A Scoping Review of Burnout in Neurosurgery

Charles E. Mackel, MD/JD*
Emmalin B. Nelton, BS*
Renée M. Reynolds, MD‡
W. Christopher Fox, MD§
Alejandro M. Spiotta, MD¶
Martina Stippler, MD*

*Department of Neurosurgery, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, Massachusetts; ‡Department of Neurosurgery, Jacobs School of Medicine and Biomedical Sciences, University at Buffalo, State University of New York, Buffalo, New York; §Department of Neurosurgery, Mayo Clinic, Jacksonville, Florida; ¶Department of Neurosurgery, Medical University of South Carolina, Charleston, South Carolina

Correspondence:
Martina Stippler, MD,
Department of Neurosurgery,
Beth Israel Deaconess Medical Center,
110 Francis St, Suite 3B,
Boston, MA 02215, USA.
Email: mstipple@bidmc.harvard.edu
Twitter: @MartinaStippler

Received, August 12, 2020.
Accepted, November 4, 2020.
Published Online, January 19, 2021.

© Congress of Neurological Surgeons 2021. All rights reserved.
For permissions, please e-mail: journals.permissions@oup.com

BACKGROUND: Burnout is a negative workplace syndrome of emotional exhaustion, cynicism, and perceived professional inefficacy that risks the patient-provider relationship, patient care, and physician well-being.

OBJECTIVE: To assimilate the neurosurgical burnout literature in order to classify burnout among domestic and international neurosurgeons and trainees, identify contributory factors, and appraise the impact of wellness programs.

METHODS: A scoping review identified the available literature, which was reviewed for key factors related to burnout among neurosurgeons. Two researchers queried PubMed, Embase, Google Scholar, Cochrane, and Web of Science for articles on burnout in neurosurgery and reduced 1610 results to 32 articles.

RESULTS: A total of 32 studies examined burnout in neurosurgery. A total of 26 studies examined prevalence and 8 studies detailed impact of wellness programs. All were published after 2011. Burnout prevalence was measured mostly through the Maslach Burnout Inventory (n = 21). In 4 studies, participants defined their own understanding of "burnout." Domestically, burnout prevalence was 11.2% to 67% among residents and 15% to 57% among attendings. Among trainees, poor operative experience, poor faculty relationships, and social stressors were burnout risks but not age, sex, or marital status. Among attendings, the literature identified financial or legal concerns, lack of intellectual stimulation, and poor work-life balance as risks. The impact of wellness programs on trainees is unclear but group exercises may offer the most benefit.

CONCLUSION: Noticeable methodological differences in studies on trainee and attending burnout contribute to a wide range of neurosurgery burnout estimates and yield significant knowledge gaps. Environment may have greater impact on trainee burnout than demographics. Wellness programs should emphasize solidarity.

KEY WORDS: Neurosurgery, Burnout, Scoping review, Wellness, Resident, Attending

Neurosurgery 88:942–954, 2021 DOI:10.1093/neuros/nyaa564 www.neurosurgery-online.com

Burnout is a negative workplace syndrome from chronic exposure to job-related stress.[1,2] Applicable to many occupations,[2,3] burnout originally described an emotional phenomenon within the healthcare sector of emotional exhaustion, cynicism, and perceived professional inefficacy that challenged the provider-recipient relationship.[1,3,4] Burnout starts in medical school,[5] increases during residency,[6] and persists in the attending physician.[7]

ABBREVIATIONS: DP, depersonalization; **EE,** emotional exhaustion; **MBI,** Maslach Burnout Inventory; **MVR,** multivariate regression; **NR,** not reported; **OR,** odds ratio; **PA,** personal achievement

By compromising the physician's individual well-being and relationship with patients and colleagues, the impact of burnout is far-reaching. Substance abuse,[8,9] sleep deprivation,[10] stress,[11] depression,[11] suicidal ideation,[11-13] poor diet and exercise,[9] career dissatisfaction,[14] deteriorating personal relationships,[12] and desire for early retirement[15] are select manifestations of physician burnout. The problem has become even more urgent with the realization that the financial cost of burnout to the healthcare system approaches $4.6 billion per year.[16] Associated medical errors,[17,18] patient noncompliance,[19] decreased care quality,[20,21] malpractice suits,[12] and physician turnover[22] contribute to this figure. Responding to burnout, hospitals and residencies have invested in "wellness programs" to counteract its impact.[23,24]

Downloaded from https://academic.oup.com/neurosurgery/article/88/5/942/6104893 by CNS Member Access user on 29 April 2021

TABLE 1. Inclusion Criteria and Search String for Scoping Review

Inclusion criteria		Written in English Provides empirical research *on* ○ Neurosurgery residents or attendings in the US or internationally *and* ○ *Burnout* prevalence *or* ○ Institutional programs aiming to mitigate *burnout*
Search string	PubMed, Google Scholar, Embase, Cochrane, Web of Science	("burnout" OR "burn out" OR "burnt out" OR "burned out") AND (neurosurgeon OR neurosurgery OR "neurological surgery" OR "neurologic surgery")

Many studies have investigated burnout in medicine and surgery, but studies dedicated to burnout among neurosurgeons are belated and few.[6,7] The objective of this scoping review was to assimilate the neurosurgical burnout literature, classify burnout's prevalence among domestic and international neurosurgeons and trainees, and contextualize its prevalence in comparison to other specialties. This review identifies protective or contributory burnout factors specific to neurosurgeons and appraises the impact of wellness programs. By identifying knowledge gaps in the literature, this review may guide future steps in mitigating burnout among neurosurgeons.

METHODS

Search Strategy and Literature Selection

We performed a scoping review of the neurosurgical burnout literature using a framework derived from Arksey and O'Malley[25] and Levac et al[26] and updated by Munn et al.[27] We adhered to the 5 mandatory parts of the framework: (1) identification of a research question, (2) identification of relevant studies, (3) study selection, (4) data charting, and (5) result collation and summarization. We deemed a scoping review appropriate as our objective was to transparently classify the neurosurgical burnout literature, summarize its key characteristics or factors, and identify outstanding knowledge gaps.[27]

The initial search was performed in PubMed, Embase, Cochrane, and Web of Science. Review of articles, references, comments, gray literature, and Google Scholar yielded additional findings. Inclusion criteria and string searches are in Table 1. Search flow is detailed in Figure 1. Repeat literature search performed prior to submission captured publications added after the initial search.

Handling and Summarizing

Eligible studies were screened in 2 stages. For the first level, only the title and abstract were reviewed. At the second level, the article was reviewed in its entirety and relevance reconciled between authors via Covidence™ (Veritas Health Innovation, Melbourne, Australia). A Microsoft Excel® Version 16.40 (Microsoft, Redmond, Washington) spreadsheet detailed neurosurgical experience (resident or attending), number of respondents and response rate, country of origin, burnout metric and prevalence, and factors that protected against or increased the risk of burnout on multivariate regression. One author (C.M.) carried out this process after authors reached consensus on relevant factors.

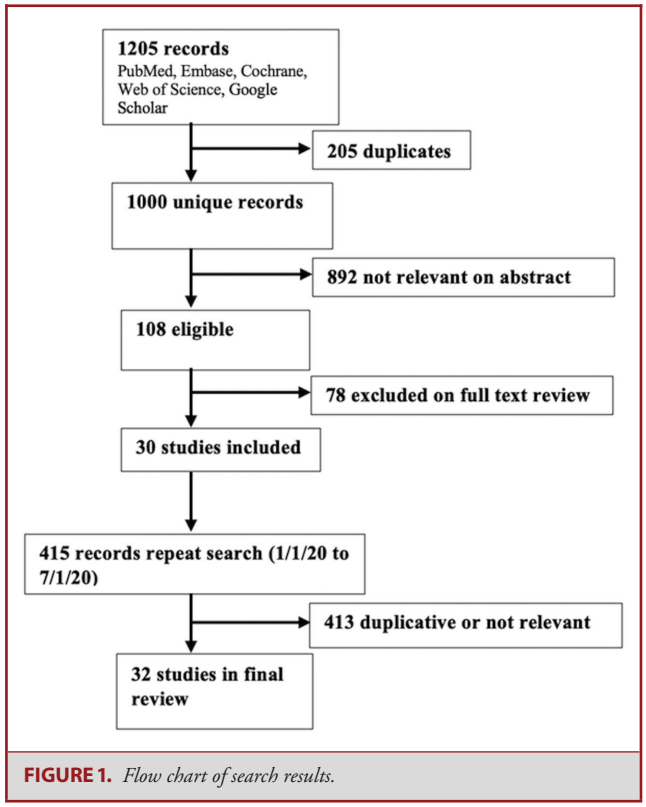

FIGURE 1. *Flow chart of search results.*

RESULTS

Overall

A total of 32 studies empirically examined burnout in neurosurgery with 26 studies examining prevalence and 8 studies detailing wellness program impact. All studies were published after 2011 with the majority (n = 22, 69%) published from 2018 to 2020 (Figure 2). Prevalence was measured most commonly through the Maslach Burnout Inventory (MBI) (n = 21) in its 22-question (n = 14), 16-question (n = 2), and 9-question (n = 3) forms, a derived 6-question form (n = 1), and a derived 2-question form (n = 1). In 4 studies, respondents defined their

Downloaded from https://academic.oup.com/neurosurgery/article/88/5/942/6104893 by CNS Member Access user on 29 April 2021

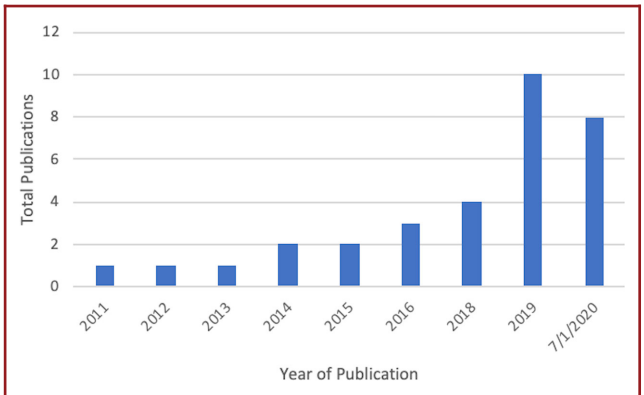

FIGURE 2. *Histogram of empirical studies related to burnout in neurosurgery published by year. Note 2020 only includes studies published prior to July 1.*

own understanding of "burnout." Prevalence was reflected in 14 studies on residents and 13 on attendings; 20 studies were US-focused, 5 international, and 1 US and international. Seven studies provided multivariate regression of factors affecting neurosurgery burnout prevalence.

Burnout Among US Neurosurgery Residents

Nine studies assessed burnout among current US neurosurgery residents with a burnout rate of 11.2% to 67%[6,28-35] (Table 2). Definition of "burnout" varied with report: the 9-question MBI was utilized in 3 studies,[28,32,35] the 22-question MBI in 2 studies,[30,34] the respondent's definition of "burnout" in 2 studies,[29,33] a cumulative score of MBI subcomponents in 1 study,[31] and a meta-analysis amalgamating 2 studies utilizing different MBIs.[6]

Three multicenter studies utilized the MBI definition for burnout of high emotional exhaustion or depersonalization.[28,30,32] These studies reported burnout of 33%,[32] 36.5%,[28] and 67%.[30] Each study reported similar rates of emotional exhaustion (29%, 32.5%,[28] and 36%[30]) but different rates of depersonalization (21.6%[28] vs 60%[30]) and low personal achievement (0.4%[28] vs 43%[30] vs 84.3%[32]). Jean et al[31] incorporated personal achievement into the definition of burnout, defined burnout as a cumulative score of the MBI subparts, and included Canadian respondents, making their 11.2% burnout rate not directly comparable.

Three studies reported factors associated on multivariate regression with burnout.[30-32] Risk factors for burnout among neurosurgery residents were poor operative experience,[30,31] poor faculty relationship,[30] and serious nonwork stressors.[30,32] The only protective factor was the trainee having children.[32] Age,[30] sex,[30,32] or marital status[30,32] did not affect burnout. On MBI subcategorization, Shakir et al reported increased depersonalization in years 2 and 4 of residency and personal achievement among married residents.[32] Although Shakir et al[32] described an inverse linear relationship between residents' burnout and "grit" ("perseverance or passion for long-term goals") or "resilience" ("measure of stress coping ability"), the correlation was weak ($r < 0.3$).

Burnout Among US Neurosurgery Attendings

Seven studies reported burnout among US neurosurgery attendings[36-42]; an eighth limited analysis to neurointerventionalists[43] (Table 3). Seven studies utilized the 22-question MBI to determine burnout[36-41,43]; one allowed respondents to define the term.[42] All studies were multicenter.[36-43] In 6 studies that included all subspecialties and utilized the MBI definition of burnout, burnout ranged from 27% to 56.7%.[36-41] Two studies documented prevalence of emotional exhaustion (range 14%-35.1%),[36,39] depersonalization (27%-31.3%),[36,39] or low personal achievement (27%-28.4%).[36,39] Burnout appeared stable over time (38.5% in 2011[40] to 40% in 2019[41]). Dandar et al[42] requested medical school faculty to identify whether they were "burned out" or "burning out" based on their definition of the terms; 103 neurosurgical faculty members reported a "burnout" rate of 5% and "burning out" rate of 10%.

McAbee et al[39] identified a challenging or academic work environment and adequate personal time or work-life balance as protective, while malpractice and financial concerns risked burnout. Respondent age, sex, or subspecialty did not predict burnout.[39] Neurosurgeon burnout was associated with reduced satisfaction with neurosurgery as a career (odds ratio [OR] = 0.17).[39] Although Fargen et al[43] analyzed factors related to neurointerventionalist burnout, this study included neurology and radiology attendings without neurosurgical subcategorization.

Neurosurgery Burnout Compared to Other US Specialties

Eight studies contextualized burnout among neurosurgery attendings with that of other specialties[37,38,40-45] (Table 4). The rate of burnout in neurosurgery was 3.9% to 15% lower than the mean burnout rate across all specialties.[37,38,41,42] In 5/5 studies, neurosurgery ranked in the bottom half of burnout,[37,38,40-42] including the lowest subjective perception among 20 specialties.[42] Using internal medicine subspecialization as the standard metric, a career in neurosurgery protected against burnout (OR = 0.476); by contrast, an emergency medicine career increased burnout odds (OR = 1.875).[41] Where neurosurgeons work closely alongside other subspecialties, such as neuro-oncologists, neurologists, or radiation oncologists,[44] or neurointerventionalists with neurology or radiology backgrounds,[43] neurosurgeons do have a markedly different burnout rate[43,44] and may have lower burnout than nonphysicians in the field.[44]

Burnout among neurosurgery residents relative to residents overall was a mixed comparison in 6 studies[6,28,29,34,46,47] (Table 5). Shakir et al[28] compared the burnout rate in their survey of neurosurgery residents (36.5%) to a literature estimate of 60% for all resident specialties and posited high personal achievement among neurosurgery residents (87.1%) vs other

Downloaded from https://academic.oup.com/neurosurgery/article/88/5/942/6104893 by CNS Member Access user on 29 April 2021

TABLE 2. Burnout Among US Neurosurgery Residents

Study	Location	Subject	Number (% response)	Burnout metric	% Burnout	Protective (on MVR)	Risk (on MVR)
Shakir (2018)[28]	US	Residents	255 (21.3%)	MBI (9-question) High EE *or* High DP	Overall = 36.5% 32.5% high EE 21.6% high DP 0.4% low PA	NR	NR
Shakir (2020)[32]	US	Residents	427 (30.8%)	MBI (9-question) High EE *or* High DP	Overall = 33% 29% high EE 84.3% low PA	Children	Significant social stressors Clinical rotation
Attenello (2018)[30]	US	Residents	346 (21%)	MBI (22-question) High EE *or* High DP	Overall = 67% 36% high EE 60% high DP 43% low PA	None identified	Inadequate cases (OR = 7.57) Hostile faculty (OR = 4.07) Significant social stressors outside of work (OR = 4.52) Unhelpful mentor (OR = 2.96)
Jean (2020)[31]	US/ Canada	Residents	107 (NR)	MBI (cumulative score of 6 questions) High EE + high DP + low PA	Overall = 11.2%	None identified	100-300 cases/year: OR = 3.808∗ ∗39.8% >300 cases/year
Dyrbye (2018)[29]	US	Residents PGY-2	26 (NR)	"EE": I feel burned out from my work *or* "DP": I have become more callous toward people since I took this job	Overall = 52%	NR	NR
Tang (2020)[33]	US	Residents Current and former Single institution	64 (67%)	"Have you experienced a burnout period that began during residency?"	Overall, current = 59% (10/17) Overall, former = 19%	NR	NR
Bui (2020)[34]	US	Residents Single institution	10 (NR)	MBI (22-question) High EE *or* High DP	Overall = 50%	NR	NR
Low (2019)[6]	US	Residents Meta-analysis[28,30]	601 (NR)	MBI (9 or 22-question) High EE *or* High DP	Overall = 52%	NR	NR
Ares (2019)[35]	US	Residents Single institution	Year 1 start: 21 (75%) Year 1 end: 25 (89%)	MBI (9-question) Moderate or high EE *or* Moderate or high DP *or* Moderate or low PA	Overall, year 1 start = 63% Overall, year 1 end = 60%	NR	NR

DP = depersonalization. EE = emotional exhaustion. MBI = Maslach Burnout Inventory. MVR = multivariate regression. NR = not reported. OR = odds ratio. PA = personal achievement

resident specialties (48.1%) protected against burnout.[28] In a meta-analysis, Low et al[6] estimated that the burnout rate among neurosurgery residents (52%) was similar to US residents overall (51%). In 3 small, single institution studies, neurosurgery residents had the lowest or second-lowest burnout rate among surveyed specialties.[34,46,47] However, Dyrbye et al[29] noted that neurosurgery residents ranked sixth in burnout among 20 specialties during the PGY-2 year.

Burnout Among International Neurosurgeons

Four studies reported burnout among international neurosurgery residents (16.9%-52.5%)[31,48-50] (Table 6). Yu et al (2020)

Downloaded from https://academic.oup.com/neurosurgery/article/88/5/942/6104893 by CNS Member Access user on 29 April 2021

TABLE 3. Burnout Among US Neurosurgery Attendings

Study	Location	Subject	Number (% response rate)	Burnout metric	% Burnout	Protective (on MVR)	Risk (on MVR)
Klimo (2013)[36]	US	Attendings	85 (50%)	MBI (22-question) High EE *or* High DP	Overall = 27% 14% high EE 27% high DP 27% low PA	NR	NR
Shanafelt (2015)[37]	US	Attendings	58 (NR)	MBI (22-question) High EE *or* High DP	Overall = 50%	NR	NR
Shanafelt (2012)[38]	US	Attendings	82 (NR)	MBI (22-question) High EE *or* High DP	Overall = 40%	NR	NR
McAbee (2015)[39]	US	Attendings	783 (24%)	MBI (22-question) High EE *or* High DP	Overall = 56.7% 35.1% high EE 31.3% high DP 28.4% low PA	Academic practice (OR = 0.69) Challenged at work (OR = 0.60) Good work-life balance (OR = 0.45) Adequate time for personal development (OR = 0.57)	Malpractice accusation (OR = 1.6) Uncertainty of future earnings/reforms (OR = 1.96)
Balch (2011)[40]	US	Attendings	184 (NR)	MBI (22-question) High EE *or* High DP	Overall = 38.5%	NR	NR
Shanafelt (2019)[41]	US	Attendings	66 (NR)	MBI (22-question) High EE *or* High DP	Overall = 40%	NR	NR
Fargen (2019)[43]	US	Attendings Neurosurgical neurointerventionalists	115 (NR)	MBI (22-question) High EE *or* High DP	Overall = 57%	NR	NR
Dandar (2019)[42]	US	Attendings Medical school faculty	103 (NR)	"Burned out" or "burning out" as defined by the respondent	Overall = 15% Burned out = 5% Burning out = 10%	NR	NR

MVR = multivariate regression. DP = depersonalization. EE = emotional exhaustion. PA = personal achievement. NR = not reported

identified factors associated with burnout. Older age (>35 yr), marriage, <70 h of work per week, higher salary, and ≥6 h of sleep per night protected against burnout with the reciprocals risking burnout.[48] Workplace violence from patients or patient families risked burnout.[48] Jean et al reported multicontinental rates of burnout, ranging from 16.9% in Africa to 26.9% in Europe,[31] and observed hours worked was the common burnout risk.[31] Notably, 41.6% of European trainees performed less than 100 cases/year, but the operative experience of 100 to 300 cases/year protected against burnout.[31]

Four studies described burnout among international neurosurgery attendings (26%-49.71%)[49-52] (Table 7). Yu et al[49] noted burnout among junior attendings (49.71%) was significantly higher than among senior attendings (37.3 8%). Pranckeviciene et al[52] included low personal achievement in their definition of burnout but only provided univariate analysis of factors. Nishimura et al[51] examined burnout among neurointerventionalists. In the neurosurgical subgroup, Nishimura et al[51] noted that additional hours worked, call shifts, and TPA cases increased burnout, whereas additional hours slept, days off, experience, income, and operative cases reduced burnout. Combining the responses of French residents with attendings, Baumgarten et al[50] found pleasure at work and an agreeable personality protected against burnout but neurotic personality, extensive work hours, and family-work conflict increased risk of burnout.

Wellness Programs and Burnout

Increasingly, neurosurgical literature describes institutional wellness programs implemented to mitigate resident burnout (Table 8). Wellness program curricula include lectures on diet,

Downloaded from https://academic.oup.com/neurosurgery/article/88/5/942/6104893 by CNS Member Access user on 29 April 2021

TABLE 4. US Neurosurgery Attending Burnout Compared to Other US Specialties

Study	Subject	Burnout metric	% Nsurg burnout	Overall	Observation
Shanafelt (2012)[38]	Attendings	MBI (22-question) High EE *or* High DP	40%	45.8%	Neurosurgery ranked 17/24 Highest odds of burnout: Emergency medicine (OR = 3.18)
Shanafelt (2015)[37]	Attendings	MBI (22-question) High EE *or* High DP	50%	54.4%	Neurosurgery ranked 18/24 Highest burnout: emergency medicine 72%
Shanafelt (2019)[41]	Attendings	MBI (22-question) High EE *or* High DP	40%	43.9%	Neurosurgery ranked 14/24 Neurosurgery was protective against burnout vs internal medicine (OR = 0.476) Emergency medicine was at greatest burnout risk vs internal medicine (OR = 1.875)
Dandar (2019)[42]	Attendings (Medical school faculty)	"Burned out" or "burning out" as defined by the respondent	15%	30%	Neurosurgery ranked 20/20 Highest cumulative burnout rate neurology (37%)
Balch (2011)[40]	Attendings (surgeons)	MBI (22-question) High EE *or* High DP	38.5%	NR	Neurosurgery ranked 8/14 in burnout Trauma surgery ranked 1 of 14 in burnout (51.6%)
Fargen (2019)[43]	Attendings (neurointerventionalists)	MBI (22-question) High EE *or* High DP	57%	56%	Radiology 57% Neurology 52%
Yust-Katz (2019)[44]	Attendings (neuro-oncology)	MBI (22-question) High EE *or* High DP *or* Low PA	NR	61%	No difference between subspecialty of neuro-oncology (radiation, surgical, medical) Lower rate of burnout vs allied health professionals (68%), basic scientists (83%)
Riccio (2020)[45]	Attendings (spine surgeons)	"Burnout" as "psychological, social, and/or behavioral debility"	NR	39%	Combined survey of orthopedic and neurologic spine surgeons Private practice as risk for burnout

MVR = multivariate regression. DP = depersonalization. EE = emotional exhaustion. PA = personal achievement. NR = not reported

exercise, alcohol, balance, physical and mental health,[35,53] guided team exercise sessions,[35,53] fitness and nonfitness team-building events,[54] mind-body wellness exercises (eg, yoga, Tai-Chi),[54] promotion of independent physical activity,[53] free gym access,[35] and mentorship programs.[35] A sample of 7 US institutions with wellness programs described >50% resident participation in 6/7 programs, >25% faculty participation in 3/7 programs at an average institutional cost of $6000 per year (range, $1500-$15 000).[54] The most published of these programs is the La Sierra project at the Medical University of South Carolina,[53,55-58] which has reported statistical improvement among volunteering residents in anxiety, quality of life, and sleep quality after 12 mo[53] with observable improvement in well-being endorsed by trainee spouses.[58] The University of Pittsburgh Medical Center explored the impact of a wellness program on burnout but did not observe a change in moderate or high burnout (63% vs 60%) after 12 mo, though the cohorts were not composed of all the same residents.[35] At a single institution, Tang et al surveyed current and former residents on program components that had a high or very high impact on recovery from burnout and reported that faculty-initiated outdoor events (52%), program social events (34%), improvements in personal health (34%), and meaningful mentor relationships (31%) aided recovery while institutional courses (9%), mindfulness techniques (5%), and hospital-wide employee wellness programs (0%) had negligible impact.[33]

Downloaded from https://academic.oup.com/neurosurgery/article/88/5/942/6104893 by CNS Member Access user on 29 April 2021

TABLE 5. US Neurosurgery Resident Burnout Compared to Other US Specialties

Study	Subject	Burnout metric	% Nsurg burnout	Overall	Observation
Shakir (2018)[28]	Residents	MBI (9-question) High EE *or* High DP	36.5%	60% (literature review)	Comparing the neurosurgery survey results with literature estimates for all resident specialties: High EE: 32.5% nsurg vs 44.2% all specialties High DP: 21.6% nsurg vs 50.3% all specialties High PA: 87.1% nsurg vs 48.1% all specialties
Low (2019)[6]	Residents meta-analysis[28,30]	MBI (9 or 22-question) High EE *or* High DP	52%	51%	Radiology 77.2% Neurology 71.9% Neurosurgery 7/14
Salles (2014)[46]	Surgical residents Single institution	MBI (cumulative score of 22 questions) High EE + High DP + low PA	NR	NR	Neurosurgery had second lowest burnout 8/9
Fowler (2020)[47]	Residents Single institution	"burnout" as defined by the participants understanding of the term.	NR	NR	Neurosurgery had lowest burnout rate (5/5) Significantly lower than internal medicine
Bui (2020)[34]	Surgical residents Single institution	MBI (22-question) High EE *or* High DP	50%	63.2%	Neurosurgery with lowest burnout rate among surgical specialties (6/6) Ob-gyn at 73%
Dyrbye (2018)[29]	Residents PGY-2	"EE": I feel burned out from my work *or* "DP": I have become more callous toward people since I took this job	52%	45.2%	Neurosurgery ranked 6/20 for burnout rate

DISCUSSION

Key Results

The World Health Organization adopts the International Classification of Disease 11th Revision definition of "burnout" as a problem associated with employment–specifically, a syndrome resulting from chronic workplace stress that has been unsuccessfully managed.[2] Burnout is characterized by feelings of depletion or exhaustion, negativity and cynicisms towards one's job, and professional ineffectiveness and unaccomplishment.[2] The MBI quantifies these dimensions to identify workers at risk of burnout.[1]

Despite the range of burnout reported among neurosurgery residents (11.2%-67%.[6,28-34]), neurosurgery residents burn out at a lower frequency than the average medical or surgical resident[6,28,34,46,47] excepting the PGY-2 year[29] (an exceptionally demanding year of neurosurgery residency[28,33]). Sporadically identified as relevant in other specialties,[59-62] the demographics of age, gender, or marital status have not been shown to affect burnout among neurosurgery trainees.[30,32] The lack of association between gender and burnout over the past decade (2010-2019) is salient in light of prior data (1990-2009) reporting higher attrition among female neurosurgery trainees compared with male colleagues.[63,64] The only demographic factor impacting trainee burnout is protective–having children, a finding replicated across specialties.[59,65,66] Traits such as "grit" and "resilience" are weakly correlated with burnout resistance in neurosurgery[32] and may instead increase likelihood of continuing residency despite burnout.

Among trainees, environmental factors have clearer impact on burnout. A portion of the trainee's environment is beyond the control of hospital and program (viz., the trainee's social situation).[30,32] Programs can mitigate resident burnout in 2 ways: by maximizing operative experience[30,31] and by minimizing deleterious faculty interaction.[30] These insights apply to programs domestic[30,31] and international[31,50] with the cost of negative faculty relationships apparent across specialties.[65,67,68] Although fewer work hours have protected international residents against burnout,[31,48] strict duty hour limits put programs in the complicated position of maximizing operative experience within this temporal constraint.[69,70]

Faculty burnout is critical for the attending physicians at burnout risk and residents whose burnout risk increases when attending physicians' burnout compromises the learning

Downloaded from https://academic.oup.com/neurosurgery/article/88/5/942/6104893 by CNS Member Access user on 29 April 2021

TABLE 6. Burnout Among International Neurosurgery Residents

Study	Location	Subject	Number (% response rate)	Burnout metric	% Burnout	Protective (on MVR)	Risk (on MVR)
Jean (2020)[31]	Asia	Residents	304 (NR)	MBI (cumulative score of 6 questions) High EE + High DP + low PA	Overall = 20%	None	80-120 h/wk work: OR = 2.713 >120 h/wk OR = 3.203
Yu (2020)[48]	China	Residents	690 (98.57)	MBI (22-question) High EE *or* High DP	Overall = 42.3% 35.65% high EE 25.51% high DP 45.36% low PA	>35 yr old OR = 0.54 married = 0.56 work < 56 h/wk 0.45 work 56-70/wk 0.55 11-15 × 10,000 yen OR = 0.63 >16 × 10,000 yen OR = 0.58 sleep ≥ 6 h 0.45	≤25 yr old OR = 1.31 divorced OR = 8.02 senior trainee OR = 1.55 working >70 h/wk, OR = 3.61 <10 × 10,000yen OR = 2.09 Workplace violence OR = 1.76 <6 h/d sleep OR = 2.24,
Yu (2019)[49]	China	Residents	372 (NR)	MBI (22-question) High EE *or* High DP	Overall = 43.54%	NR	NR
Jean (2020)[31]	Europe	Residents	196 (NR)	MBI (cumulative score of 6 questions) High EE + High DP + low PA	Overall = 26.9%	Call 2x/wk, OR = 0.390) Number of operations 100-300: OR = 0.392* *41.6% Europe trainees <100 cases	No limit on consecutive hours worked OR = 2.062)
Baumgarten (2020)[50]	France	Residents	141 (100)	MBI (22-question) High EE *or* High DP	Overall = 52.5%	Pleasure at work Agreeableness (DP) **analyzed in conjunction with attending responses*	Work-family conflict Neuroticism (EE) Work duration (EE) **analyzed in conjunction with attending responses*
Jean (2020)[31]	Latin America	Residents	107 (NR)	MBI (cumulative score of 6 questions) High EE + High DP + low PA	Overall = 24.5%	None	80-120 h/wk work OR = 2.971
Jean (2020)[31]	Africa	Residents	65 (NR)	MBI (cumulative score of 6 questions) High EE + High DP + low PA	Overall = 16.9%	None	Every other day call OR = 7.714

MVR = multivariate regression. DP = depersonalization. EE = emotional exhaustion. PA = personal achievement. NR = not reported

environment. Whereas surgical attendings in obstetrics, otolaryngology, and orthopedic surgery are less likely to burn out compared to their trainees,[71] burnout among US neurosurgery attending physicians appears similar to that of trainees (27%-57%[36-41] vs 33%-67%[28,30,32,34]). For US and international neurosurgeons, financial and legal concerns augment burnout risk whereas intellectual challenge and work-life balance protect.[39,51] Although attending neurosurgeons burn out at somewhat lower rates than other specialties,[37,38,40-44] observations that compensation,[72] malpractice,[73] loss of autonomy,[74] time squandered

Downloaded from https://academic.oup.com/neurosurgery/article/88/5/942/6104893 by CNS Member Access user on 29 April 2021

TABLE 7. Burnout Among International Neurosurgery Attendings

Study	Location	Subject	Number (% response rate)	Burnout metric	% Burnout	Protective (on MVR)	Risk (on MVR)
Nishimura (2014)[51]	Japan	Attendings Neurosurgical neurointerventionalist	1673 (NR)	MBI (16-question) High EE *or* High DP *or* Low PA	NR	Hour slept/day: OR = 0.84 Days off/week OR = 0.64 Experience/10 yr OR = 0.96 Income/1million yen OR = 0.96 # operations OR = 0.9	Hours worked/wk OR = 1.17 Extra calls/5 calls OR = 1.24 # tpa cases OR = 1.17
Yu (2019)[49]	China	Junior attendings	509 (NR)	MBI (22-question) High EE *or* High DP	Overall = 49.71%	NR	NR
Yu (2019)[49]	China	Senior attendings	321 (NR)	MBI (22-question) High EE *or* High DP	Overall = 37.38%	NR	NR
Pranckeviciene (2016)[52]	Lithuania	Attendings	31 (39%)	MBI (16-question) High EE *or* High DP *or* Low PA	Overall = 26% 26% high EE 16% high DP 26% low PA	NR	NR
Baumgarten (2020)[50]	France	Attendings	102 (23.6%)	MBI (22-question) High EE *or* High DP	Overall = 47.5%	Pleasure at work Agreeableness (DP) **analyzed in conjunction with resident responses*	Work-family conflict Neuroticism (EE) Work duration (EE) **analyzed in conjunction with resident responses*

on "unmeaningful" clerical work,[75,76] infringement of work on personal time,[72,74] and poor leadership culture[72] are risk factors for burnout common across specialties.

Whether the institution of "wellness programs" meaningfully mitigates resident burnout remains an outstanding question.[33,35,53] Probably, wellness lectures or mindfulness techniques do not redound as much benefit as group exercises, which increase resident exposure to faculty invested in volunteering time. Faculty buy-in must be meaningful; for example, "unsuccessful" mentorship programs have been associated with negative resident program evaluations.[77] However, institutional culture and behavior modeling by faculty may not always concur with wellness program goals since neurosurgery as a field has not traditionally emphasized personal health.[78]

Strengths, Limitations, and Knowledge Gaps

A strong point of this review is its breadth and holistic account of neurosurgery burnout. The integration of the literature provides a comprehensive review of burnout among domestic and international neurosurgery trainees and attendings and for the first time contextualizes these findings within a single review. We also indicated which factors have been demonstrated on multivariate regression to affect burnout to clarify avenues of intervention. The search and inclusion process, which included a research specialist and utilized multiple databases and queries, is another point of strength. The primary limitation of this study is inherent to scoping reviews: included studies are exempt from scrutiny as to quality. Although study deficiencies may be acknowledged (eg, small sample size, poor response rate), the purpose of a scoping review is to assimilate a fragmented literature and crystallize where research should proceed.

Interpretation

We identified multiple knowledge gaps in neurosurgery burnout research. First, heterogeneity persists in the definition of "burnout" and limits comparison of studies. Most studies use the MBI to determine "burnout" but vary in MBI form (9-, 16-, 22-question) and inclusion of personal achievement, while a subset leave respondents to provide their own definition of "burnout." Qualifying as "burned out" on the 22-question MBI requires only several instances of emotional exhaustion or depersonalization per month,[7] yet Dandar et al[42] reported among attending

Downloaded from https://academic.oup.com/neurosurgery/article/88/5/942/6104893 by CNS Member Access user on 29 April 2021

TABLE 8. Empirical Studies of American Neurosurgery Wellness Programs

Study	Composition	Subjects	Key findings
Spiotta (2019)[53]	La Sierra Project Baseline psychological & sleepiness testing Biweekly wellness lectures Weekly, guided, 1-h long, team-based exercise sessions Promotion of independent physical activity	Compared improvement from July 2015 to June 2016 Eight voluntary resident participants at 1 institution	*Improvement in* Generalized anxiety disorder 7-Item Scale ($P = .039$) Quality of life scale ($P = .007$) Epworth sleepiness scale ($P = .019$) *No change in* 8-item Personal Health Questionnaire Depression Scale
Buchholz (2018)[55]	La Sierra Project	Survey of eight voluntary resident participants at 1 institution with 1-3 yr' experience in the program	8/8 residents reported wellness program was "Very important" to residents "Largely positive" to department
Spiotta (2016)[56]	La Sierra Project	Survey of 6 faculty and 9 residents at a single institution prior to implementing wellness program	15/15 respondents Desired more time for self-care Valued nutrition and exercise in a healthy lifestyle
Fargen (2016)[57]	La Sierra Project	Survey of 6 faculty and 9 residents at a single institution 4 mo after implementing wellness program	10/11 reported improved team-building and camaraderie 10/11 described program as important for residents 9/11 reported positive impact on department
Estrella (2019)[58]	La Sierra Project	Survey of trainee spouses' perspectives regarding impact of La Sierra wellness program on trainee partner	55% of spouses were concerned "often" or "every day" about trainee partner's overall health 100% of spouses felt fitness program benefited personal and professional life of trainee at least "somewhat" Spouses perceived "actual exercise" and "department leadership valuing physical wellness" as the two most important aspects of the fitness program to their trainee partner
Ares (2019)[35]	Free gym access Bimonthly wellness lectures Weekly group gym visits Renewed mentorship focus	Preintervention vs postintervention Voluntary responses from 21 vs 25 residents over 1 calendar year at 1 institution	*No improvement in* MBI Burnout (63% → 60%, NS) Perceived social support (Multidimensional Scale of Perceived Social Support)
Tang (2020)[33]		Survey of 64 current and former residents from a single institution of recovery factors for wellness and burnout	*Frequency of "recovery factors" cited as "high impact"* Outdoor activities initiated by faculty = 52% Meaningful relationships with peers 42% Residency program parties/social events = 34% Improved exercise, nutrition, and/or personal health = 34% Meaningful relationship with mentor = 31% Institutional symposia and courses = 9% Mindfulness techniques = 5% Hospital's employee wellness program = 0%
Wolfe (2019)[54]		Survey of program directors from 7 institutions (MUSC, LSU-New Orleans, Minnesota, Tufts, Florida, Vanderbilt, Wake Forest)	>50% regular resident participation: 6/7 <25% regular faculty participation: 4/7 >2 yr in existence: 4/7 Regular group/team-building events: 5/7 Regular wellness lectures: 5/7 Average cost: $6000/year (range, $1500-$15 000)

Downloaded from https://academic.oup.com/neurosurgery/article/88/5/942/6104893 by CNS Member Access user on 29 April 2021

physicians subjective declarations of burnout significantly less than estimated by MBI studies. These discrepancies suggest (a) the MBI is overly sensitive in identifying burnout and might not represent "clinically significant" burnout or (b) "burned out" respondents are unaware of and underestimate their burnout.[79] Additionally, response rates in these studies are typically poor; it is unknown what degree of burnout nonresponders experience and whether significant response bias exists among responders.

Second, precision should be introduced to concepts such as "financial security," "personal stressors," and "work-life conflict." Higher compensation might mitigate burnout by alleviating financial stressors, but it does not follow that high salary alone inoculates against cynicism or exhaustion. Similarly, it would be useful to identify the sort of work-life balance associated with lower burnout (eg, stable partnerships, raising children in harmony, hobbies pursued). Third, as we assert that resident and attending physician burnout is intertwined, resident and attending burnout must be investigated within the same study, including the understanding of each as to the other's burnout. Tang et al reported discrepancy between resident response of burnout during residency and attending physician recall of burnout during residency, which points to misunderstanding of each other's experiences.[33] Finally, many factors that potentially contribute to burnout are underexplored. Exposure to "morally injurious experiences" (acts violating deeply held moral values)[80] and patient suffering are sources of provider harm[80-82] that might reasonably hazard burnout among trainees and attending physicians. Frustration with electronic medical records, hospital administration, and insurance could also be probed with a focus on neurosurgery.

Generalizability

This scoping review summarized burnout research as it pertains to neurosurgery. Generalizability to other specialties is limited. One finding that may prove generalizable is that meaningful work (even if demanding) protects against burnout. The protective factors of operative exposure among neurosurgery trainees and intellectual challenge among neurosurgery attending physicians may explain why neurosurgeons have lower burnout rates than other specialties.

CONCLUSION

The prevalence of burnout and means to combat it are increasingly researched in neurosurgery. Heterogenous methodology, few large-scale empirical studies, and differences between domestic, international, trainee, and attending neurosurgeons complicate aggregation of results. Tentatively, burnout may be best mitigated among residents by maximizing operative exposure and by minimizing ill will, whereas faculty may benefit from preservation of financial security and work-life balance and reduction of "meaningless" tasks. The optimal components of a wellness program to mitigate neurosurgery resident burnout are undetermined but probably emphasize resident-resident and resident-faculty solidarity. Despite the rigors of neurosurgery as a field, practitioners are somewhat less likely to burn out than those in other specialties. Further research must unify the definition of burnout, investigate variation between a respondent's burnout "score" and the neurosurgeon's subjective experience of burnout, examine additional factors such as patient suffering and moral injury in provider burnout, and consider how attending and resident neurosurgeon burnout may be fundamentally connected.

Funding

This study did not receive any funding or financial support.

Disclosures

The authors have no personal, financial, or institutional interest in any of the drugs, materials, or devices described in this article.

REFERENCES

1. Maslach C, Leiter MP. Burnout. In: Fink G, ed. *Stress: Concepts, Cognition, Emotion, and Behavior: Handbook of Stress Series*. Vol 1. San Diego, CA: Academic Press; 2016:351-357.
2. World Health Organization. Mental Health: Mental Health Evidence and Research (MER). *Burn-Out an "Occupational Phenomenon": International Classification of Diseases*. https://www.who.int/mental_health/evidence/burn-out/en/. Accessed September 12, 2020.
3. Schaufeli WB, Leiter MP, Maslach C. Burnout: 35 years of research and practice. *Career Dev Int*. 2009;14(3):204-220.
4. Maslach C, Jackson SE, Leiter MP. *Maslach Burnout Inventory Manual*. 4th ed. Menlo Park, CA: Mind Garden; 2016.
5. IsHak W, Nikravesh R, Lederer S, Perry R, Ogunyemi D, Bernstein C. Burnout in medical students: a systematic review. *Clin Teach*. 2013;10(4):242-245.
6. Low ZX, Yeo KA, Sharma VK, et al. Prevalence of burnout in medical and surgical residents: a meta-analysis. *Int J Environ Res Public Health*. 2019;16(9):1479.
7. Rotenstein LS, Torre M, Ramos MA, et al. Prevalence of burnout among physicians: a systematic review. *JAMA*. 2018;320(11):1131-1150.
8. Oreskovich MR, Kaups KL, Balch CM, et al. Prevalence of alcohol use disorders among American surgeons. *Arch Surg*. 2012;147(2):168-174.
9. Alexandrova-Karamanova A, Todorova I, Montgomery A, et al. Burnout and health behaviors in health professionals from seven European countries. *Int Arch Occup Environ Health*. 2016;89(7):1059-1075.
10. Vela-Bueno A, Moreno-Jiménez B, Rodríguez-Muñoz A, et al. Insomnia and sleep quality among primary care physicians with low and high burnout levels. *J Psychosom Res*. 2008;64(4):435-442.
11. Lebares CC, Guvva EV, Ascher NL, O'Sullivan PS, Harris HW, Epel ES. Burnout and stress among US surgery residents: psychological distress and resilience. *J Am Coll Surg*. 2018;226(1):80-90.
12. Balch CM, Freischlag JA, Shanafelt TD. Stress and burnout among surgeons: understanding and managing the syndrome and avoiding the adverse consequences. *Arch Surg*. 2009;144(4):371-376.
13. Van der Heijden F, Dillingh G, Bakker A, Prins J. Suicidal thoughts among medical residents with burnout. *Arch Suicide Res*. 2008;12(4):344-346.
14. Dyrbye LN, Varkey P, Boone SL, Satele DV, Sloan JA, Shanafelt TD. Physician satisfaction and burnout at different career stages. *Mayo Clin Proc*. 2013;88(12):1358-1367.
15. Campbell DA Jr, Sonnad SS, Eckhauser FE, Campbell KK, Greenfield LJ. Burnout among American surgeons. *Surgery*. 2001;130(4):696-705.
16. Han S, Shanafelt TD, Sinsky CA, et al. Estimating the attributable cost of physician burnout in the United States. *Ann Intern Med*. 2019;170(11):784-790.
17. Fahrenkopf AM, Sectish TC, Barger LK, et al. Rates of medication errors among depressed and burnt out residents: prospective cohort study. *BMJ*. 2008;336(7642):488-491.
18. Shanafelt TD, Balch CM, Bechamps G, et al. Burnout and medical errors among American surgeons. *Ann Surg*. 2010;251(6):995-1000.
19. Halbesleben JRB, Rathert C. Linking physician burnout and patient outcomes: exploring the dyadic relationship between physicians and patients. *Health Care Manage Rev*. 2008;33(1):29-39.

Downloaded from https://academic.oup.com/neurosurgery/article/88/5/942/6104893 by CNS Member Access user on 29 April 2021

20. Shanafelt TD, Bradley KA, Wipf JE, Back AL. Burnout and self-reported patient care in an internal medicine residency program. *Ann Intern Med*. 2002;136(5):358-367.
21. Shirom A, Nirel N, Vinokur AD. Overload, autonomy, and burnout as predictors of physicians' quality of care. *J Occup Health Psychol*. 2006;11(4):328-342.
22. Hamidi MS, Bohman B, Sandborg C, et al. Estimating institutional physician turnover attributable to self-reported burnout and associated financial burden: a case study. *BMC Health Serv Res*. 2018;18(1):851.
23. Harvey F. Physician burnout quality of life/wellness resource pilot program. *J Med Res Health Sci*. 2020;3(2):886-912.
24. Raj KS. Well-being in residency: a systematic review. *J Grad Med Educ*. 2016;8(5):674-684.
25. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol*. 2005;8(1):19-32.
26. Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. *Implementation Sci*. 2010;5(1):69.
27. Munn Z, Peters MDJ, Stern C, Tufanaru C, McArthur A, Aromataris E. Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *BMC Med Res Methodol*. 2018;18(1):143.
28. Shakir HJ, McPheeters MJ, Shallwani H, Pittari JE, Reynolds RM. The prevalence of burnout among US neurosurgery residents. *Neurosurgery*. 2018;83(3):582-590.
29. Dyrbye LN, Burke SE, Hardeman RR, et al. Association of clinical specialty with symptoms of burnout and career choice regret among US resident physicians. *JAMA*. 2018;320(11):1114-1130.
30. Attenello FJ, Buchanan IA, Wen T, et al. Factors associated with burnout among US neurosurgery residents: a nationwide survey. *J Neurosurg*. 2018;129(5):1349-1363.
31. Jean WC, Ironside NT, Felbaum DR, Syed HR. The impact of work-related factors on risk of resident burnout: a global neurosurgery pilot study. *World Neurosurg*. 2020;138:e345-e353.
32. Shakir HJ, Cappuzzo JM, Shallwani H, et al. Relationship of grit and resilience to burnout among U.S. neurosurgery residents. *World Neurosurg*. 2020;134:e224-e236.
33. Tang OY, Dunn KA, Yoon JS, Ponce FA, Sonntag VKH, Lawton MT. Neurosurgery resident wellness and recovery from burnout: a 39-year single-institution experience. *World Neurosurg*. 2020;138:e72-e81.
34. Bui AH, Ripp JA, Oh KY, et al. The impact of program-driven wellness initiatives on burnout and depression among surgical trainees. *Am J Surg*. 2020;219(2):316-321.
35. Ares WJ, Maroon JC, Jankowitz BT. In pursuit of balance: the UPMC Neurosurgery Wellness Initiative. *World Neurosurg*. 2019;132:e704-e709.
36. Klimo Jr P, DeCuypere M, Ragel BT, McCartney S, Couldwell WT, Boop FA. Career satisfaction and burnout among US neurosurgeons: a feasibility and pilot study. *World Neurosurg*. 2013;80(5):e59-e68.
37. Shanafelt TD, Hasan O, Dyrbye LN, 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(12):1600-1613.
38. Shanafelt TD, Boone S, Tan L, et al. Burnout and satisfaction with work-life balance among US physicians relative to the general US population. *Arch Intern Med*. 2012;172(18):1377-1385.
39. McAbee JH, Ragel BT, McCartney S, et al. Factors associated with career satisfaction and burnout among US neurosurgeons: results of a nationwide survey. *J Neurosurg*. 2015;123(1):161-173.
40. Balch CM, Shanafelt TD, Sloan JA, Satele DV, Freischlag JA. Distress and career satisfaction among 14 surgical specialties, comparing academic and private practice settings. *Ann Surg*. 2011;254(4):558-568.
41. Shanafelt TD, West CP, Sinsky C, 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(9):1681-1694.
42. Dandar V, Grigsby RK, Bunton S. Burnout among US medical school faculty. *AAMC Anal Brief*. 2019;19(1):1-3.
43. Fargen KM, Arthur AS, Leslie-Mazwi T, et al. A survey of burnout and professional satisfaction among United States neurointerventionalists. *J NeuroIntervent Surg*. 2019;11(11):1100-1104.
44. Yust-Katz S, O'Brien B, Vera E, Acquaye A, Weller M, Armstrong T. Burnout and career satisfaction in neuro-oncology: a survey of the Society for Neuro-Oncology and the European Association of Neuro-Oncology memberships. *Neuro Oncol*. 2020;22(6):838-850.
45. Riccio A, Entezami P, Bishop A, Carl A. Debility among spinal surgeons. *World Neurosurg*. 2020;141:e254-e260.
46. Salles A, Cohen GL, Mueller CM. The relationship between grit and resident well-being. *Am J Surg*. 2014;207(2):251-254.
47. Fowler JB, Fiani B, Kiessling JW, et al. The correlation of burnout and optimism among medical residents. *Cureus*. 2020;12(2):e6860.
48. Yu J, Zou F, Sun Y. Job satisfaction, engagement, and burnout in the population of orthopedic surgeon and neurosurgeon trainees in mainland China. *Neurosurg Focus*. 2020;48(3):E3.
49. Yu J, Gao J, Chen J, Sun Y. Academic versus non-academic neurosurgeons in China: a national cross-sectional study on workload, burnout and engagement. *BMJ Open*. 2019;9(10):e028309.
50. Baumgarten CA-O, Michinov E, Rouxel G, Bonneterre V, Gay E, Roche PH. Personal and psychosocial factors of burnout: a survey within the French neurosurgical community. *PLoS One*. 2020;15(5):e0233137.
51. Nishimura K, Nakamura F, Takegami M, et al. Cross-sectional survey of workload and burnout among Japanese physicians working in stroke care. *Circ Cardiovasc Qual Outcomes*. 2014;7(3):414-422.
52. Pranckeviciene A, Tamasauskas A, Deltuva VP, Bunevicius A. Professional burnout and its correlates in Lithuanian neurosurgeons. *Acta Neurochir*. 2016;158(8):1437-1445.
53. Spiotta AM, Fargen KM, Patel S, Larrew T, Turner RD. Impact of a residency-integrated wellness program on resident mental health, sleepiness, and quality of life. *Neurosurgery*. 2019;84(2):341-346.
54. Wolfe SQ, West JL, Hunt MA, et al. A comparison of the existing wellness programs in neurosurgery and institution champion's perspectives. *Neurosurgery*. 2019;84(5):1149-1155.
55. Buchholz AL, Henderson F Jr, Lowe S, et al. Perspectives from a residency training program following the implementation of a wellness initiative. *World Neurosurg*. 2018;119:e947-e955.
56. Spiotta AM, Fargen KM, Denham SL, et al. Incorporation of a physical education and nutrition program into neurosurgery: a proof of concept pilot program. *Neurosurgery*. 2016;79(4):613-619.
57. Fargen KM, Spiotta AM, Turner RD, Patel S. Operation La Sierra: a novel wellness initiative for neurological surgery residents. *J Grad Med Educ*. 2016;8(3):457-458.
58. Estrella M, Henderson BG, Porto SC, et al. The pursuit of wellness in neurosurgery: investing in residents' current and future health: spouses' perspectives. *Neurol India*. 2019;67(1):44.
59. Woodside JR, Miller MN, Floyd MR, McGowen KR, Pfortmiller DT. Observations on burnout in family medicine and psychiatry residents. *Acad Psychiatry*. 2008;32(1):13-19.
60. West CP, Shanafelt TD, Kolars JC. Quality of life, burnout, educational debt, and medical knowledge among internal medicine residents. *JAMA*. 2011;306(9):952-960.
61. Spataro BM, Tilstra SA, Rubio DM, McNeil MA. The toxicity of self-blame: sex differences in burnout and coping in internal medicine trainees. *J Womens Health (Larchmt)*. 2016;25(11):1147-1152.
62. Kimo Takayesu J, Ramoska EA, Clark TR, et al. Factors associated with burnout during emergency medicine residency. *Acad Emerg Med*. 2014;21(9):1031-1035.
63. Lynch G, Nieto K, Puthenveettil S, et al. Attrition rates in neurosurgery residency: analysis of 1361 consecutive residents matched from 1990 to 1999. *J Neurosurg*. 2015;122(2):240-249.
64. Renfrow JJ, Rodriguez A, Liu A, et al. Positive trends in neurosurgery enrollment and attrition: analysis of the 2000-2009 female neurosurgery resident cohort. *J Neurosurg*. 2016;124(3):834-839.
65. Elmore LC, Jeffe DB, Jin L, Awad MM, Turnbull IR. National survey of burnout among US general surgery residents. *J Am Coll Surg*. 2016;223(3):440-451.
66. Appelbaum NP, Lee N, Amendola M, Dodson K, Kaplan B. Surgical resident burnout and job satisfaction: the role of workplace climate and perceived support. *J Surg Res*. 2019;234:20-25.
67. Somerson JS, Patton A, Ahmed AA, Ramey S, Holliday EB. Burnout among United States orthopaedic surgery residents. *J Surg Educ*. 2020;77(4):961-968.
68. Golub JS, Weiss PS, Ramesh AK, Ossoff RH, Johns III MM. Burnout in residents of otolaryngology–head and neck surgery: a national inquiry into the health of residency training. *Acad Med*. 2007;82(6):596-601.

Downloaded from https://academic.oup.com/neurosurgery/article/88/5/942/6104893 by CNS Member Access user on 29 April 2021

69. Cohen-Gadol AA, Piepgras DG, Krishnamurthy S, Fessler RD. Resident duty hours reform: results of a national survey of the program directors and residents in neurosurgery training programs. *Neurosurgery*. 2005;56(2):398-403.
70. McCall T, Rao G, Kestle J. Work hour restrictions: impact on neurosurgical resident training at the University of Utah. *AANS Bull*. 2005;14(4):17-23.
71. Pulcrano M, Evans SRT, Sosin M. Quality of life and burnout rates across surgical specialties: a systematic review. *JAMA Surg*. 2016;151(10):970-978.
72. West CP, Dyrbye LN, Shanafelt TD. Physician burnout: contributors, consequences and solutions. *J Intern Med*. 2018;283(6):516-529.
73. Balch CM, Oreskovich MR, Dyrbye LN, et al. Personal consequences of malpractice lawsuits on American surgeons. *J Am Coll Surg*. 2011;213(5):657-667.
74. Glasheen JJ, Misky GJ, Reid MB, Harrison RA, Sharpe B, Auerbach A. Career satisfaction and burnout in academic hospital medicine. *Arch Intern Med*. 2011;171(8):782-790.
75. Shanafelt TD, West CP, Sloan JA, et al. Career fit and burnout among academic faculty. *Arch Intern Med*. 2009;169(10):990-995.
76. Shanafelt TD, Dyrbye LN, Sinsky C, et al. Relationship between clerical burden and characteristics of the electronic environment with physician burnout and professional satisfaction. *Mayo Clin Proc*. 2016;91(7):836-848.
77. Khan NR, Derstine PL, Gienapp AJ, Klimo P, Barbaro NM. A survey of neurological surgery residency program mentorship practices compared to Accreditation Council for Graduate Medical Education resident outcome data. *Neurosurgery*. 2020;87(5):E566-E572.
78. Spiotta AM, Patel S. Generational tensions are a distraction from addressing the burnout crisis in neurosurgery. *Neurol India*. 2018;66(6):1572.
79. Knox M, Willard-Grace R, Huang B, Grumbach K. Maslach Burnout Inventory and a self-defined, single-item burnout measure produce different clinician and staff burnout estimates. *J Gen Intern Med*. 2018;33(8):1344-1351.
80. Stovall M, Hansen L, van Ryn M. A critical review: moral injury in nurses in the aftermath of a patient safety incident. *J Nurs Scholarsh*. 2020;52(3):320-328.
81. Jacob Sendler D, Rutkowska A, Makara-Studzinska M. How the exposure to trauma has hindered physicians' capacity to heal: prevalence of PTSD among healthcare workers. *Eur J Psychiatry*. 2016;30(4):321-334.
82. Decety J, Yang C-Y, Cheng Y. Physicians down-regulate their pain empathy response: an event-related brain potential study. *Neuroimage*. 2010;50(4):1676-1682.

Acknowledgments

The authors thank Megan McNichol for assistance with the literature query and Teresa Odle for assistance with editing.

COMMENT

We are in the stage of "I can't define it but I know it when I see it" in our understanding of burnout in physicians in general and specifically neurosurgeons. The authors highlight this in their decision to search for all articles discussing "burnout" in neurosurgery rather than setting any sort of requirement for specific characteristics of a formal definition. In this setting a "scoping" review is appropriate. Such reviews generally are intended to be broad, identifying aspects of definition, types of evidence available, key characteristics or factors related to and knowledge gaps of a subject. The goal is usually to inform agendas for further research.

The authors identify the Maslach Burnout Inventory (MBI) as an attempt to standardize certain aspects of the phenomenon of burnout. They do not provide any information about the validity and reliability of the measurement tool. One of the difficulties that authors of summaries of publications face is that they cannot strengthen the quality of the studies they examine. The lack of validity and reliability for the MBI is one example. Another is the difficulty in comparing characteristics whose definitions have not been clearly specified by the primary authors. For example, "Where neurosurgeons work closely alongside other subspecialties" is a concept that is difficult to give an operational definition. We all know neurosurgeons whose definition of "working closely" with others are markedly different. The authors give some reference to this in their discussion "The primary limitation of this study is inherent to scoping reviews: included studies are exempt from scrutiny as to quality." That statement should warn the reader to be very cautious in drawing conclusions from the literature summarized in this article.

Fortunately, the authors recognize this and their conclusions are modest and appropriate. They have done a service to the profession in bringing this topic forward and pointing out the need for more research of higher quality in order to identify ways to minimize this problem in neurosurgery.

Stephen J. Haines
Minneapolis, Minnesota

Downloaded from https://academic.oup.com/neurosurgery/article/88/5/942/6104893 by CNS Member Access user on 29 April 2021