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Effects of physician burnout on patient safety, professionalism and patient satisfaction: A systematic review and meta-analysis.

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Author Contributions

The original idea for the research was developed by MP and AE. The analysis was conducted by MP, KG and AH. MP, KG, JJ and YS conducted the searches, study selection, quality assessments and other data extraction. MP wrote the paper. KG, JJ, AZ, EP, CCG, DP, AH, RR and AE interpreted the findings and contributed to critical revision of the manuscript. MP is the guarantor. MP affirms that the manuscript is an honest, accurate, and transparent account of the research findings and no important aspects of the study have been omitted.

Conflict of interests

All authors declare no conflict of interest

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Abstract

IMPORTANCE: Physician burnout has taken the form of an 'epidemic' which may affect core domains of the healthcare delivery, including patient safety, quality of care and patient satisfaction. However this evidence has not been systematically quantified.

OBJECTIVE: We examined whether physician burnout is associated with increased risk of patient safety incidents, suboptimal care outcomes due to low professionalism and lower patient satisfaction.

DATA SOURCES: Medline, Embase, PsycInfo and Cinahl, were searched until October 2017. We have undertaken detailed standardized searches with no language restriction. The reference lists of eligible studies and other relevant systematic reviews were hand-searched.

STUDY SELECTION: Quantitative observational studies were selected.

DATA EXTRACTION AND SYNTHESIS: Two independent reviewers were involved. The main meta-analysis was followed by subgroup and sensitivity analyses. All analyses were performed using random-effects models. Formal tests for heterogeneity (I^2) and publication bias were performed.

MAIN OUTCOME AND MEASURES: The core outcomes were the quantitative associations between burnout and patient safety, professionalism and patient satisfaction reported as odds ratios with their 95% confidence intervals.

RESULTS: Of the 5,234 records identified, 47 studies on 42,473 physicians were included in the meta-analysis. Physician burnout was associated with an increased risk of patient safety incidents (OR=1.89, 95% CI=1.63 to 2.15), poorer quality of care due to low professionalism (OR = 2.00, 95% CI= 1.71 to 2.30) and reduced patient satisfaction (OR = 2.28, 95% CI= 1.50 to 3.07). The heterogeneity was high and the study quality was low to moderate. The links between burnout and low professionalism were larger in resident/early career physicians compared to middle/late career physicians (Cohen's Q = 7.27, $p<0.01$). The reporting method of patient safety incidents

and professionalism (physician-reported vs system-recorded) significantly influenced the main results (Cohen's Q = 8.14, $p<0.01$).

CONCLUSION: This meta-analysis provides evidence that physician burnout may jeopardize patient care, a fundamental healthcare policy goal across the globe. Healthcare organizations are encouraged to invest in efforts to improve physician wellness, particularly for early career physicians. The methods of recording patient care quality and safety outcomes require improvements to concisely capture the impact of burnout on the performance of healthcare organizations.

Key points

Question Is physician burnout linked with low quality, unsafe patient care?

Findings This meta-analysis on 42,473 physicians found that burnout is associated with 2-fold increased odds for unsafe care, unprofessional behaviors and low patient satisfaction. The depersonalization dimension of burnout had the strongest links with these outcomes. The association between unprofessionalism and burnout was particularly high across studies of early career physicians.

Meaning Physician burnout is associated suboptimal patient care and professional inefficiencies. Healthcare organizations have a duty to jointly improve these core and complementary facets of their function. Key priority areas are signs of depersonalization and early career physicians.

Introduction

The view that physician wellness is an indicator of the quality of healthcare organizations is not new – it was introduced over few decades ago and has since gained increasing support.[1-4] The most well-known inverse metric of physician wellness is burnout, defined as *a response to prolonged exposure to occupational stress encompassing feelings of emotional exhaustion, depersonalization and reduced professional efficacy*. [5] There is strong evidence that the prevalence of burnout in physicians is high and that its impact on the personal lives of physicians is profound. [6] The 2017 Medscape Physician Lifestyle Report suggests that 50% of doctors report signs of burnout in the US, representing a rise of 4% within a year [7]. Burnout is linked with increased risk for cardiovascular disease and shorter life expectancy, problematic alcohol use, broken relationships, depression, and suicide. [8,9]

Despite consistent findings regarding the high prevalence of burnout and the detrimental personal consequences of this for physicians, research evidence about the impact of physician burnout on the quality of care delivered to patients is less definitive. A number of empirical studies have found that burnt-out physicians are more likely to be involved in patient safety incidents,[8] to fail on critical aspects of professionalism which determine the quality of patient care (e.g. adherence to treatment guidelines, quality of communication and empathy) and to receive lower patient satisfaction ratings.[10] Moreover, two recent systematic reviews have linked high burnout in healthcare professionals with the receipt of less safe patient care. [11,12] However, these reviews suffer from significant limitations. One included heterogeneous samples of healthcare professionals rather than physicians in particular (making quantification of these links using meta-analysis risky)[12] ; the second focused on a limited number of studies. [11] Both failed to explore complementary dimensions of patient safety such as suboptimal care outcomes resulting from low-professionalism, and patient satisfaction, and neither used meta-analysis to quantify the strength of associations.[11]

In this systematic review we examined whether physician burnout is associated with lower quality of patient care focusing on (1) patient safety incidents, (2) suboptimal care outcomes resulting from low professionalism and (3) lower patient satisfaction. We also evaluated the influence of key sources of heterogeneity on these associations including the healthcare setting in which physicians are working and the reporting method of patient care outcomes (physician-reported; patient-reported; system-recorded). This study is essential to acquire a holistic understanding of the impact of physician burnout on healthcare service delivery and to confirm the need for dynamic organization-wide resolutions to mitigate burnout.

Methods

This systematic review was conducted and reported in accordance with the Reporting Checklist for Meta-analyses of Observational Studies (MOOSE)[13] and Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidance.[14] The completed MOOSE checklist is available in eTable 1.

Searches

Medline, PsycInfo, Embase, and Cinahl were searched until October 22nd, 2017 with assistance by a librarian. The searches included combinations of 3 key blocks of terms (physicians; burnout; patient care) involving medical subject headings (MESH terms) and text words (eTable 2). Relevant systematic reviews and the reference lists of the eligible studies were hand-searched.

Eligibility criteria

Population: Physicians working in any healthcare setting.

Measure of physician burnout: Burnout was the primary outcome measured with standardized measures such the Maslach Burnout Inventory (MBI) or equivalent. The MBI assesses the three

dimensions of the burnout experience, including emotional exhaustion, depersonalization and personal accomplishment and produces separate scores for each dimension. [15] We also included studies reporting measures of depression and emotional distress as these are closely related to burnout, but these outcomes were analyzed separately.[16]

Measure of suboptimal patient care:

- Patient safety incidents defined as 'any unintended events or hazardous conditions resulting from the process of care, rather than due to the patient's underlying disease, that led or could have led to unintended health consequences for the patient or health care processes linked to safety outcomes'. [17] Examples of patient safety incidents are adverse events, adverse drug events or other therapeutic and diagnostic incidents.
- Professionalism operationalized based on Stern's four core principles: excellence, accountability, altruism and humanism.[18] As indicators of low professionalism we included suboptimal compliance to treatment guidelines (e.g. US Preventive Services Task Force guidelines on prescription of recommended treatments and medications, tests ordering practices, referrals to treatment/other services and discharge), reduced professional integrity (e.g. malpractice claims), poor communication practices (e.g. provision of suboptimal information to patients) and low empathy. We viewed reduced professionalism as an indicator of suboptimal quality of care and a precursor of patient safety incidents[19] as it involves some type of omission or commission error with potential to result in a patient safety incident.
- Patient-reported outcomes such as satisfaction and perceived enablement scores.

Quantitative data for the association between physician burnout and patient outcomes: Data to allow the computation of an effect size in each study were sought. We extracted these data from

the published reports where available, and we contacted the lead authors of studies which did not report sufficient data to compute an effect size (i.e. only reported p-values).

Design: Any quantitative study reporting data on the association between physician burnout and patient safety.

Setting: Any healthcare setting and language.

Exclusions: Grey literature (e.g. unpublished conference presentations, theses; government reports and policy statements) was excluded. We excluded studies which reported generic health outcomes such as quality of life, overall well-being or resilience.

Data selection, extraction and critical appraisal

The results of the searches were exported into Endnote. After removal of duplicates, a two-stage stage selection process was followed. At stage 1, titles and abstracts of studies were screened for relevance. At stage 2, full texts of studies ranked as relevant in stage 1 were accessed and fully screened against the eligibility criteria. A standardized excel data extraction spreadsheet was devised to facilitate the extraction of a) descriptive data from the studies including study characteristics (e.g. design and setting), participant characteristics (age, gender) and main outcome measures (physician burnout measure; indicators of suboptimal care); b) quantitative data for computing effect sizes in each study. The data extraction spreadsheet was piloted in 5 randomly selected studies before use. We used 3 widely used fundamental criteria adapted from guidance on the assessment of observational studies (cross-sectional and cohort studies).[20]

1) A response rate of 70% or greater at baseline (Yes=1; No/Unclear=0);
2) Control for confounding factors in analysis (Yes=1; No/Unclear=0);
3) Study design (Longitudinal=1; Cross-sectional=0).

206 Ratings were not used to exclude papers prior to synthesis but to provide a context for assessing
207 the validity of the findings (e.g. sensitivity analyses). Screening, data extraction and the critical
208 appraisal were independently undertaken by two reviewers. The interrater agreement was high
209 (0.91, 0.89, and 0.88, respectively). Any disagreements were resolved by discussion and the
210 involvement of a third reviewer.
211
212 **Data synthesis**
213 The primary outcome was the association of burnout (overall burnout; emotional exhaustion,
214 depersonalization and personal accomplishment) with suboptimal patient care indicators (patient
215 safety incidents, professionalism and patient satisfaction). Secondary outcomes were
216 depression/emotional distress with suboptimal patient care. Odds ratios (ORs) together with the
217 95% confidence intervals were calculated for all primary and secondary outcomes in each study.
218 Studies were eligible for inclusion in more than one analyses (e.g. if they reported all three
219 dimensions of burnout and/or more than one suboptimal patient care outcomes) but none of
220 the studies is represented twice in the same analysis (to avoid double counting). ORs were
221 typically computed from dichotomous data (number/rates of safety incidents), but continuous
222 data (i.e. means) were also converted to ORs using appropriate methods proposed in the
223 Cochrane Handbook. An OR >1 indicates that burnout is associated with increased risk of
224 suboptimal patient care outcomes, whereas an OR <1 indicates burnout is associated with
225 reduced risk for suboptimal patient care outcomes. Due to high heterogeneity, random effects
226 models were applied to calculate pooled ORs in all analyses. [35,36]
227
228 Heterogeneity was assessed using the I^2 statistic with values of 25%, 50%, and 75% indicating
229 low, moderate, and high heterogeneity, respectively. [21] A sensitivity analysis was performed to
230 evaluate the stability of the results when only studies less susceptible to risk of bias were retained
231 in the analysis. One pre-specified subgroup analysis explored whether the main findings were

influenced by the reporting method of patient care outcomes (physician-reported; system-based). We also conducted two post-hoc subgroup analyses to examine whether the geographic region of the studies (US versus non-US studies) and the career stage of physicians (residents/early career versus middle/late career) influenced the main findings. We inspected the symmetry of the funnel plots and performed the Egger's test to examine for publication bias.[22] All meta-analyses were performed in STATA (version 14) using the metaan command.[23] Funnel plots were constructed using the metafunnel command,[24] and the Egger test was computed using the metabias command. [25]

Results

We identified 5,234 records and following the removal of duplicates, we screened 3,554 titles and abstracts for eligibility in this review. Following screening, 47 studies met our inclusion criteria. [4,8,10,26-69] The flowchart of the study selection process is presented in Figure 1.

Descriptive characteristics of the included studies

Descriptive details of the eligible studies are presented in Table 1. Across all 47 studies, a pooled cohort of 42,473 physicians was formed. The median number of recruited physicians= 243; range=24 to 7,926; 59% men with a median age of physicians of 38 (range=27 to 53 years). Our pooled cohort consisted of physicians at different stages of their career; 21 studies were primarily based on residents and early career (up to 5 years post-residency) physicians (46%) and 26 on experienced physicians (55%). Thirty studies were based on hospital physicians (63%), 13 studies were based on primary care physicians (28%) and 4 studies were based on mixed samples of physicians across any healthcare setting (9%). Thirty-seven studies were cross-sectional (79%) and 10 were prospective cohort studies (21%). Half of the studies were conducted in the US (51%), 15 in Europe (31%) and 9 elsewhere (19%).

All studies used validated measures of physician burnout. The Maslach Burnout Inventory (the original or revised iterations) was the most common measure of burnout (n=41 out of 43 studies which reported data on burnout; 83%). Fourteen studies reported secondary measures of depression and emotional distress, which were analyzed separately. Twenty-one studies reported patient safety incidents, 28 reported indicators of low professionalism, and 7 studies reported measures of patient satisfaction. Nine studies reported more than one of these outcomes. Patient safety incidents and suboptimal patient care due to low professionalism were assessed based on physician self-reports across the majority of the studies (n=17 out of 21 studies; n=22 out of 29 respectively) whereas the remaining used patient record reviews and surveillance systems. Patient satisfaction was based on self-reports by patients.

Nineteen studies reported a response rate of 70% or greater at baseline (40% met criterion 1), 36 studies adjusted for confounders in the analyses (77% met criterion 2) and 10 studies were prospective cohorts (21% met criterion 3). In total, 20 (43%) studies met at least 2 of the 3 quality criteria whereas only 5 studies (11%) met all three criteria.

Main Meta-analyses

Burnout and patient safety incidents: The pooled effects of the main analysis indicated that physician overall burnout is associated with twice the odds of involvement in patient safety incidents (OR=1.82, 95% CI=1.59 to 2.04, I^2=88%; Figure 2). All dimensions of burnout, were associated with significantly increased odds of involvement in patient safety incidents (emotional exhaustion: OR = 1.62, 95% CI = 1.42 to 1.82, I^2 = 87%; depersonalization: OR = 2.05, 95% CI = 1.52 to 2.58, I^2 = 89%; personal accomplishment: OR = 1.45, 95% CI = 1.23 to 1.66, I^2 = 86%). The heterogeneity across all analyses was moderate to high in most analyses as indicated by the I^2 values.

Symptoms of depression/emotional distress in physicians was associated with a two-fold increased risk of involvement in patient safety incidents (OR = 2.38, 95% CI = 1.84 to 2.92, I^2 = 74%; eFigure 1).

Burnout and professionalism: Overall burnout in physicians was associated with twice the odds of exhibiting low professionalism (OR = 2.00, 95% CI= 1.70 to 2.30, I^2 = 90%). Particularly, the depersonalization was associated with a 3-fold increased risk for reporting low professionalism (OR = 3.25, 95% CI= 2.42 to 4.07, I^2 = 94%, p<0.001). Emotional exhaustion and reduced personal accomplishment were associated with over 2.5-fold increased odds for low professionalism (OR = 2.59, 95% CI = 1.95 to 3.22, I^2 = 90%; OR = 2.50, 95% CI = 1.82 to 3.18, I^2 = 89%)

Symptoms of depression or emotional distress was associated with 1.5 times increased risk for low professionalism (OR = 1.68, 95% CI = 1.44 to 1.92, I^2 = 61.0%; eFigure 2).

*Burnout and patient satisfaction***:** Overall burnout in physicians was associated with a 2-fold increased odds for low patient-reported satisfaction (OR = 2.28, 95% CI= 1.50 to 3.07, I^2 = 81%). Particularly, depersonalization was associated with 5-fold increased odds for low patient-reported satisfaction (OR = 5.15, 95% CI= 1.40 to 8.90, I^2 = 82%). Personal accomplishment were also associated with over 2-fold increased odds for low patient-reported satisfaction (OR = 1.89, 95% CI = 1.05 to 2.73, I^2 = 72%) whereas emotional exhaustion was not significantly associated with patient-reported satisfaction (OR = 2.76, 95% CI = 0.19 to 5.41, I^2 = 87%).

Small-Study Bias: No substantial funnel plot asymmetry was observed in the main analyses, indicating that the results were not influenced by publication bias (Egger test P = 0.07; eFigure3).

Sensitivity analysis: The pooled effect sizes derived by the studies with higher quality scores (studies which met 2 of the 3 criteria) were similar to the pooled effect sizes of the main analyses (overall burnout and safety incidents: OR=1.93, 95% CI = 1.45 to 2.41; overall burnout and professionalism: OR=2.32, 95% CI = 1.66 to 2.98).

Subgroup analyses

Reporting method of patient care outcomes: Burnout was associated with twice the risk of physician-reported safety incidents and low professionalism (OR=2.07, 95% CI=2.03 to 2.11, I^2=65%; OR=2.67, 95% CI=2.19 to 3.15, I^2=56%, respectively) whereas the association between physician burnout and system-recorded safety incidents and low professionalism was statistically nonsignificant or marginally significant (OR=1.00, 95% CI=0.81 to 1.18, I^2=15% ; OR=1.15, 95% CI=1.02 to 1.31, I^2=10%, respectively). Both subgroup differences were statistically significant (Cohen's Q = 8.14 and Q=7.78, p<0.01).

Country of origin: The pooled associations of physician burnout with patient safety incidents and low professionalism did not differ across studies based on US physicians (OR=1.69, 95%CI=1.46 to 1.92; I^2=71% OR=2.02, 95% CI=1.59 to 2.44, I^2=75% respectively) and studies based on physicians in other countries (OR=1.96, 95%CI=1.62 to 2.30; OR=1.97, I^2=82% 95% CI=1.57 to 2.38, I^2=87% respectively). The Cohen's Q tests for both analyses were statistically non-significant (p>0.05).

Career stage of physicians: The pooled association of burnout with patient safety incidents did not differ across studies based on residents/early career physicians and studies based on middle/late career physicians (OR=1.73, 95%CI=1.46 to 2.00, I^2=79% versus OR=1.87, 95%CI=1.49 to 2.25, I^2=76% respectively; Cohen's Q=1.32, p=0.172). However, the pooled association of burnout with low professionalism was significantly larger across studies based in residents/early

career physicians, compared to studies based on middle/late career physicians (OR=3.39, 95% CI=2.38 to 4.40, I^2=23% versus OR=1.73, 95%ci=1.46 to 2.01, I^2=67%, respectively; Cohen's Q = 7.27, p=0.003).

Discussion

Summary of main findings

This systematic review and meta-analysis provides robust quantitative evidence that physician burnout is associated with suboptimal patient care in the process of healthcare service delivery. We found that burnt-out physicians are twice as likely to be involved in patient safety incidents, twice as likely to deliver suboptimal care to patients due to low professionalism, and three times more likely to receive low satisfaction ratings from patients. The depersonalization dimension of burnout appears to have the most adverse impact on the quality and safety of patient care and on patient satisfaction. The association of burnout with low professionalism was particularly strong among studies based on residents and early career physicians. The reporting method of patient safety incidents and professionalism had a significant influence on the results suggesting that improved assessment standards for patient safety and professionalism are needed in the healthcare.

Strengths and limitations

We undertook a rigorous quantitative assessment of the association between burnout and patient care quality and safety in a pooled sample of over 42 thousand physicians. Meta-analysis allowed us to compare the results across individual studies, to examine the consistency of effects and to explore variables that might account for inconsistency. However, there are also limitations. A wide range of outcomes were included in this review, and some of outcomes pooled together in the same subcategory exhibited substantial variation (e.g. professionalism). Similarly, although we focused on physicians, this is a broad research population of health professionals working in

various healthcare settings and specialties. We accounted for the large heterogeneity by applying random effects models, to adjust for study-level variations, and by undertaking subgroup analyses to explore key factors that may account for variation. We only explored the impact of basic sources of heterogeneity, because multiple subgroup analyses inflate the probability of finding false results.[70] We excluded grey literature because the quality of research contained in the grey literature is generally lower and more difficult to combine with research contained in peer-reviewed journal articles.[71] The visual inspection of the funnel plot and Egger test did not identify evidence of publication bias in any of our analyses which supports our decision. However, we cannot fully eliminate the possibility that the exclusion of grey literature has introduced undetected selection bias. Finally, the design of the original studies (mostly cross-sectional) imposes limits on our ability to establish causal links between physician burnout and patient safety, professionalism and patient satisfaction and the mechanisms that underpin these links.

Comparison with previous systematic reviews

Two previous systematic reviews have linked burnout in healthcare professionals with patient safety outcomes.[11,12] In the present review we undertook a meta-analysis, enabling the quantification of these links and the exploration of key sources of heterogeneity among the studies. We focused on physicians alone but established links between burnout/stress and a wider range of patient care indicators, including patient safety incidents, low professionalism and patient satisfaction. We chose to focus on physicians as the function of any healthcare system primarily relies on physicians but evidence suggests that physicians are two-times more likely to experience burnout than any other worker including other healthcare professionals.[1,72,73] We thought it is critical, therefore, to better understand the impact of physician burnout on patient safety, professionalism and patient satisfaction. We chose to investigate a wider range of patient care indicators as while professionalism/patient satisfaction are precursors of safety risks with

potential to lead to active patient safety incidents[19], previous research has not systematically reviewed the association between burnout/stress and these outcomes. Moreover, aspects of professionalism such as poor empathy and suboptimal patient-physician rapport could result in under-investigated but important adversities for patients such as psychological harm and an overall negative experience of healthcare.

Implications for researchers, clinicians and policymakers

We found that physician burnout is associated with a reduced efficiency of healthcare systems to deliver high quality, safe care to patients. Preventable adverse events cost several billions to healthcare systems every year.[74] Physician burnout therefore is costly for healthcare organizations and undermines a fundamental societal need for the receipt of safe care. Current interventions for improving healthcare quality and safety have mainly focused on identifying and monitoring *vulnerable patients* (e.g. patients with complex healthcare needs) and occasionally *vulnerable systems*.[75,76] Our findings support the view that existing care quality and patient safety standards are incomplete; a core but neglected contributor is physician wellness.[1-4] This recommendation is in accordance with all well-recognized patient safety classification systems (e.g. WHO) which concur that there are three major contributory factors to patient safety incidents: patient factors, healthcare system factors and clinician factors.

High depersonalization in physicians was particularly indicative that patient care could be at risk, as it had strong associations with both increased patient safety incidents and reduced professionalism. It was also closely linked with lower patient satisfaction, suggesting its effects can be perceived by patients. These findings are consistent with existing evidence showing that depersonalization is strongly related to low professionalism. [77,78] Depersonalization scores in physicians could be measured by healthcare organizations together with other well-established

411 quality strategies, to guide system-level interventions for improving quality of healthcare and
412 patient safety.
413
414 The vast majority of the studies relied on patient care outcomes which were self-reported by
415 physicians. However, we failed to show significant links between physician burnout and patient
416 safety outcomes recorded in the healthcare systems (e.g. the health records of patients;
417 surveillance). Concerns have frequently been raised about poor and inconsistent system
418 recording of patient safety outcomes.[79] As such, our findings suggest that existing system-based
419 assessment methods are incomplete and less sensitive to the full range of patient safety outcomes
420 reported by physicians and patients. These uncaptured safety outcomes might include 'near
421 misses' but may also concern incidents different in nature such as psychological harm which do
422 not result in directly observable patient harm but may affect the physician-patient relationship
423 and harm indirectly both parties. Reporting systems for quality of care and patient safety
424 outcomes require revision and better standardization across healthcare organizations. This
425 standardization will enable larger and more rigorous studies of the impact of physician burnout
426 on key aspects of patient care which will be accessible at organizational level and will impact on
427 policy decisions. An alternative explanation for this finding is that physicians' perceptions of
428 safety are unreliable; however this conclusion is not supported by previous research suggesting
429 that staff-reported patient safety outcomes overlap with objective safety indicators.[80,81] That said,
430 the impact of burnout and self-criticism on physicians' reports of patient safety outcomes
431 warrants further investigation.
432
433 Another important finding is that studies based on resident/early career physicians reported
434 stronger links between burnout and low professionalism compared to studies based on
435 middle/late career physicians. It is likely that burnout signs among residents and early career
436 physicians have detrimental impact on their work satisfaction, professional values and integrity.

[82-84] Healthcare organizations have a duty to support physicians in the demanding transition from training to professional life. Residents will be responsible for the healthcare delivery for over two decades in the future. Investments on their wellness and professional values - which are largely shaped at early career years - is perhaps the most efficient strategy for building organizational immunity against workforce shortages and patient harm/mistrust.

Conclusion

The headline conclusion of this review is that physician burnout might jeopardize patient care. Physician wellness and quality of patient care are critical and complementary dimensions of the healthcare organization efficiency. Investments on organizational strategies to jointly monitor and improve physician wellness and patient care outcomes are needed. Interventions aimed at improving the culture of healthcare organizations as well as interventions focused on individual physicians but supported and funded by healthcare organizations are effective. [2,85,86] They should therefore be evaluated at scale and implemented.

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References

1. Wallace JE, Lemaire JB, Ghali WA. Physician wellness: a missing quality indicator. *Lancet.* Nov 14 2009;374(9702):1714-1721.
2. Firth-Cozens J. Interventions to improve physicians' well-being and patient care. *Soc Sci Med.* 2001;52(2):215-222.
3. Firth-Cozens J, Greenhalgh J. Doctors' perceptions of the links between stress and lowered clinical care. *Soc Sci Med.* 1997/04/01/ 1997;44(7):1017-1022.
4. Shanafelt TD, Bradley KA, Wipf JE, Back AL. Burnout and self-reported patient care in an internal medicine residency program. *Ann Intern Med.* Mar 5 2002;136(5):358-367.
5. Maslach C, Schaufeli WB, Leiter MP. Job burnout. *Annual review of psychology.* 2001;52:397-422.
6. 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 Clinic proceedings.* Dec 2015;90(12):1600-1613.
7. Peckham C. *Medscape Cardiologist Lifestyle Report 2017: Race and Ethnicity, Bias and Burnout.* 2017.
8. Shanafelt TD, Balch CM, Bechamps G, et al. Burnout and Medical Errors Among American Surgeons. *Ann Surg.* Jun 2010;251(6):995-1000.
9. Shanafelt TD, Gradishar WJ, Kosty M, et al. Burnout and Career Satisfaction Among US Oncologists. *Journal of Clinical Oncology.* Mar 1 2014;32(7):678-+.
10. Anagnostopoulos F, Liolios E, Persefonis G, Slater J, Kafetsios K, Niakas D. Physician burnout and patient satisfaction with consultation in primary health care settings: evidence of relationships from a one-with-many design. *J Clin Psychol Med Settings.* Dec 2012;19(4):401-410.

11. Dewa CS, Loong D, Bonato S, Trojanowski L. The relationship between physician burnout and quality of healthcare in terms of safety and acceptability: a systematic review. *BMJ Open.* 2017;7(6).

12. Hall LH, Johnson J, Watt I, Tsipa A, O'Connor DB. Healthcare Staff Wellbeing, Burnout, and Patient Safety: A Systematic Review. *PloS one.* 2016;11(7):e0159015.

13. Stroup DF, Berlin JA, Morton SC, et al. Meta-analysis of observational studies in epidemiology: a proposal for reporting. Meta-analysis Of Observational Studies in Epidemiology (MOOSE) group. *JAMA.* Apr 19 2000;283(15):2008-2012.

14. Moher D, Liberati A, Tetzlaff J, Altman DG, Group P. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS medicine.* Jul 21 2009;6(7):e1000097.

15. Maslach C, Jackson S, Leiter M. *Maslach Burnout Inventory Manual.* Palo Alto, CA: Consulting Psychologists Press;; 1996.

16. Bianchi R, Schonfeld IS, Laurent E. Burnout-depression overlap: a review. *Clinical psychology review.* Mar 2015;36:28-41.

17. Vincent C. *Patient Safety* Edinburgh: Churchill Livingstone; 2005.

18. Kanter MH, Nguyen M, Klau MH, Spiegel NH, Ambrosini VL. What Does Professionalism Mean to the Physician? *The Permanente Journal.* Summer 2013;17(3):87-90.

19. Panagioti M, Stokes J, Esmail A, et al. Multimorbidity and Patient Safety Incidents in Primary Care: A Systematic Review and Meta-Analysis. *PLoS ONE.* 2015;10(8):e0135947.

20. Thomas BH, Ciliska D, Dobbins M, Micucci S. A process for systematically reviewing the literature: providing the research evidence for public health nursing interventions. *Worldviews on evidence-based nursing / Sigma Theta Tau International, Honor Society of Nursing.* 2004;1(3):176-184.

21. Higgins JP, Thompson SG, Deeks JJ, Altman DG. Measuring inconsistency in meta-analyses. *Bmj.* Sep 6 2003;327(7414):557-560.

513 **22.** Egger M, Davey Smith G, Schneider M, Minder C. Bias in meta-analysis detected by a
514 simple, graphical test. *Bmj.* Sep 13 1997;315(7109):629-634.
515 **23.** Kontopantelis E, Reeves D. metaan: Random-effects meta-analysis. *Stata Journal.*
516 2010;10(3):395-407.
517 **24.** Sterne JAC, Harbord RM. Funnel plots in meta-analysis. *Stata J.* 2004;4(2):127-141.
518 **25.** Harbord RM, Harris RJ, Sterne JAC. Updated tests for small-study effects in meta-
519 analyses. *Stata J.* 2009;9(2):197-210.
520 **26.** Asai M, Morita T, Akechi T, et al. Burnout and psychiatric morbidity among physicians
521 engaged in end-of-life care for cancer patients: a cross-sectional nationwide survey in
522 Japan. *Psychooncology.* May 2007;16(5):421-428.
523 **27.** Baer TE, Feraco AM, Tuysuzoglu Sagalowsky S, Williams D, Litman HJ, Vinci RJ.
524 Pediatric Resident Burnout and Attitudes Toward Patients. *Pediatrics.* Mar 2017;139(3).
525 **28.** Balch CM, Oreskovich MR, Dyrbye LN, et al. Personal consequences of malpractice
526 lawsuits on American surgeons. *J Am Coll Surg.* Nov 2011;213(5):657-667.
527 **29.** Bourne T, Wynants L, Peters M, et al. The impact of complaints procedures on the
528 welfare, health and clinical practise of 7926 doctors in the UK: a cross-sectional survey.
529 *BMJ Open.* 2015;5(1):e006687.
530 **30.** Brazeau CMLR, Schroeder R, Rovi S, Boyd L. Relationships Between Medical Student
531 Burnout, Empathy, and Professionalism Climate. *Acad Med.* Oct 2010;85:S33-S36.
532 **31.** Brown R, Dunn S, Byrnes K, Morris R, Heinrich P, Shaw J. Doctors' stress responses
533 and poor communication performance in simulated bad-news consultations. *Acad Med.*
534 Nov 2009;84(11):1595-1602.
535 **32.** Chen K-Y, Yang C-M, Lien C-H, et al. Burnout, job satisfaction, and medical malpractice
536 among physicians. *Int J Med Sci.* 2013;10(11):1471-1478.
537 **33.** Cooke GPE, Doust JA, Steele MC. A survey of resilience, burnout, and tolerance of
538 uncertainty in Australian general practice registrars. *BMC Med Educ.* 2013;13:2.

539 **34.** de Oliveira GS, Jr., Chang R, Fitzgerald PC, et al. The prevalence of burnout and
540 depression and their association with adherence to safety and practice standards: a survey
541 of United States anesthesiology trainees. *Anesth Analg.* Jul 2013;117(1):182-193.
542 **35.** Dollarhide AW, Rutledge T, Weinger MB, et al. A real-time assessment of factors
543 influencing medication events. *J Healthc Qual.* Sep-Oct 2014;36(5):5-12.
544 **36.** Eckleberry-Hunt J, Kirkpatrick H, Taku K, Hunt R. Self-Report Study of Predictors of
545 Physician Wellness, Burnout, and Quality of Patient Care. *South Med J.* Apr
546 2017;110(4):244-248.
547 **37.** Fahrenkopf AM, Sectish TC, Barger LK, et al. Rates of medication errors among
548 depressed and burnt out residents: prospective cohort study. *Bmj.* 2008;336(7642):488-
549 491.
550 **38.** Garrouste-Orgeas M, Perrin M, Soufir L, et al. The Iatroref study: medical errors are
551 associated with symptoms of depression in ICU staff but not burnout or safety culture.
552 *Intensive Care Med.* Feb 2015;41(2):273-284.
553 **39.** Halbesleben JRB, Rathert C. Linking physician burnout and patient outcomes: exploring
554 the dyadic relationship between physicians and patients. *Health Care Manage Rev.* Jan-Mar
555 2008;33(1):29-39.
556 **40.** Hansen RP, Vedsted P, Sokolowski I, Sondergaard J, Olesen F. General practitioner
557 characteristics and delay in cancer diagnosis. a population-based cohort study. *BMC Fam*
558 *Pract.* 2011;12:100.
559 **41.** Hayashino Y, Utsugi-Ozaki M, Feldman MD, Fukuhara S. Hope modified the
560 association between distress and incidence of self-perceived medical errors among
561 practicing physicians: prospective cohort study. *PLoS ONE.* 2012;7(4):e35585.
562 **42.** Kalmbach DA, Arnedt T, Song PX, Guille C, Sen S. Sleep Disturbance and Short Sleep
563 as Risk Factors for Depression and Perceived Medical Errors in First-Year Residents.
564 *Sleep.* Mar 1 2017;40(3).

565 **43.** Kang EK, Lihm HS, Kong EH. Association of intern and resident burnout with self-
566 reported medical errors. *Korean J Fam Med.* 2013;34(1):36-42.
567 **44.** Klein J, Grosse Frie K, Blum K, von dem Knesebeck O. Burnout and perceived quality
568 of care among German clinicians in surgery. *Int J Qual Health Care.* 2010;22(6):525-530.
569 **45.** Krebs EE, Garrett JM, Konrad TR. The difficult doctor? Characteristics of physicians
570 who report frustration with patients: an analysis of survey data. *BMC Health Serv Res.*
571 2006;6:128.
572 **46.** Kwah J, Weintraub J, Fallar R, Ripp J. The Effect of Burnout on Medical Errors and
573 Professionalism in First-Year Internal Medicine Residents. *Journal of graduate medical*
574 *education.* Oct 2016;8(4):597-600.
575 **47.** Lafreniere JP, Rios R, Packer H, Ghazarian S, Wright SM, Levine RB. Burned Out at the
576 Bedside: Patient Perceptions of Physician Burnout in an Internal Medicine Resident
577 Continuity Clinic. *J Gen Intern Med.* Feb 2016;31(2):203-208.
578 **48.** Linzer M, Manwell LB, Williams ES, et al. Working conditions in primary care: physician
579 reactions and care quality. *Ann Intern Med.* Jul 7 2009;151(1):28-36, W26-29.
580 **49.** Lu DW, Dresden S, McCloskey C, Branzetti J, Gisondi MA. Impact of Burnout on Self-
581 Reported Patient Care Among Emergency Physicians. *West J Emerg Med.* 2015;16(7):996-
582 1001.
583 **50.** O'Connor P, Lydon S, O'Dea A, et al. A longitudinal and multicentre study of burnout
584 and error in Irish junior doctors. *Postgrad Med J.* Jun 09 2017.
585 **51.** Ozvacic Adzic Z, Katic M, Kern J, Soler JK, Cerovecki V, Polasek O. Is burnout in
586 family physicians in Croatia related to interpersonal quality of care? *Arh Hig Rada*
587 *Toksikol.* Jun 2013;64(2):69-78.
588 **52.** Park C, Lee YJ, Hong M, et al. A Multicenter Study Investigating Empathy and Burnout
589 Characteristics in Medical Residents with Various Specialties. *J Korean Med Sci.* Apr
590 2016;31(4):590-597.

591 **53.** Passalacqua SA, Segrin C. The effect of resident physician stress, burnout, and empathy
592 on patient-centered communication during the long-call shift. *Health Commun.*
593 2012;27(5):449-456.
594 **54.** Pedersen AF, Carlsen AH, Vedsted P. Association of GPs' risk attitudes, level of
595 empathy, and burnout status with PSA testing in primary care. *Br J Gen Pract.* Dec
596 2015;65(641):E845-E851.
597 **55.** Prins JT, van der Heijden FMMA, Hoekstra-Weebers JEHM, et al. Burnout, engagement
598 and resident physicians' self-reported errors. *Psychol Health Med.* Dec 2009;14(6):654-666.
599 **56.** Qureshi HA, Rawlani R, Mioton LM, Dumanian GA, Kim JYS, Rawlani V. Burnout
600 phenomenon in U.S. plastic surgeons: risk factors and impact on quality of life. *Plast*
601 *Reconstr Surg.* Feb 2015;135(2):619-626.
602 **57.** Ratanawongsa N, Roter D, Beach MC, et al. Physician burnout and patient-physician
603 communication during primary care encounters. *J Gen Intern Med.* Oct 2008;23(10):1581-
604 1588.
605 **58.** Shanafelt TD, West C, Zhao X, et al. Relationship between increased personal well-being
606 and enhanced empathy among internal medicine residents. *J Gen Intern Med.* Jul
607 2005;20(7):559-564.
608 **59.** Toral-Villanueva R, Aguilar-Madrid G, Juarez-Perez CA. Burnout and patient care in
609 junior doctors in Mexico City. *Occup Med (Oxf).* Jan 2009;59(1):8-13.
610 **60.** Torres OY, Areste ME, Mora JRM, Soler-Gonzalez J. Association between Sick Leave
611 Prescribing Practices and Physician Burnout and Empathy. *PLoS ONE.* Jul 21
612 2015;10(7).
613 **61.** Travado L, Grassi L, Gil F, Ventura C, Martins C. Physician-Patient Communication
614 among Southern European Cancer Physicians: The Influence of Psychosocial
615 Orientation and Burnout. *Psychooncology.* Aug 2005;14(8):661-670.

62. van den Hombergh P, Kuenzi B, Elwyn G, et al. High workload and job stress are associated with lower practice performance in general practice: an observational study in 239 general practices in the Netherlands. *BMC Health Serv Res.* Jul 15 2009;9.

63. Walocha E, Tomaszewski KA, Wilczek-Ruzyczka E, Walocha J. Empathy and burnout among physicians of different specialities. *Folia Med Cracov.* 2013;53(2):35-42.

64. Weigl M, Schneider A, Hoffmann F, Angerer P. Work stress, burnout, and perceived quality of care: a cross-sectional study among hospital pediatricians. *Eur J Pediatr.* 2015;174(9):1237-1246.

65. Welp A, Meier LL, Manser T. Emotional exhaustion and workload predict clinician-rated and objective patient safety. *Frontiers in psychology.* 2014;5:1573.

66. Wen J, Cheng Y, Hu X, Yuan P, Hao T, Shi Y. Workload, burnout, and medical mistakes among physicians in China: A cross-sectional study. *Biosci Trends.* 2016;10(1):27-33.

67. Weng H-C, Hung C-M, Liu Y-T, et al. Associations between emotional intelligence and doctor burnout, job satisfaction and patient satisfaction. *Med Educ.* Aug 2011;45(8):835-842.

68. West CP, Huschka MM, Novotny PJ, et al. Association of perceived medical errors with resident distress and empathy: a prospective longitudinal study. *Jama.* Sep 6 2006;296(9):1071-1078.

69. West CP, Tan AD, Habermann TM, Sloan JA, Shanafelt TD. Association of resident fatigue and distress with perceived medical errors. *Jama.* Sep 23 2009;302(12):1294-1300.

70. Kontopantelis E, Springate DA, Reeves D. A Re-Analysis of the Cochrane Library Data: The Dangers of Unobserved Heterogeneity in Meta-Analyses. *PLoS ONE.* Jul 26 2013;8(7).

71. McAuley L, Pham B, Tugwell P, Moher D. Does the inclusion of grey literature influence estimates of intervention effectiveness reported in meta-analyses? *Lancet.* Oct 7 2000;356(9237):1228-1231.

642 **72.** Shanafelt TD, Hasan O, Dyrbye LN, et al. Changes in Burnout and Satisfaction With
643 Work-Life Balance in Physicians and the General US Working Population Between 2011
644 and 2014. *Mayo Clinic Proceedings.*90(12):1600-1613.
645 **73.** Shanafelt TD, Boone S, Tan L, et al. BUrnout and satisfaction with work-life balance
646 among us physicians relative to the general us population. *Archives of Internal Medicine.*
647 2012;172(18):1377-1385.
648 **74.** Bates DW, Spell N, Cullen DJ, et al. The costs of adverse drug events in hospitalized
649 patients. Adverse Drug Events Prevention Study Group. *Jama.* 1997;277(4):307-311.
650 **75.** Avery AJ, Rodgers S, Cantrill JA, et al. A pharmacist-led information technology
651 intervention for medication errors (PINCER): a multicentre, cluster randomised,
652 controlled trial and cost-effectiveness analysis. *Lancet.* Apr 7 2012;379(9823):1310-1319.
653 **76.** Khalil H, Bell B, Chambers H, Sheikh A, Avery AJ. Professional, structural and
654 organisational interventions in primary care for reducing medication errors. *Cochrane*
655 *Database Syst Rev.* Oct 4 2017;10:CD003942.
656 **77.** Dyrbye LN, West CP, Shanafelt TD. Defining Burnout as a Dichotomous Variable. *J*
657 *Gen Intern Med.* Mar 2009;24(3):440-440.
658 **78.** West CP, Dyrbye LN, Rabatin JT, et al. Intervention to promote physician well-being,
659 job satisfaction, and professionalism: a randomized clinical trial. *JAMA Intern Med.* Apr
660 2014;174(4):527-533.
661 **79.** Sari AB, Sheldon TA, Cracknell A, Turnbull A. Sensitivity of routine system for
662 reporting patient safety incidents in an NHS hospital: retrospective patient case note
663 review. *Bmj.* Jan 13 2007;334(7584):79.
664 **80.** Mardon RE, Khanna K, Sorra J, Dyer N, Famolaro T. Exploring relationships between
665 hospital patient safety culture and adverse events. *J Patient Saf.* 2010;6(4):226-232.
666 **81.** Hansen LO, Williams MV, Singer SJ. Perceptions of hospital safety climate and incidence
667 of readmission. *Health Serv Res.* Apr 2011;46(2):596-616.

82. Thomas NK. Resident burnout. *Jama.* 2004;292(23):2880-2889.

83. Dyrbye L, Shanafelt TD. A narrative review on burnout experienced by medical students and residents. *Med Educ.* 2016;50(1):132-149.

84. Dyrbye LN, Varkey P, Boone SL, Satele DV, Sloan JA, Shanafelt TD. Physician Satisfaction and Burnout at Different Career Stages. *Mayo Clin Proc.* Dec 2013;88(12):1358-1367.

85. West CP, Dyrbye LN, Erwin PJ, Shanafelt TD. Interventions to prevent and reduce physician burnout: a systematic review and meta-analysis. *Lancet.* Nov 5 2016;388(10057):2272-2281.

86. Panagioti M, Panagopoulou E, Bower P, et al. Controlled Interventions to Reduce Burnout in Physicians A Systematic Review and Meta-analysis. *JAMA Intern Med.* Feb 2017;177(2):195-205.

690 Figure 1: PRISMA flowchart

691 *Figure legend: Flowchart of the inclusion of studies in the review*

692

693 Figure 2: Forest plot of the association between physician burnout and patient safety incidents

694 *Figure legend: Meta-analysis of individual study and pooled effects. Each line represents one study in the meta-*
695 *analysis, plotted according to the logarithmic odds ratios (log OR). The black box on each line shows the log OR*
696 *for each study and the blue box represents the pooled log OR. Random effects model used. 95% CI=95%*
697 *confidence intervals.*

698

699 Figure 3: Forest plot of the association between physician burnout and low professionalism
700 outcomes

701 *Figure legend: Meta-analysis of individual study and pooled effects. Each line represents one study in the meta-*
702 *analysis, plotted according to the logarithmic odds ratios (log OR). The black box on each line shows the log OR*
703 *for each study and the blue box represents the pooled log OR. Random effects model used. 95% CI=95%*
704 *confidence intervals.*

705

706 Figure 4: Forest plot of the association between physician burnout and reduced patient
707 satisfaction

708 *Figure legend: Meta-analysis of individual study and pooled effects. Each line represents one study in the meta-*
709 *analysis, plotted according to the logarithmic odds ratios (log OR). The black box on each line shows the log OR*
710 *for each study and the blue box represents the pooled log OR. Random effects model used. 95% CI=95%*
711 *confidence intervals.*

712

713

714 **Table 1: Descriptive characteristics of included studies**

Study	Country	Healthcare setting	Research design	N	Men	Mean age	Burnout measure	Depression/ distress measure	Patient safety	Professionalism	Patient satisfaction	Risk of bias
Anagnosto-poulos et al. [10] 2012	Greece	Physicians in 3 large primary care centers	Cross-sectional	30	85%	48 years	MBI	n/r	n/r	n/r	Patient satisfaction	2
Asai et al.[26] 2013	US	Physicians in of life care (Hospitals and cancer centers)	Cross-sectional	697	92%	45 years	MBI	General Health Questionnaire	n/r	Self-reported non-optimal communication	n/r	1
Baer et al.[27] 2017	US	Residents in 11 pediatric residency programs	Cross-sectional	258	21%	29 years	2-items from MBI	n/r	Self-reported medical errors	Self-reported non-optimal communication	n/r	1
Balch et al.[28] 2011	US	Surgeons, members of the American College of Surgeons (hospitals)	Cross-sectional	7164	85%	53 years	MBI	2-item Primary Care Evaluation of Mental Disorders	n/r	Self-reported malpractice claims	n/r	1
Bourne et al.[29] 2015	UK	Physicians registered to the British Medical Association	Cross-sectional	7926	54%	n/r	n/r	General Health Questionnaire	n/r	Self-reported patient complaints	n/r	0
Brazeau et al.[30] 2010	US	Faculty and resident physicians in 1 hospital	Cross-sectional	125	52%	n/r	MBI	n/r	n/r	Self-reported professionalism	n/r	2
Brown et al.[31] 2009	Australia	Interns or residents in 1 hospital	Cross-sectional	24	60%	42 years	MBI	n/r	n/r	Self-reported non-optimal communication	n/r	1

Chen et al.[32] 2013	Taiwan	Physicians registered in several medical associations	Cross-sectional	839	79%	36 years	MBI	n/r	n/r	Self-reported malpractice claims	n/r	2
Cooke et al.[33] 2013	Australia	General practitioners in primary care	Cross-sectional	128	33%	35 years	1-item for emotional exhaustion subscale of MBI	n/r	n/r	Self-reported non-optimal communication	n/r	1
de Oliveira et al.[34] 2013	US	Anesthesiology residents in hospitals	Cross-sectional	1508	54%	33 years	MBI	n/r	Self-reported medical errors	Self-reported safety practice scores	n/r	1
Dollarhide et al.[35] 2014	US	Physicians in 4 hospitals	Cross-sectional	185	46%	30 years	n/r	Emotional stress using the Diary of Ambulatory Behavioral States	Self-reported medication errors	n/r	n/r	1
Eckleberry-Hunt et al[36] 2017	US	Physicians registered in American Academy of Family Physicians	Cross-sectional	449	54%	42 years	MBI	n/r	n/r	Self-reported quality of patient care	n/r	1
Frahrenkopf et al.[37] 2008	US	Residents in pediatric residency hospitals	Prospective	123	30%	29 years	MBI	Harvard depression scale	Medication errors identified by surveillance	n/r	n/r	1
Garrouste-Orgeas et al.[38] 2015	France	Physicians in 31 Intensive Care Units	Prospective	540	58%	33 years	MBI	CES-Depression scale	Self-reported medical errors	n/r	n/r	3
Halbesleben et al.[39] 2008	US	Primary care physicians of hospitalized patients in 1 hospital	Cross-sectional	178	47%	46 years	MBI	n/r	n/r	n/r	Patient satisfaction	1

Hansen et al.[40] 2011	Denmark	Primary care physicians of a national cohort of cancer patients	Cross-sectional	334	70%	n/r	MBI	n/r	Delayed cancer diagnosis based on patient records	n/r	n/r	2
Hayashino et al.[41] 2012	Japan	Physicians based in hospitals approached by a national survey.	Prospective	836	92%	46 years	MBI	WHO depression index	Self-reported medical errors	n/r	n/r	3
Kalmbach et al.[42] 2017	US	Physicians of several specialties in 33 hospitals	Prospective	1215	31%	28 years	n/r	Patient Health Questionnaire-9	Self-reported medical errors	n/r	n/r	3
Kang et al.[43] 2013	Korea	Interns and residents working in 1 university hospital	Cross-sectional	86	74%	37 years	MBI	2-item Primary Care Evaluation of Mental Disorders	Self-reported medical errors	n/r	n/r	1
Klein et al.[44] 2010	Germany	Surgeons in general hospitals	Cross-sectional	1311	60%	n/r	Copenhagen Burnout Inventory	n/r	Self-reported therapeutic errors	Self-reported quality of patient care	n/r	1
Krebs et al.[45] 2006	US	Primary care physicians responded to the Physician Worklife Survey	Cross-sectional	1391	77%	47 years	n/r	One 5-point Likert scale for depression	n/r	Self-reported non-optimal communication	n/r	1
Kwah et al.[46] 2017	US	1st year residents in 1 hospital	Prospective	54	50%	32 years	MBI	n/r	Prescription errors in system records	Professionalism (discharge practices)	n/r	2

Lafreniere et al.[47] 2016	US	Internal medicine residents in 1 large urban academic hospital	Cross-sectional	44	43%	51 years	MBI	n/r	n/r	n/r	Patient-reported empathy	2
Linzer et al.[48] 2009	US	General internists and family physicians in 119 ambulatory clinics	Cross-sectional	422	56%	43 years	Validated single item from MBI	n/r	Medical errors in system records	Quality of patient care (using system indicators)		1
Lu et al.[49] 2015	US	Attending and post-graduate physicians in emergency department	Cross-sectional	77	62%	n/r	MBI	n/r	Self-reported treatment errors	Self-reported professionalism (discharge practices)	n/r	0
O'Connor et al.[50] 2017	Ireland	Interns in 5 national intern-training hospitals	Prospective	172	44%	27 years	MBI	n/r	Self-reported medical errors	n/r	n/r	2
Ozvacic Adzic et al.[51] 2012	Croatia	Physicians working in family practices selected randomly using a multistage, stratified proportional study selection design	Cross-sectional	125	18%	46 years	MBI	n/r	n/r	Professionalism (consultation length)	Patient-reported enablement	0
Park et al.[52] 2016	Korea	Physicians in 4 university hospitals	Cross-sectional	317	68%	30 years	MBI	n/r	n/r	Self-reported empathy	n/r	0
Passalacqua et al.[53] 2012	US	Residents in internal medicine rotating between 3 hospitals	Cross-sectional	93	70%	30 years	MBI	n/r	n/r	Self-reported non-optimal communication	n/r	0
Pedersen et al.[54] 2016	Denmark	General practitioners registered in Regional Registry of Health Providers	Cross-sectional	129	100%	49 years	MBI	n/r	n/r	Professionalism (test practices)	n/r	2

Prins et al.[55] 2009	Netherlands	Residents receiving training for a referral specialty	Cross-sectional	2115	39%	32 years	MBI	n/r	Self-reported action errors	n/r	n/r	1
Qureshi et al.[56] 2015	US	Plastic surgeons members of the American Society of Plastic Surgeons	Prospective	1691	75%	51 years	MBI	n/r	Self-reported medical errors	n/r	n/r	2
Ratanawongsa et al.[57] 2008	US	Physicians in 5 primary care practices	Prospective	40	34%	42 years	Six-item scale derived from MBI	n/r	n/r	Self-reported empathy	Patient satisfaction	2
Shanafelt et al.[4] 2002	US	Residents in the university of Washington Affiliated Hospitals Internal Medicine Residency program	Cross-sectional	115	47%	28 years	MBI	n/r	n/r	Self-reported quality of patient care	n/r	2
Shanafelt et al.[58] 2005	US	Internal medicine residents at Mayo Clinic Rochester	Cross-sectional	115	70%	28 years	MBI	n/r	n/r	Self-reported empathy	n/r	2
Shanafelt et al.[8] 2010	US	Surgeons, members of the American College of Surgeons	Cross-sectional	7905	87%	51 years	MBI	2-item Primary Care Evaluation of Mental Disorders	Self-reported medical errors	n/r	n/r	2
Toral-Villanueva et al.[59] 2009	Mexico	Junior doctors in 3 hospitals	Cross-sectional	312	57%	28 years	MBI	n/r	n/r	Self-reported quality of patient care	n/r	1
Torres et al.[60] 2015	Spain	Physicians in 22 primary care centers	Cross-sectional	108	46%	49 years	MBI	n/r	n/r	Professionalism (system-recorded sick leave)	n/r	0

Travado et al.[61]	Italy	Physicians in cancer centers of 3 hospitals	Cross-sectional	125	46%	42 years	MBI	n/r	n/r	Self-reported non-optimal communication)	n/r	1
van der Hombergh et al.[62] 2009	Netherlands	General practitioners in 239 general practices	Cross-sectional	546	61%	47 years	GP burnout involving experience of inappropriate patient demands, commitment with the job, excessive workload	n/r	n/r	Self-reported quality of patient care	Patient satisfaction	1
Walocha et al.[63] 2013	Poland	Physicians working in surgical and non-surgical hospital wards and primary care outpatient departments	Cross-sectional	71	64%	n/r	MBI	n/r	n/r	Self-reported empathy	n/r	0
Weigl et al.[64] 2015	Germany	Physicians in 1 pediatric hospital	Cross-sectional	96	47%	38 years	MBI	n/r	n/r	Self-reported quality of patient care	n/r	2
Welp et al.[65] 2014	Switzerland	Physicians Intensive Care Units	Cross-sectional	243	50%	39 years	MBI	n/r	Self-reported safety errors	n/r	n/r	1
Wen et al.[66] 2016	China	Physicians in 44 hospitals providing tertiary, secondary, and 25 primary care	Cross-sectional	1537	56%	38 years	MBI	n/r	Self-reported medical errors	n/r	n/r	2
Weng et al.[67] 2011	Taiwan	Internists in 2 hospitals	Cross-sectional	110	85%	41 years	MBI	n/r	n/r	n/r	Patient satisfaction	1

West et al.[68] 2006	US	Internal Medicine Residency program in Mayo Clinic in academic years between 2003 to 2006	Prospective	184	51%	28 years	MBI	2-item Primary Care Evaluation of Mental Disorders	Self-reported medical errors	n/r	n/r	3
West et al.[69] 2009	US	Internal Medicine Residency program in Mayo Clinic between July 2003 and February 2009	Prospective	380	62%	28 years	MBI	2-item Primary Care Evaluation of Mental Disorders	Self-reported medical errors	n/r	n/r	3

715 MBI= Maslach Burnout Inventory; N= sample size; n/r=not reported.