

Although a potential link between cognitive load and burnout is intuitive, no large-scale study has evaluated the correlation between perception of these dimensions in health care professionals.[3] In the present study, we evaluated the cognitive load of a clinical workday in a national sample of US physicians and its relationship with burnout and professional satisfaction.

METHODS

The aim of this study was to evaluate the relationship between physician task load (PTL) and burnout scores. We conducted a national survey of US physicians between October 2017 and March 2018. A description of the survey administration process, participation rates, and demographic characteristics of the overall sample was similar to prior studies[4,5] and has been previously reported.[18] The physician sample for the survey was assembled using the American Medical Association (AMA) Physician Masterfile, a nearly complete record of all US physicians independent of AMA membership, and included physicians of all specialty disciplines. Participation was voluntary, and all responses were anonymous. As previously reported, 5,197 (17.1%) of the 30,456 physicians who opened at least one invitation e-mail and/or received a paper mailing of the survey participated in the study.

An intensive secondary survey was sent to a random sample of 500 physicians who did not respond to the initial electronic survey.[19] These individuals were mailed a paper copy of the survey with a $20 incentive to participate. Physicians who did not respond to the initial mailing of the secondary survey were sent a second mailing without additional compensation three weeks later. Twenty-four mailed surveys were returned as undeliverable, yielding a final sample of 476. A total of 248 (52.1%) responded to the secondary survey. As previously reported, we found no statistically significant differences in age, years in practice, mean or median burnout scores, or satisfaction with work-life integration (WLI) among participants in the initial electronic survey and the secondary survey with a higher response rate. These findings support the absence of response bias in the electronic survey respondents with respect to burnout and satisfaction with WLI, which suggests that participants were generally representative of US physicians in these domains. Given this consistency with respect to the experience of burnout and WLI, all responders were pooled into a sample of 5,445 physicians for further analysis. Of these 5,445 physicians, the 5,276 (96.9%) who were actively practicing at the time of the survey were included in the present analysis evaluating PTL in practicing physicians.

Burnout Measurement

Responding physicians provided information on demographics (age, gender) and professional characteristics (specialty, practice setting, hours worked per week, nights on call per week). Burnout was measured using the Emotional

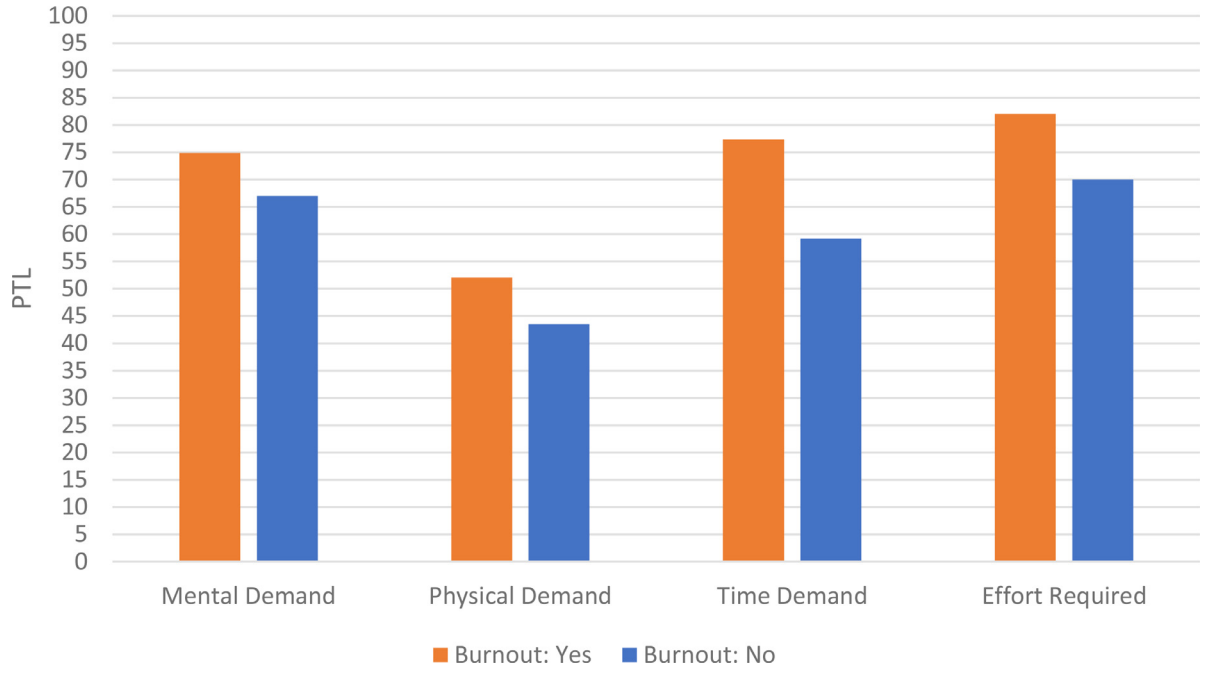

Figure 2: Four domains of PTL based on presence or absence of burnout symptoms. Significant difference between those with and without burnout for all domains ($p < .0001$).

Exhaustion and Depersonalization scales of the Maslach Burnout Inventory (MBI), a validated questionnaire considered the gold standard tool for measuring burnout.[20–23] Consistent with convention,[24–26] we considered physicians with a high score on the Depersonalization and/or Emotional Exhaustion scales of the MBI to have at least one manifestation of professional burnout.[27] For Emotional Exhaustion and Depersonalization scales, if the responder was missing at most one item from the individual scale, the full scale score was imputed. The scores were not imputed and were considered missing if a responder had more than one missing item from a scale.

Task Load Index

The National Aeronautics and Space Administation (NASA) Task Load Index (TLX) was chosen to evaluate PTL.[28] The NASA-TLX comprises six subscales: Mental Demand, Physical Demand, Temporal Demand, Frustration, Effort, and Performance. It was developed over a three-year cycle including more than 40 laboratory simulations. Over the ensuing 30 years, the instrument has been used across industries to evaluate the cognitive load of work environments, including many health care environments.[29,30] The NASA-TLX consists of a total workload score that is determined by adding the six subscales. Using the prompt "Please reflect on a day you performed clinical work during the last 1–2 weeks that is representative of a typical current clinical workday," survey participants rated their perception of each individual demand type. The scale ranged from 0 to 100 (100 being the highest level of demand) with anchors of "very low" at the zero end of the scale and "very high" at the high end of the scale. The performance domain was also rated using the "very low/very high" anchors, scored in reverse and renamed as reduced performance. Accordingly, all items were scored such that higher scores reflect greater demand in the respective domain.

Some of the six components of the NASA-TLX explore themes similar to the burnout construct (for example, frustration and performance), and previous studies suggest that four of the TLX items may be a more direct measure of task load.[29] To evaluate this aspect, we conducted a principal component analysis with oblimin rotation and Kaiser normalization to determine underlying patterns between the six items of the NASA-TLX and the Emotional Exhaustion and Depersonalization scales of the MBI. Two components emerged from principal component analysis (Appendix 1, available in online article). The scores of two items from the NASA-TLX (frustration and reduced performance) clustered as one component along with emotional exhaustion and depersonalization scores, suggesting that these domains of the NASA-TLX are measures of work-related distress (along with measures of burnout) and would be expected to be colinear with burnout measures (rather than representative of a distinct factor affecting burnout). Consistent with previous reports,[29] the other four domains (effort, and mental, physical, and temporal demands) clustered as a separate component distinct from emotional exhaustion and burnout, indicating that together they are a distinct dimension. The four items in this distinct dimension were summed to calculate the PTL score. (See "Statistical Analysis" for further details).

Statistical Analysis

As described above, PTL score was calculated by adding the scores for effort and mental, physical, and temporal demand items for each physician (ranging from 0 to 400). Missing data for any of the four items were documented as missing the PTL score. Standard descriptive summary statistics were used to describe the characteristics of our sample. We used one-way analysis of variance (ANOVA) and Welch's ANOVA (to compensate for heterogeneous variances where applicable) to examine the associations between categorical variables and PTL scores. A multivariable logistic regression was used to assess the relationship between burnout and quintiles of PTL score (as a categorical variable), age, gender (reference group: male), hours worked per week, practice setting (reference group: private practice), and specialty (reference group: internal medicine subspecialty). These reference groups were selected to remain consistent with previous analyses.[31] All tests were two-sided with type I error rates of 0.05. Analyses were completed using SAS 9.4 (SAS Institute Inc., Cary, North Carolina).

RESULTS

Participants

The 5,276 physicians who were actively practicing at the time of the survey were included in this analysis. At least one question of the NASA-TLX was completed by 4,641 (88.0%) physicians, and 4,517 (85.6%) responded to the four items used to measure PTL. Appendix 2 provides the descriptive characteristics of our sample, including 61.8% who self-identified as male, 37.9% as female, and 0.3% as other gender. The median age was 53 years. Twenty-four specialties were identified, with 23.8% of respondents in a primary care discipline. The internal medicine subspecialty category represented the largest respondent group at 12.1%. The median weekly number of work hours was 50, with the largest cohort reporting working between 50 and 59 hours per week. The median number of nights on call per week was 1, with the majority of respondents citing zero on-call nights per week. Nearly half of respondents (49.7%) identified as practicing in private practice, and 44.8% had been in practice for 21 years or more. In aggregate, 38.8% of participants scored in the high range for emotional exhaustion, 27.4% scored in the high range for depersonalization, and 44.0% had at least one symptom of burnout.

PTL Scores

The mean score for each individual subdomain of PTL is presented in Table 1a. Physicians reported high mean scores for mental demand and having to work hard to accomplish tasks (effort). The mean PTL score was 260.9 (standard deviation = 71.4). The specialties with the highest PTL score were emergency medicine, urology, anesthesiology, general surgery subspecialties, radiology, and internal medicine subspecialties with subtle variations across individual PTL domains (Table 1b).

In addition to specialty, the PTL score varied by gender, age, practice setting, number of hours worked per week, number of nights on call per week, and years in practice (Table 2). The individual domains of PTL (Appendices 3 and 4, available in online article) and the PTL score were also strongly correlated with emotional exhaustion and depersonalization scores, as well as the overall risk of burnout (Appendices 5 and 6).

Multivariable Analysis

Table 3a displays the relationship between quintile of PTL score and burnout, illustrating a dose response relationship between increasing quintile of PTL and risk of burnout. Respondents in the top quintile had a 67.8% rate of burnout as opposed to the reference group of the bottom quintile, with a 22.1% rate of burnout (odds ratio [OR] = 7.4, 95% confidence interval [CI] = 6.01–9.10, $p < 0.0001$). Table 3b displays the multivariable analysis examining the relationship between burnout and quintiles of PTL score after adjusting for hours worked per week, age, gender, practice setting, and specialty. A dose response relationship was observed between the PTL score and the risk of burnout af-

Table 1a. Physician Task Load (PTL)

Please reflect on a day you performed clinical work during the last 1–2 weeks that is representative of a typical current clinical workday.	Range	Median	Mean ± SD
How mentally demanding was the workday?*	0–100	75	70.5 ± 20.8
How physically demanding was the workday?*	0–100	50	47.2 ± 27.2
How hurried or rushed was the pace of the workday?*	0–100	70	67.2 ± 25.0
How hard do you have to work to accomplish your level of performance during the workday?*	0–100	80	75.3 ± 20.8
PTL score†	0–400	270	260.9 ± 71.4

* Higher score unfavorable.
† Calculated only for individuals who provided a response for all four domains of PTL ($n = 4,517$, mean score on a 400-point scale).
SD, standard deviation.

Table 1b. Four Load Domains by Specialty with Color-Coded Quartiles

Means by specialty					
	Mental Demand	Physical Demand	Timd Demand	Effort Required	Sum PTL
Emergency medicine	75.8	55.8	81.4	82.0	369.8
Urology	71.5	62.7	77.4	78.4	353.7
General surgery subspecialty	69.1	61.7	65.8	75.5	343.9
General internal medicine	73.0	45.6	68.5	78.4	343.5
Internal medicine subspecialty	73.0	47.5	69.7	78.4	342.2
Radiology	78.9	42.5	71.7	78.4	341.6
Obstetrics and gynecology	69.1	50.5	69.5	73.8	337.6
Otolaryngology	67.2	50.2	74.6	77.1	336.9
Pathology	75.7	38.5	63.7	74.9	335.7
Neurology	74.7	43.3	65.2	73.2	335.5
Family medicine	71.4	41.0	68.2	77.5	335.3
Anesthesiology	67.1	61.2	72.7	73.6	334.5
General surgery	67.5	60.1	63.5	71.9	334.2
Radiation Oncology	68.9	40.0	64.1	73.4	333.5
Preventive medicine/Occupational medicine	68.4	49.1	60.9	71.6	324.1
General Pediatrics	66.7	44.0	66.4	73.9	323.2
Pediatric subspecialty	68.4	44.8	65.6	74.2	322.3
Neurosurgery	68.6	60.8	61.7	73.0	321.5
Dermatology	63.9	46.5	69.3	76.2	319.2
Physical medicine and rehabilitation	64.6	38.5	64.9	74.3	316.8
Orthopedic surgery	65.6	52.5	63.2	72.7	315.0
Ophthalmology	68.6	44.8	67.7	72.6	314.9
Other	65.2	39.8	57.8	70.2	304.6
Psychiatry	69.7	28.8	56.4	68.8	287.4
Minimum	63.9	28.8	56.4	68.8	287.4
25%	66.3	37.4	61.2	71.4	310.9
Median	68.7	46.0	66.1	74.1	334.3
75%	73.8	54.4	73.7	78.0	352.0
Maximum	78.9	62.7	81.4	82.0	369.8

ter adjusting for these factors. In another multivariable analysis using PTL as a continuous variable and adjusting for the same variables, we found that a 4-point (1%) decrease in average PTL score on the 0–400 scale was associated with 4% lower odds of experiencing burnout (OR = 0.961, 95% CI = 0.957–0.966, $p < 0.0001$). For every 40-point (10%) decrease in PTL score, there was 33% lower odds of experiencing burnout (OR = 0.67, 95% CI = 0.65–0.70, $p < 0.0001$) In multivariable analysis, the logistic regression R-square was 0.15 in comparison to 0.11 for the unadjusted model with only PTL, suggesting that PTL is a significant predictor of burnout independent of age, gender, specialty, hours worked, and practice setting.

DISCUSSION

To our knowledge, this is the first large-scale national study to evaluate the PTL associated with the daily clinical work of US physicians. PTL varied widely by specialty and practice setting and was strongly associated with the risk of burnout. Each of the four domains of the TLX demonstrated a dose response relationship with emotional exhaustion and depersonalization scores, as well as the risk of burnout. The PTL score was strongly related to burnout independent of age, gender, practice setting, specialty, and hours worked per week.

Intriguing differences in PTL were also observed by specialty, with many of the specialties at highest risk for burnout also demonstrating high PTL scores. Not only did the PTL score vary substantively by specialty, each specialty had a unique profile with respect to the relative PTL intensity of the four individual domains. Not surprisingly, several surgical disciplines were associated with greater physical demands, while other specialties had greater demands from time pressure or mental demands. Emergency medicine, which has frequently been found to be the specialty at highest risk for burnout, had the highest PTL score. Notably, the associations between some specialties and the risk of burnout (including emergency medicine) were attenuated in our multivariate models after adjusting for the PTL score.

The highest mean TLX subdomain for all specialties was effort required, followed closely by mental demand and

Table 2. Relationship of Personal and Professional Characteristics with Summed Physician Task Load (PTL)

	Sum PTL Score	*P* Value*
Gender		
Male	258.3	0.01
Female	265.0	
Other	236.5	
Age in Years		
< 35	261.9	< 0.0001
35–44	266.2	
45–54	268.2	
55–64	267.4	
≥ 65	230.5	
Primary Care†		
Primary Care	260.3	0.70
Not Primary Care	261.2	
Specialty		
Anesthesiology	274.8	< 0.0001
Dermatology	255.9	
Emergency medicine	295.3	
Family medicine	257.9	
Radiology	272.2	
Neurology	256.7	
Obstetrics and gynecology	263.5	
Ophthalmology	255.7	
Pathology	255.0	
Physical medicine and rehabilitation	242.8	
Psychiatry	224.0	
Other	236.3	
General internal medicine	266.4	
Internal medicine subspecialty	269.4	
General Pediatrics	251.2	
Pediatric subspecialty	253.1	
General surgery	265.3	
General surgery subspecialty	272.6	
Neurosurgery	264.4	
Orthopedic surgery	253.7	
Otolaryngology	269.1	
Urology	290.0	
Preventive medicine/Occupational medicine	250.0	
Radiation Oncology	246.4	
Hours Worked per Week		
< 40	234.3	< 0.0001
40–49	243.9	
50–59	263.4	
60–69	272.4	
70–79	286.3	
≥ 80	295.4	
Number of Nights on Call per Week		
0	247.5	< 0.0001
1	267.7	
2	272.8	
3+	266.2	
Primary Practice Setting		
Private practice	257.4	< 0.0001
Academic medical center	268.9	
Veterans hospital	240.8	
Active military practice	244.0	
Other	260.1	
Years in Practice		
< 10	265.8	< 0.0001
10–19	268.4	
> 19	253.1	
Burnout		
Emotional Exhaustion		< 0.0001
Low score	229.5	
Intermediate score	265.8	
High score	290.6	
Depersonalization		< 0.0001
Low score	245.8	
Intermediate score	269.3	
High score	284.5	
Overall Burnout		
No symptoms burnout	227.3	< 0.0001
1 symptom burnout (high EE or DP)	286.7	< 0.0001

* F-test: One-way analysis of variance (ANOVA) or Welch's ANOVA where applicable.

† Primary care specialties include internal medicine-general, general practice, family medicine, obstetrics/gynecology and pediatrics-general.

EE, emotional exhaustion; DP, depersonalization.

Table 3a. Analysis Examining the Relationship Between Burnout and Quintiles of PTL Score

Quintiles of PTL*	% Burnout†	OR	95% CI	*P* Value
1st (reference group)	22.1	–	–	–
2nd	34.5	1.86	1.51–2.27	< 0.0001
3rd	46.2	3.02	2.47–3.70	< 0.0001
4th	54.5	4.21	3.43–5.17	< 0.0001
5th	67.8	7.40	6.01–9.10	< 0.0001

* Quintiles of PTL: 1: 0–205; 2: 206–250; 3: 251–285; 4: 286–320; 5: ≥ 321.

† *Burnout* is defined as a high score on the Emotional Exhaustion (≥ 27) and/or Depersonalization (≥ 10) scales of the Maslach Burnout Inventory.

PTL, physician task load; OR, odds ratio; CI, confidence interval.

Table 3b. Multivariable Analysis Examining the Relationship Between Burnout and Quintiles of Sum PTL Score After Adjusting for Hours Worked per Week, Age, Gender, Practice Setting, and Specialty

	OR	95% CI	*P* Value
Quintiles of PTL*			< 0.0001
1st (reference group, PTL ≤ 205)	–	–	–
2nd (PTL 206–250)	1.63	1.31–2.01	< 0.0001
3rd (PTL 251–285)	2.60	2.10–3.22	< 0.0001
4th (PTL 286–320)	3.66	2.94–4.55	< 0.0001
5th (PTL ≥ 321)	6.61	5.28–8.28	< 0.0001
Hours worked per week	1.02	1.01–1.02	< 0.0001
Age in years	0.97	0.97–0.98	< 0.0001
Gender			< 0.0001
Male (reference group)	–	–	–
Missing/other	2.51	0.92–6.82	0.07
Female	1.36	1.17–1.57	< 0.0001
Setting			0.006
Private practice (reference group)	–	–	–
Missing	2.59	0.72–9.29	0.14
Academic medical center	0.77	0.65–0.91	0.00
Active military practice	0.69	0.36–1.30	0.25
Other	1.08	0.90–1.29	0.44
Veterans hospital	0.92	0.58-1.46	0.73
Specialty			0.001
Internal medicine subspecialty (reference group)	–	–	–
Missing	0.73	0.31–1.73	0.47
Anesthesiology	0.77	0.55–1.10	0.15
Dermatology	1.17	0.75–1.83	0.49
Emergency medicine	1.41	1.01–1.98	0.05
Family medicine	1.32	0.98–1.78	0.06
General Pediatrics	0.92	0.65–1.31	0.65
General internal medicine	1.04	0.77–1.39	0.82
General surgery	0.99	0.65–1.50	0.95
General surgery subspecialty	0.67	0.49–0.91	0.01
Neurology	1.67	1.14–2.46	0.01
Neurosurgery	0.57	0.30–1.08	0.09
Obstetrics and gynecology	1.09	0.74–1.60	0.68
Ophthalmology	0.99	0.63–1.53	0.95
Orthopedic surgery	0.87	0.61–1.23	0.42
Other	1.18	0.72–1.93	0.51
Otolaryngology	1.38	0.69–2.78	0.37
Pathology	0.79	0.51–1.23	0.30
Pediatric subspecialty	0.66	0.46–0.96	0.03
Physical medicine and rehabilitation	1.43	0.91–2.25	0.13
Preventive medicine/Occupational medicine	1.00	0.37–2.69	0.99
Psychiatry	1.14	0.84–1.54	0.41
Radiation Oncology	1.19	0.57–2.48	0.64
Radiology	1.05	0.73–1.52	0.79
Urology	0.93	0.41-2.10	0.86

* Quintiles of PTL: 1: 0–205; 2: 206–250; 3: 251–285; 4: 286–320; 5: ≥ 321.

OR, odds ratio; CI, confidence interval; PTL, physician task load.

temporal demand. Although it is intuitive that mental demand should be high in such a complex field, the temporal demand and effort required are system-based constructs (examples of extraneous cognitive load) that are modifiable. For example, offering processing and prior triaging of in-basket messages and systems such as centralized prior authorization for various tests and treatments decreases the extraneous cognitive load of these tasks.

These observations have potential implications to reduce PTL as a strategy to mitigate professional burnout, namely focusing on system redesign. This redesign will be necessary at both the micro (independent clinical level) and the macro (Centers for Medicare & Medicaid Services regulations and insurance regulations) level. Each workspace will need to evaluate redundancy and inefficiencies in their workflow, while governing and regulatory bodies need to consider the downstream task load of mandates and reporting requirements, all of which contribute to extraneous cognitive load. For example, decreases in interruptions reduce the issue of split attention of the provider and thus would decrease extraneous load.[16] This intervention has also been shown to increase perception of teamwork and decrease stress, overall workload, and risk of error.[32,33] The goal, ultimately, would be to eliminate all extraneous load, allowing all load to be used for features intrinsic to the task or germane to learning the task. It is also critical that interventions focus on the workplace culture, because stress, which can be caused by toxic work cultures, can decrease available working memory and the ability to process information.[16] Many examples of interventions that focus on workplace culture have previously been discussed.[34,35]

The results also provide a framework to think about variation in burnout by specialty highlighting which dimension(s) of PTL may represent the highest yield to target for each specialty. Similarly, the degree of variation across sites, highlighted by the standard deviation of 71.4 for PTL, indicates that some specialties and clinical practice sites may have best practices worth evaluating in pursuit of extraneous load elimination. Each environment will need a tailored evaluation specific to the cognitive load required for tasks in that workspace. Areas of work that require a high degree of elemental interactivity, or the need to attend to many items at once, are common among the specialties with higher TLX scores, as expected due to the resulting increase in intrinsic load. Unnecessary extraneous load added to a higher intrinsic load is a recipe for overload. The ideal PTL is unclear, and further studies are necessary to identify a threshold PTL over which patient care is likely to suffer. However, looking to specialties and work sites that have lower PTL scores would be a good place to start the evaluation. Because the four items from the NASA-TLX used to determine PTL are simple, free to use, and easy to administer, they can be used to evaluate individual work units to focus local efforts.

The concept of PTL as a causal driver of burnout fits the existing body of knowledge on cognitive load in fields outside of medicine, but our results are cross-sectional and cannot determine causality or the potential direction of effect between these dimensions. For example, it is possible that physicians who are experiencing burnout have diminished resources to deal with task load and will perceive a higher task load as part of the emotional exhaustion component of burnout. Although longitudinal studies should evaluate this relationship, both the effort required to complete an average workday and burnout must be addressed to optimize system performance and system approaches.[7]

Several factors other than specialty were also correlated with higher PTL scores, including gender other than male, younger age, increasing number of hours worked per week, number of nights on call per week, practice setting with the highest PTL reported in academic medical centers, and years in practice with higher PTL in those with 10 to 19 years of practice. The PTL score increased with age to a peak in the range of 45 to 55 years, with a subsequent decline that could be explained by an expertise effect, which is known to relate to cognitive load.[13] When learning a new skill set, significant cognitive energy is spent to build mental models around new content (germane load). Cognitive load subsequently decreases as expertise develops. This also highlights the importance of providing an environment that allows individuals to develop expertise, which may include a different work intensity during the first several years in practice, space for continuing medical education, and protected academic development time.

In addition to the development of expertise, extraneous cognitive load can decrease with attention to minimizing split attention, avoiding redundancy, and increasing standardization.[13] Split attention is a common problem in clinical settings, with pagers, interruptions, and alarms leading to alert fatigue, which can lead to errors.[36] Redundancy is often touted as a patient safety mechanism, while many well-conducted studies have demonstrated the risk it poses in overloading cognitive capacities.[16] Finally, lack of standardization is rampant, with electronic health record customization and many medical units in the same facility operating with different policies and procedures.

Limitations

There are several potential limitations of this study, including the correlation of PTL with burnout measures and our relatively low response rate. There could be sample response bias due to people who are overloaded being less likely to respond, although we rigorously evaluated response bias in secondary surveys and did not find bias based on burnout scores or work-life integration scores. In addition, this is a proof of concept study to display the relationship between PTL and burnout. Further studies will need to be done to determine causality. In addition, as detailed in our method-

ology, no differences in the mean burnout score were identified between this sample size and the more intensively surveyed, larger sample size, indicating a likely representative sample. Finally, because the TLX was initially intended to measure specific tasks, a future, more detailed study that evaluates the task load of specific tasks, such as order entry, discharging a patient, or obtaining insurance authorization, might elucidate the highest task load activities in a clinical workflow. Several types of workload assessments have been evaluated in health care, including patient based and operator based, and have demonstrated that the operator-based TLX was the most reliable and valid questionnaire to measure workload. Other studies show the TLX to be a reliable measure of overall workload in health care settings.[29,30]

CONCLUSION

This study identifies a strong association between PTL and burnout. Although the directionality cannot be ascertained, the relationship between PTL score and burnout provides a framework to approach the practice environment by focusing on cognitive ergonomics that improve how well systems and processes are designed and implemented to fit capabilities of the user and optimize use—for example, by evaluating the effort required to complete a task and the time demand, and considering ways to decrease or distribute both. Using this process to consider opportunities for standardization and consolidation of similar work streams can decrease both effort and time required. Identification of areas in daily workflow that decrease standardization, increase redundancy, and split attention are all potential targets to reduce extraneous cognitive load. Even a modest decrease in PTL was associated with a decrease in burnout, suggesting standard process improvement has the potential to positively affect PTL using this lens. This knowledge offers frontline providers and administrators the opportunity to consider the impact of the overall PTL of new procedures, policies, and quality improvement projects.

Conflicts of Interest. Drs. Dyrbye and Shanafelt are co-inventors of the Physician Well-being Index, Medical Student Well-Being Index, Nurse Well-Being, and Well-Being Index. Mayo Clinic holds the copyright to these instruments and has licensed them for external use. Drs. Dyrbye and Shanafelt receive a portion of any royalties paid to Mayo Clinic. All other authors reported no conflicts of interest.
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SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jcjq.2020.09.011.

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REFERENCES

1. Plsek PE, Wilson T. Complexity, leadership, and management in healthcare organisations. BMJ. 2001 Sep 29;323:746–749.
2. Rouse WB. Health care as a complex adaptive system: implications for design and management. Bridge (Kans City). 2008;38(1):17–25.
3. Privitera MR, et al. Physician burnout and occupational stress: an inconvenient truth with unintended consequences. J Hosp Adm. 2015;4(1):27–35.
4. Shanafelt TD, et al. Changes in burnout and satisfaction with work-life balance in physicians and the general US working population between 2011 and 2014. Mayo Clin Proc.. 2015;90:1600–1613.
5. Shanafelt TD, et al. Burnout and satisfaction with work-life balance among US physicians relative to the general US population. Arch Intern Med. 2012 Oct 8;172:1377–1385.
6. West CP, Dyrbye LN, Shanafelt TD. Physician burnout: contributors, consequences and solutions. J Intern Med. 2018;283:516–529.
7. Sinsky CA, Privitera MR. Creating a "manageable cockpit" for clinicians: a shared responsibility. JAMA Intern Med. 2018 Jun 1;178:741–742.
8. Sikka R, Morath JM, Leape L. The Quadruple Aim: care, health, cost and meaning in work. BMJ Qual Saf. 2015;24:608–610.
9. Bodenheimer T, Sinsky C. From Triple to Quadruple Aim: care of the patient requires care of the provider. Ann Fam Med. 2014;12:573–576.
10. Privitera MR. Addressing human factors in burnout and the delivery of healthcare: quality & safety imperative of the Quadruple Aim. Health. 2018;10:629–644. Accessed Oct 13, 2020 https://www.scirp.org/journal/paperinformation.aspx?paperid=84825 .
11. Hämmig O. Explaining burnout and the intention to leave the profession among health professionals—a cross-sectional study in a hospital setting in Switzerland. BMC Health Serv Res. 2018 Oct 19;18:785.
12. Kahneman D. Attention and Effort. Englewood Cliffs, NJ: Prentice-Hall, 1973.
13. Sweller J. Cognitive load theory. In: Mestre JP, Ross BH, editors. The Psychology of Learning and Motivation: Cognition in Education, vol. 55. San Diego: Academic Press. p. 37–76.
14. Chajut E, Algom D. Selective attention improves under stress: implications for theories of social cognition. J Pers Soc Psychol. 2003;85:231–248.

15. Broadbent DE. The current state of noise research: reply to Poulton. Psychol Bull. 1978;85:1052–1067.
16. Ruskin K, Stiegler MP, Rosenbaum SH, editors. Quality and Safety in Anesthesia and Perioperative Care. New York: Oxford University Press, 2016.
17. National Aeronautics and Space Administration. Stress, Cognition, and Human Performance: A Literature Review and Conceptual Framework. Staal M. NASA/TM—2004–212824. Aug 2004. Accessed Oct 13, 2020. https://hsi.arc.nasa.gov/publications/20051028105746_IH-054%20Staal.pdf.
18. Shanafelt TD, et al. Changes in burnout and satisfaction with work-life integration in physicians and the general US working population between 2011 and 2017. Mayo Clin Proc.. 2019;94:1681–1694.
19. Cimiotti JP, et al. Nurse staffing, burnout, and health care–associated infection. Am J Infect Control. 2012;40:486–490 Erratum in Am J Infect Control. 2012;40:680.
20. Maslach C, Jackson SE, Leiter MP. Maslach Burnout Inventory: thrid edition. In: Zalaquett CP, Wood RJ, editors. Evaluating Stress: A Book of Resources. Lanham, MD: Scarecrow Press. p. 191–218. Accessed Oct 13, 2020 https://www.researchgate.net/profile/Christina_Maslach/publication/277816643_The_Maslach_Burnout_Inventory_Manual/links/5574dbd708aeb6d8c01946d7/The-Maslach-Burnout-Inventory-Manual.pdf.
21. Rafferty JP, et al. Validity of the Maslach Burnout Inventory for family practice physicians. J Clin Psychol. 1986;42:488–492.
22. Lee RT, Ashforth BE. A meta-analytic examination of the correlates of the three dimensions of job burnout. J Appl Psychol. 1996;81:123–133.
23. Leiter MP, Durup J. The discriminant validity of burnout and depression: a confirmatory factor analytic study. Anxiety Stress Coping. 1994;7:357–373.
24. Thomas NK. Resident burnout. JAMA. 2004 Dec 15;292:2880–2889.
25. Shanafelt TD, et al. Burnout and self-reported patient care in an internal medicine residency program. Ann Intern Med. 2002 Mar 5;136:358–367.
26. Rosen IM, et al. Evolution of sleep quantity, sleep deprivation, mood disturbances, empathy, and burnout among interns. Acad Med. 2006;81:82–85.
27. Maslach C, Jackson SE, Leiter M. The Maslach Burnout Inventory Manual. Palo Alto, CA: Consulting Psychologists Press, 1996.
28. National Aeronautics and Space Administration. NASA-Task Load Index (NASA-TLX); 20 Years Later. Hart SG. Oct 1, 2006. Accessed Oct 13, 2020. https://humansystems.arc.nasa.gov/groups/TLX/downloads/HFES_2006_Paper.pdf.
29. Tubbs-Cooley HL, et al. The NASA Task Load Index as a measure of overall workload among neonatal, paediatric and adult intensive care nurses. Intensive Crit Care Nurs. 2018;46:64–69.
30. Hoonakker P, et al. Measuring workload of ICU nurses with a questionnaire survey: the NASA Task Load Index (TLX). IIE Trans Healthc Syst Eng. 2011;1:131–143.
31. Dyrbye LN, et al. Burnout among U.S. medical students, residents, and early career physicians relative to the general U.S. population. Acad Med. 2014;89:443–451.
32. Wheelock A, et al. The impact of operating room distractions on stress, workload, and teamwork. Ann Surg. 2015;261:1079–1084.
33. Cloete L. Reducing medication errors in nursing practice. Nurs Stand. 2015 Jan 20;29:50–59.
34. Shanafelt TD, Noseworthy JH. Executive leadership and physician well-being: nine organizational strategies to promote engagement and reduce burnout. Mayo Clin Proc. 2017;92:129–146.
35. Swensen S, Kabcenell A, Shanafelt T. Physician-organization collaboration reduces physician burnout and promotes engagement: the Mayo Clinic experience. J Healthc Manag. 2016;61:105–127.
36. Nanji KC, et al. Medication-related clinical decision support alert overrides in inpatients. J Am Med Inform Assoc. 2018 May 1;25:476–481.