



HAL
open science

Suicide among physicians and health-care workers: A systematic review and meta-analysis

Frédéric Dutheil, Claire Aubert, Bruno Pereira, Michael Dambrun, Fares Moustafa, Martial Mermillod, Julien Baker, Marion Trousselard, François-Xavier Lesage, Valentin Navel

► To cite this version:

Frédéric Dutheil, Claire Aubert, Bruno Pereira, Michael Dambrun, Fares Moustafa, et al.. Suicide among physicians and health-care workers: A systematic review and meta-analysis. PLoS ONE, 2019, 14 (12), pp.e0226361. 10.1371/journal.pone.0226361 . hal-02971858

HAL Id: hal-02971858

<https://hal.science/hal-02971858>

Submitted on 26 May 2021

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



Distributed under a Creative Commons Attribution 4.0 International License

RESEARCH ARTICLE

Suicide among physicians and health-care workers: A systematic review and meta-analysis

Frédéric Dutheil^{1,2}*, Claire Aubert³, Bruno Pereira⁴, Michael Dambrun⁵, Fares Moustafa⁶, Martial Mermillod^{7,8}, Julien S. Baker⁹, Marion Trousselard¹⁰, François-Xavier Lesage¹¹, Valentin Navel¹²

1 Université Clermont Auvergne, CNRS, LaPSCo, Physiological and Psychosocial Stress, CHU Clermont-Ferrand, University Hospital of Clermont-Ferrand, Occupational and Preventive Medicine, WittyFit, Clermont-Ferrand, France, **2** Australian Catholic University, Faculty of Health, School of Exercise Science, Melbourne, Victoria, Australia, **3** Université de Versailles Saint-Quentin-en-Yvelines, Faculty of Health Science Simone Veil, Versailles, France, **4** CHU Clermont-Ferrand, University Hospital of Clermont-Ferrand, Biostatistics Unit, the Clinical Research and Innovation Direction, Clermont-Ferrand, France, **5** Université Clermont Auvergne, CNRS, LaPSCo, Physiological and Psychosocial Stress, Clermont-Ferrand, France, **6** CHU Clermont-Ferrand, University Hospital of Clermont-Ferrand, Emergency, Clermont-Ferrand, France, **7** Univ. Grenoble Alpes, Univ. Savoie Mont Blanc, CNRS, LPNC, Grenoble, France, **8** Institut Universitaire de France, Paris, France, **9** Centre for Health and Exercise Science Research, Department of Sport, Physical Education and Health, Hong Kong Baptist University, Kowloon Tong, Hong Kong, **10** French Armed Forces Biomedical Research Institute-IRBA, Neurophysiology of Stress, Neuroscience and Operational Constraint Department, Brétigny-sur-Orge, France, **11** University of Montpellier, Laboratory Epsilon EA, Dynamic of Human Abilities & Health Behaviors, CHU Montpellier, University Hospital of Montpellier, Occupational and Preventive Medicine, Montpellier, France, **12** CHU Clermont-Ferrand, University Hospital of Clermont-Ferrand, Ophthalmology, Clermont-Ferrand, France

* These authors contributed equally to this work.

* frederic.dutheil@uca.fr



OPEN ACCESS

Citation: Dutheil F, Aubert C, Pereira B, Dambrun M, Moustafa F, Mermillod M, et al. (2019) Suicide among physicians and health-care workers: A systematic review and meta-analysis. PLoS ONE 14(12): e0226361. <https://doi.org/10.1371/journal.pone.0226361>

Editor: Takeru Abe, Yokohama City University, JAPAN

Received: July 31, 2019

Accepted: November 24, 2019

Published: December 12, 2019

Peer Review History: PLOS recognizes the benefits of transparency in the peer review process; therefore, we enable the publication of all of the content of peer review and author responses alongside final, published articles. The editorial history of this article is available here: <https://doi.org/10.1371/journal.pone.0226361>

Copyright: © 2019 Dutheil et al. This is an open access article distributed under the terms of the [Creative Commons Attribution License](https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Data Availability Statement: All relevant data are within the manuscript and its Supporting Information files.

Abstract

Background

Medical-related professions are at high suicide risk. However, data are contradictory and comparisons were not made between gender, occupation and specialties, epochs of times. Thus, we conducted a systematic review and meta-analysis on suicide risk among health-care workers.

Method

The PubMed, Cochrane Library, Science Direct and Embase databases were searched without language restriction on April 2019, with the following keywords: suicide* AND (« health care worker* » OR physician* OR nurse*). When possible, we stratified results by gender, countries, time, and specialties. Estimates were pooled using random-effect meta-analysis. Differences by study-level characteristics were estimated using stratified meta-analysis and meta-regression. Suicides, suicidal attempts, and suicidal ideation were retrieved from national or local specific registers or case records. In addition, suicide attempts and suicidal ideation were also retrieved from questionnaires (paper or internet).

Funding: The authors received no specific funding for this work.

Competing interests: The authors have declared that no competing interests exist.

Results

The overall SMR for suicide in physicians was 1.44 (95CI 1.16, 1.72) with an important heterogeneity ($I^2 = 93.9\%$, $p < 0.001$). Female were at higher risk (SMR = 1.9; 95CI 1.49, 2.58; and ES = 0.67; 95CI 0.19, 1.14; $p < 0.001$ compared to male). US physicians were at higher risk (ES = 1.34; 95CI 1.28, 1.55; $p < 0.001$ vs Rest of the world). Suicide decreased over time, especially in Europe (ES = -0.18; 95CI -0.37, -0.01; $p = 0.044$). Some specialties might be at higher risk such as anesthesiologists, psychiatrists, general practitioners and general surgeons. There were 1.0% (95CI 1.0, 2.0; $p < 0.001$) of suicide attempts and 17% (95CI 12, 21; $p < 0.001$) of suicidal ideation in physicians. Insufficient data precluded meta-analysis on other health-care workers.

Conclusion

Physicians are an at-risk profession of suicide, with women particularly at risk. The rate of suicide in physicians decreased over time, especially in Europe. The high prevalence of physicians who committed suicide attempt as well as those with suicidal ideation should benefits for preventive strategies at the workplace. Finally, the lack of data on other health-care workers suggest to implement studies investigating those occupations.

Introduction

Suicide risk was increased in certain occupational groups, especially in medical-related professions [1]. Physicians, and other health-care workers such as nurses [2,3], were considered like high risk group of suicide in different countries [4,5,6], especially for women [6,7,8]. Indeed, despite considerably higher risk of suicides in men than women in the general population [9], female doctors have higher suicide rates than men [10], putatively because of their social family role [11], or a poor status integration within the profession [7]. Suicide rate in physicians was also not homogenous in all countries [12], and physicians' satisfaction has been reported to change between different epochs of times [13]. Physicians working conditions varied substantially between countries and over contemporary times, these factors were never investigated in relationships with suicide in physicians. For example, there were tentative to regulate working time of physicians over the recent years, such as in Europe with its European Working Time Directive (EWT) [14]. Some specialties have been suggested to be particularly at risk of suicides [15,16] with occupational factors individualized in different medical or surgical specialties: heavy workload and working hours involved in the job such as long shifts and unpredictable hours (with the sleep deprivation associated) [17], stress of the situations (life and death emergencies) [18], and easy access to a means of committing suicide [19]. To implement coordinated and synergistic preventive strategies, we need to identify physicians in mental health suffering [20], therefore statistical analyses on suicide attempts and suicidal ideation were necessary. However, robust statistics on health-care workers were desperately lacking for suicides, suicide attempts and suicidal ideation. The latest meta-analysis summarized physicians suicide risk before 2000s [6], we need for updated synthesis of literature. We hypothesized that 1) physicians are more at risk to commit suicide than the general population, 2) women physicians are more at risk to commit suicide than their male counterparts, 3) some countries would have higher rates of suicide in physicians, 4) with an improvement over time, 5) some medical or surgical specialties would be at higher risk of suicide, 6) physicians would also exhibit higher rates of suicide attempts and suicidal ideation, and 7) other health care workers would also be at risk of suicide.

Thus, we aimed to conduct a systematic review of the literature and meta-analysis to provide evidence-based data for suicide risk among health-care workers, considering gender, geographic zone, epoch of time, medical and surgical specialties. Finally, we wanted to expand our study to suicide attempts and suicidal ideation.

Methods

Search strategy and study eligibility

We reviewed all studies involving suicides, suicide attempts or suicidal ideation in health-care workers. Students were excluded because of the difference in responsibilities in comparisons with health-care workers, and because of the existence of previous recent meta-analyses focusing specifically on health-care students [21,22,23,24]; we included interns because they were not included in the aforementioned meta-analyses on prevalence of suicides, suicide attempts or suicidal ideation, and because they could have similar responsibilities to senior practitioners. The PubMed, Cochrane Library, Science Direct and Embase databases were searched on April 2019, with the following keywords: suicide* AND (« health care worker* » OR physician* OR nurse*). The search was not limited by years or languages. To be included, articles had to be peer-reviewed and to describe original empirical data on suicides, suicide attempt or suicidal ideation in health-care workers. When data were available, we also collected data from a control group (such as general population) for comparisons purposes. In addition, reference lists of all publications meeting the inclusion criteria will be manually searched to identify any further studies not found through digital research. The search strategy was presented in Fig 1. Three authors (Claire Aubert, Valentin Navel and Frederic Dutheil) conducted all literature searches, and separately reviewed the abstracts and decided the suitability of the articles for inclusion. Two others authors (Bruno Pereira and Martial Mermillod) have been asked to review the articles when consensus on suitability was debated. Then all authors reviewed the eligible articles.

Quality of assessment

Although not designed for quantifying the integrity of studies [25], the “STrengthening the Reporting of Observational studies in Epidemiology” (STROBE) criteria [26] and Newcastle-Ottawa Scale (NOS) were used to check the quality of articles [27]. The maximum score in STROBE criteria was 30 with assessment of 22 items, in NOS criteria was 9 with assessment of 8 items (one star for each item within the selection and exposure category and a maximum of two stars for comparability) (Figs 2 and 3).

Statistical considerations

Statistical analysis was conducted using Comprehensive Meta-analysis software (version 2, Biostat Corporation) [28,29,30] and Stata software (version 13, StataCorp, College Station, US) [28,29,31]. Main characteristics were summarized for each study sample and reported as mean (standard-deviation) and number (%) for continuous and categorical variables respectively. Statistical heterogeneity between results was assessed by examining forest plots, confidence intervals (CI) and using formal tests for homogeneity based on I^2 statistic, which is the most common metric for measuring the magnitude of heterogeneity between studies and is easily interpretable. I^2 values range between 0% and 100% and are typically considered low for <25%, moderate for 25–50%, and high for > 50%. Random effect meta-analysis (DerSimonian and Liard approach) were conducted when data could be pooled [32]. P values < 0.05 were considered statistically significant. We conducted: 1) meta-analyses on the Standardized Mortality Ratio (SMR) for suicides i.e. the ratio between the observed and expected number of

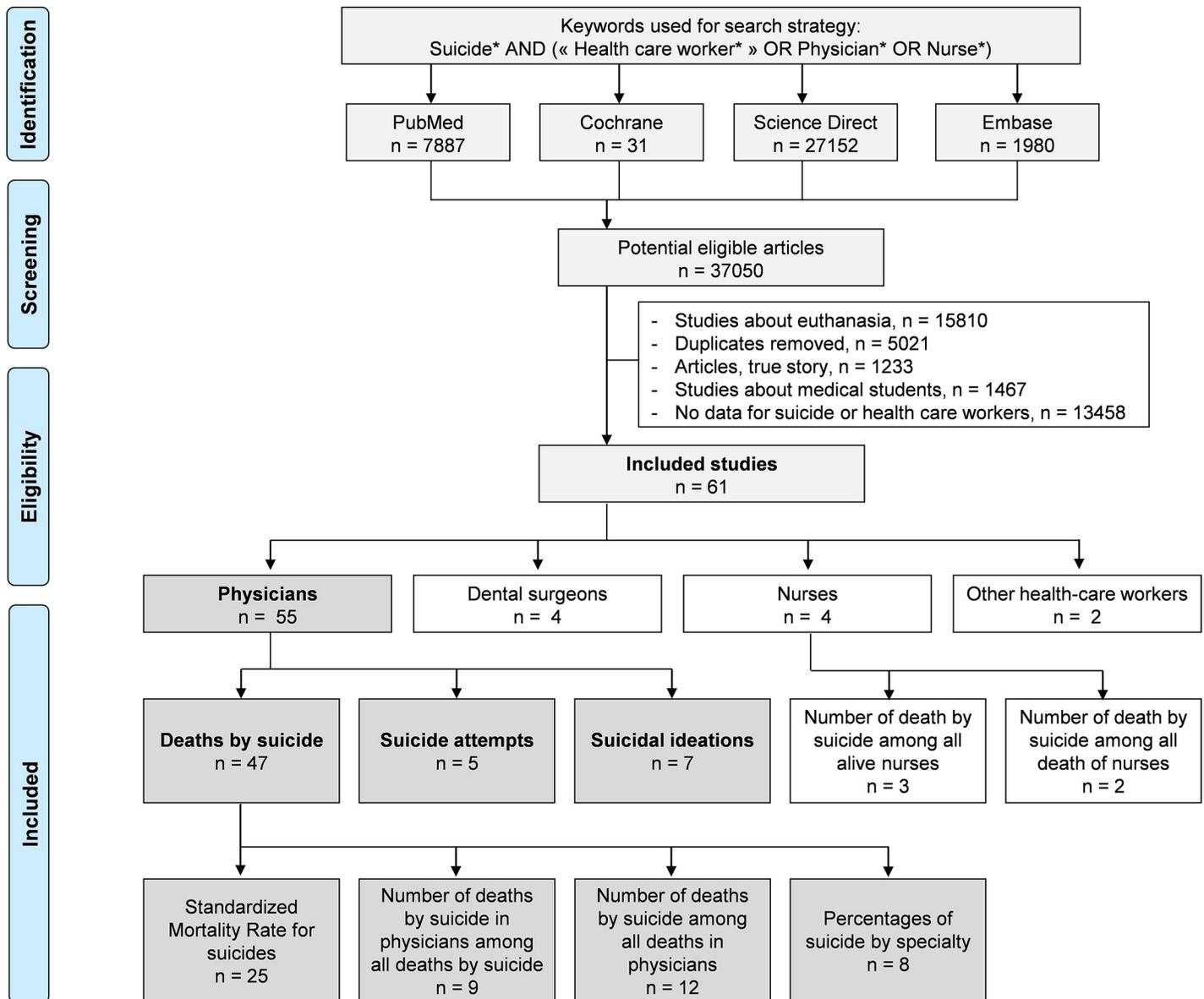


Fig 1. Search strategy.

<https://doi.org/10.1371/journal.pone.0226361.g001>

death among physicians, stratified by sex (Fig 4; and Fig 5 for metaregressions), geographic zones (Fig 6), epochs of time, and by categories of specialties (main groups of specialties (Fig 7 and S1 Fig), surgical specialties (Fig 8 and S2 Fig), then medical specialties (Fig 9 and S3 Fig), 2) meta-analyses on the prevalence of health-care workers died by suicide among all health-care workers death (Fig 10), 3) meta-analyses on the prevalence of health-care workers died by suicide among all the deaths by suicide in the general population (S4 Fig), 4) meta-analyses on suicide attempts (S5 Fig) and suicidal ideation (Fig 11). Effect-size was estimated for quantitative endpoints as number of physicians having done suicide attempt and number of physicians with suicidal ideation. A scale for ES has been suggested with 0.8 reflecting a large effect, 0.5 a moderate effect, and 0.2 a small effect [33]. When possible (sufficient sample size), meta-regressions were proposed to study relation between prevalence and epidemiological relevant

Methodological quality of included articles using Newcastle – Ottawa Quality Assessment Scale
 Yes: +
 No: -
 Can't say: ?
 Not applicable: NA

	Selection bias			Comparability bias			Outcome bias		
	Representativeness of the exposed	Selection of the non exposed	Ascertainment of exposed	Outcome of interest was no present at start	Study controls for the most important factor	Study controls for any important factor	Assessment of outcome follow-up long enough	Adequacy of follow up	
Aasland 2001	+	+	+	+	+	+	+	+	
Aasland 2011	+	+	+	+	+	+	+	+	
Arnetz 1987	+	+	+	+	+	?	+	+	
Austin 2013	+	+	+	+	NA	+	+	+	
Baymar 1986	+	+	+	+	+	?	+	+	
Brooks 2017	-	+	-	+	+	+	-	+	
Carpenter 1997	+	+	+	+	+	-	+	+	
Craig 1968	+	+	+	+	+	+	+	+	
Davidson 2018	+	+	+	+	+	+	+	+	
Dean 1969	+	+	+	+	+	+	-	+	
Desole 1969	+	NA	+	+	NA	NA	+	+	
Everson 1975	+	NA	+	+	+	+	-	+	
Franck 1999	-	+	-	-	+	+	NA	-	
Franck 2000	+	+	+	+	+	+	+	+	
Fridner 2009	+	+	-	NA	+	?	-	-	
Gagne 2011	+	+	+	+	+	+	+	+	
Gold 2013	+	+	+	+	+	+	+	+	
Gunnarsdottir 1995	+	+	+	+	+	?	+	+	
Hawton 2001	+	+	+	+	+	+	+	+	
Hawton 2002	+	+	+	+	+	+	+	-	
Hawton 2011	+	+	+	+	+	+	+	+	
Hem 2000	-	+	-	+	+	?	-	-	
Hem 2005	+	+	+	+	+	+	+	+	
Hemenway 1993	-	?	+	+	+	?	-	-	
Herner 1993	NA	NA	NA	NA	NA	NA	NA	NA	
Hikiji 2013	+	+	+	+	+	+	+	+	
Hubbard 1922	NA	NA	NA	NA	NA	NA	NA	NA	
Innos 2002	-	+	+	+	+	+	+	+	
Jones 1977	-	NA	+	+	+	+	-	+	
Juel 1999	+	+	+	+	+	+	+	+	
Lew 1979	+	NA	+	+	+	+	+	+	
Linde 1981	+	+	+	+	+	+	+	+	
Lindeman 1997	+	+	+	+	+	+	+	+	
Lindeman 2007	+	+	+	+	+	?	-	+	
Lindfors 2009	+	?	+	+	+	+	-	-	
Lindhardt 1963	+	+	+	+	+	?	+	+	
Loas 2018	+	+	-	+	+	NA	-	-	
Mintz 2018	+	+	+	+	+	+	+	+	
No author 1986	+	+	+	+	+	+	-	-	
Nordentoft 1988	NA	NA	NA	NA	NA	NA	NA	NA	
Olkinuora 1990	+	+	+	+	+	+	+	+	
Palhares-Alves 2015	+	+	+	+	+	+	+	+	
Petersen 2008	+	+	+	+	+	+	+	+	
Pitts 1979	+	+	+	+	+	+	+	+	
Rafnsson 1998	NA	NA	NA	NA	NA	NA	NA	NA	
Revicki 1985	+	+	+	+	+	+	+	+	
Rich 1979	+	+	+	+	+	+	+	+	
Rich1980	+	?	+	+	+	+	+	+	
Rimpela 1987	+	+	+	+	+	+	+	+	
Rose 1973	+	?	+	+	+	+	+	+	
Roy 1985	NA	NA	NA	NA	NA	NA	NA	NA	
Samkoff 1995	+	+	+	+	+	-	+	+	
Schlicht 1990	+	+	+	+	+	+	+	+	
Shang 2011	+	+	+	+	+	+	+	+	
Shang 2012	+	+	+	?	+	?	+	+	
Simon 1968	-	-	+	+	+	-	-	+	
Stefansson 1991	+	+	+	+	+	+	+	+	
Torre 2005	+	+	+	+	+	+	+	+	
Ulmann 1991	+	+	+	+	+	+	+	+	
Wang 2017	-	-	-	+	?	?	-	?	
Zang 2018	+	+	+	+	+	+	+	+	

Fig 2. Methodological quality of included articles using Newcastle–Ottawa Quality Assessment Scale.

<https://doi.org/10.1371/journal.pone.0226361.g002>

parameters determined according to the literature: sex, geographic zone, epoch of time (for studies with a follow-up over several consecutive years, we based our statistics on the mean year of epoch of time). Results were expressed as regression coefficient and 95% CI.

Results

An initial search produced a possible 37050 articles (Fig 1). Removal of duplicates and use of the selection criteria reduced the search to 61 articles [1, 2, 5, 7, 8, 15, 16, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87]. In those 61 articles, 55 articles were on physicians [1, 5, 7, 8, 15, 16, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 82, 83, 84, 85], four on dental surgeons [55, 56, 62, 70], four on nurses [2, 79, 80, 86], and two on other health-care workers [70, 87]. Among those 55 on physicians, 47 reported data on deaths by suicide [1, 5, 7, 8, 15, 16, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 82, 83], five on suicide attempts [47, 73, 75, 77, 85], and seven on suicidal ideation [74, 75, 76, 77, 78, 84, 85]. In those 47 articles on deaths by suicide among physicians, 25 described SMR for suicide [7, 8, 41, 46, 52, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 82], eight reported percentages of suicide by specialty [15, 16, 40, 43, 45, 47, 51, 83], 12 reported the number of physicians died by suicide among all deaths in

Risk of bias summary Cohort Studies

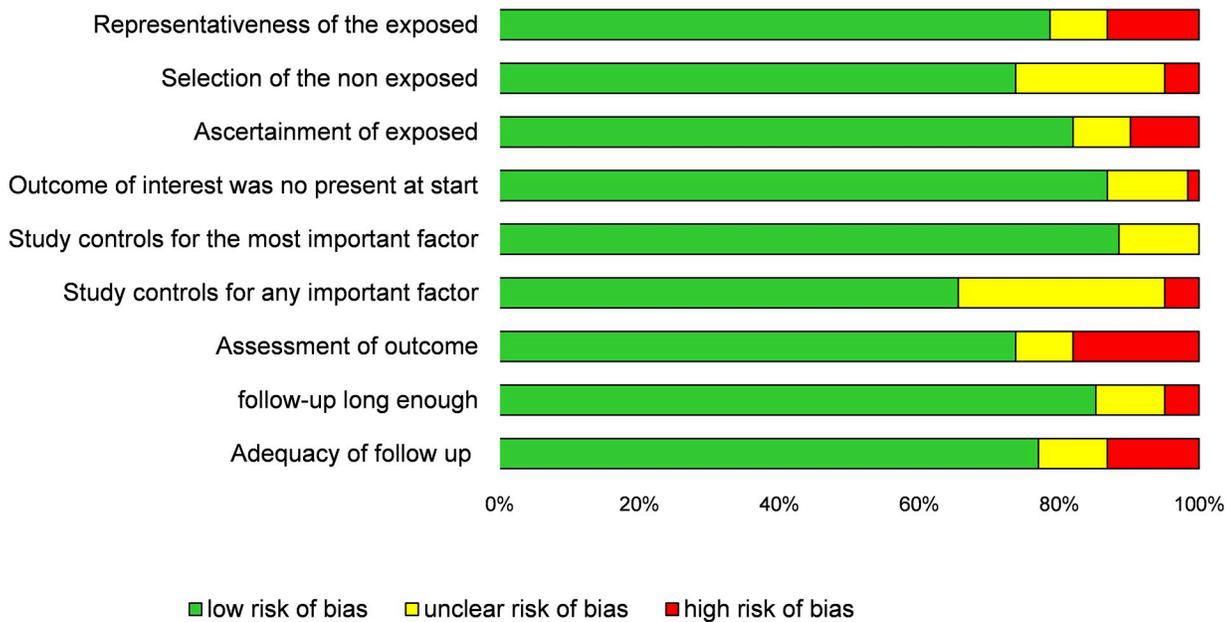


Fig 3. Summary bias risk of included articles using the Newcastle–Ottawa Quality Assessment Scale model.

<https://doi.org/10.1371/journal.pone.0226361.g003>

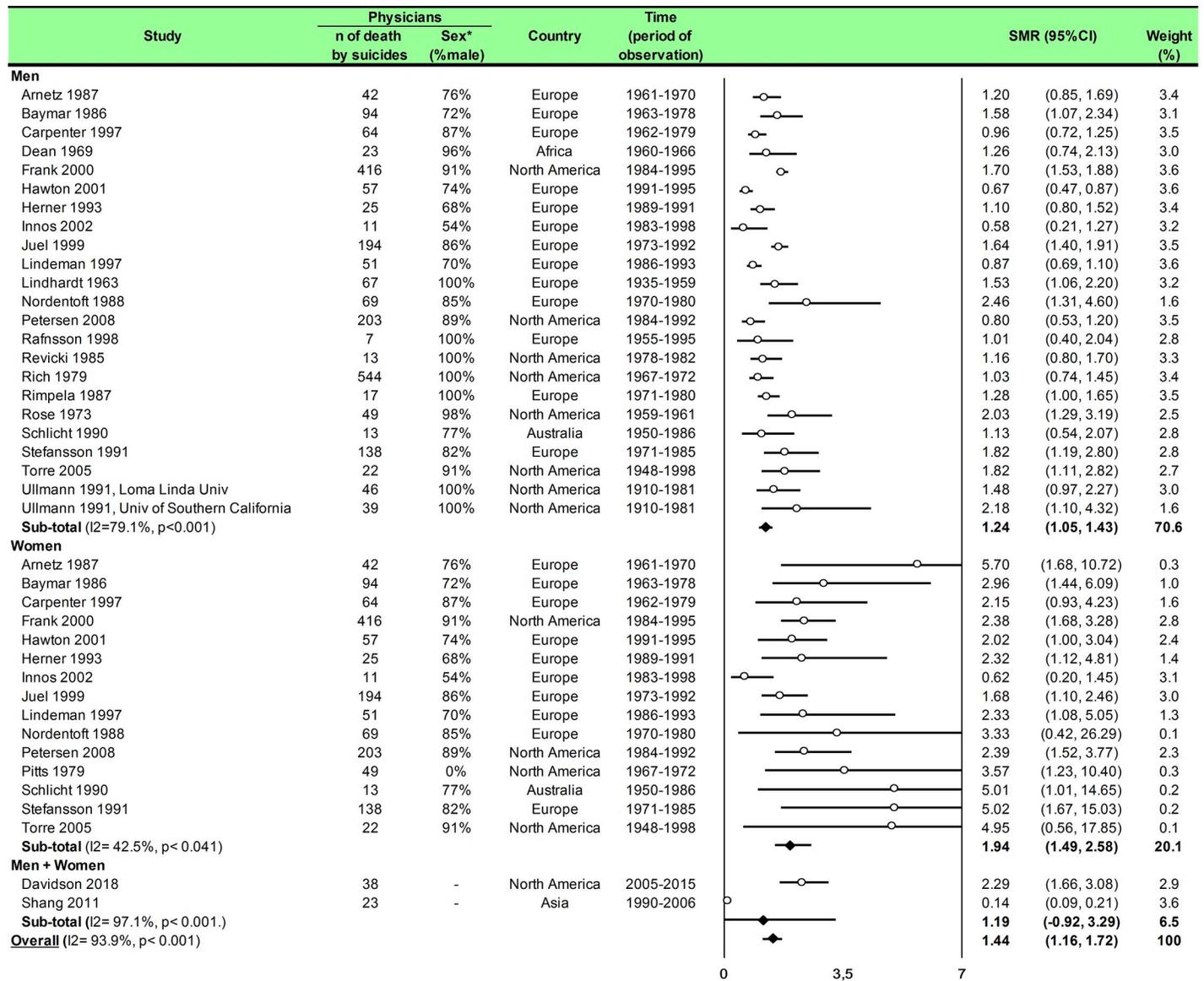


Fig 4. Meta-analysis of standardized mortality rate for suicides among physicians by gender.

<https://doi.org/10.1371/journal.pone.0226361.g004>

physicians [16,39,41,42,44,46,48,49,50,51,52,53], and nine reported the number of physicians died by suicide among all the deaths by suicide in the general population [1,5,15,34,35,36,37,38,82]. As there are few exploitable studies about dental surgeons, nurses and other health-care workers, we won't treat them in that meta-analysis.

More details on study characteristics (Table 1), quality of articles (Figs 2 and 3), method of sampling for markers analysis, inclusion and exclusion criteria, characteristics of participants, outcomes and aims of the studies, and study designs of included articles are described in S1 Appendix.

Meta-analysis of the standardized mortality rate for suicides among physicians

We included 25 studies. The overall SMR was 1.44 (95CI 1.16, 1.72) with an important heterogeneity ($I^2 = 93.9\%$). Among the 25 included studies, 17 studies reported both male and female

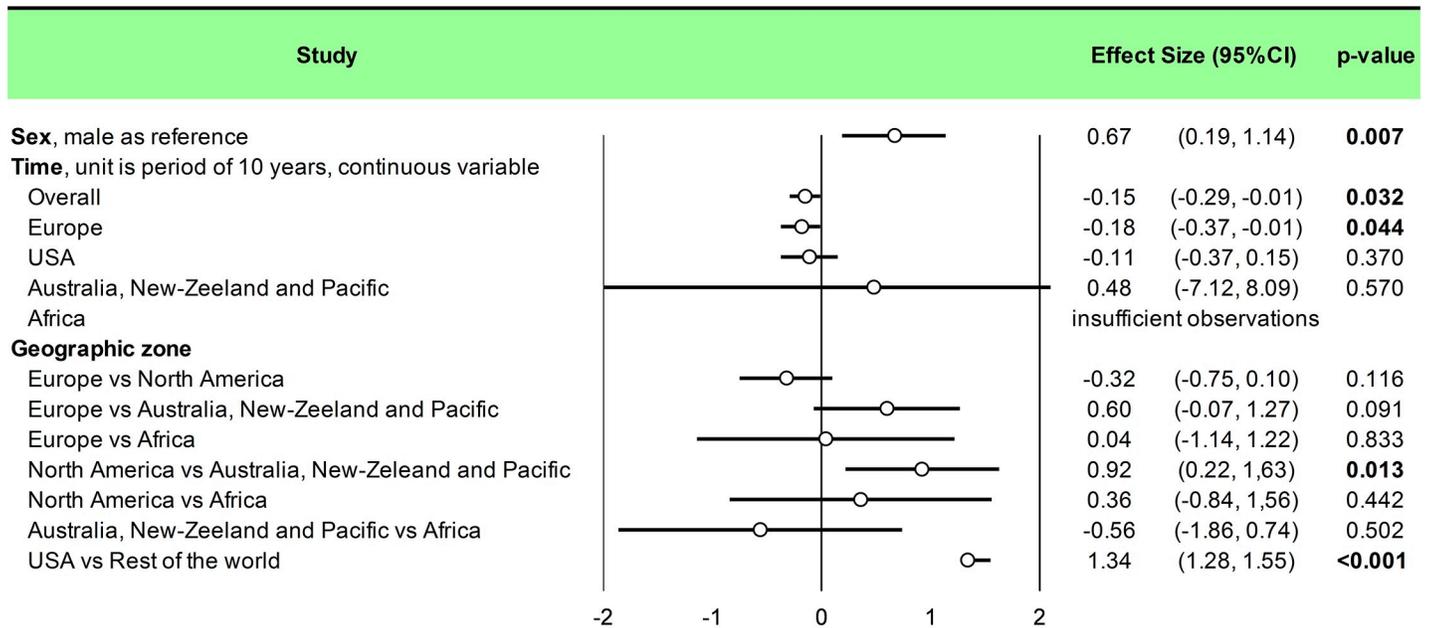


Fig 5. Meta-regression of standardized mortality rate for suicides among physicians.

<https://doi.org/10.1371/journal.pone.0226361.g005>

physicians [7,8,41,46,52,54,55,56,57,58,59,61,62,68,70,71,82], six reported only male physicians [60,64,65,66,67,72], and one only reported female physicians [63]. We found a significantly higher risk of suicide among male physicians than in the general population (SMR = 1.24; 95CI 1.05, 1.43; $P < 0.001$; $I^2 = 79.1\%$) and for suicide among female physicians than in the general population (SMR = 1.94; 95CI 1.49, 2.58; $P < 0.041$; $I^2 = 42.5\%$) (Fig 4). Meta-regressions demonstrated that women physicians had a higher risk than their counterpart men to commit suicide (0.67; 95CI 0.19, 1.14; $P = 0.007$) (Fig 5). We further demonstrated that the risk of suicide was not homogeneous over all the countries. SMR was 1.27 (95CI 1.05, 1.49; $P < 0.001$; $I^2 = 71.3\%$) in Europe, 1.63 (95CI 1.29, 1.96; $P < 0.001$; $I^2 = 74.1\%$) in North America, 0.79 (95CI 0.03, 1.62; $P = 0.002$; $I^2 = 79.5\%$) in Australia, New-Zeeland and Pacific and 1.26 (95CI 0.56, 1.96) in Africa (Fig 6). Meta-regressions demonstrated a higher risk of suicide in North America than in Australia, New-Zeeland and Pacific (0.92; 95CI 0.22, 1.63; $P = 0.013$) and especially higher in USA vs the rest of the world (1.34; 95CI 1.28, 1.55; $P < 0.001$) (Fig 5).

Finally, we demonstrated an overall time effect (-0.15; 95CI -0.29, -0.01; $P = 0.032$) which signify that the risk decreased over time. This relationship is significant in Europe (-0.18; 95CI -0.37, -0.01; $P = 0.044$) but not in USA (-0.11; 95CI -0.37, 0.15; $P = 0.370$) or in Australia, New-Zeeland and Pacific (-0.48; 95CI -8.09, 7.12; $P = 0.570$). For Africa, there were insufficient observations (Fig 5).

Meta-analysis of percentage of suicide in physicians by group of specialties

We included eight studies [15,16,40,43,45,47,51,83]. The percentage of suicide in general practitioners was 32% (95CI 21, 43; $P < 0.001$; $I^2 = 93.1\%$), in internal medicine was 16% (95CI 9, 23; $P < 0.001$; $I^2 = 88.6\%$), in psychiatrists was 11% (95CI 9, 14; $P = 0.30$; $I^2 = 17.5\%$), in other medical specialties was 3% (95CI 3, 4; $P = 0.02$; $I^2 = 40.7\%$), in surgeons was 4% (95CI 2, 5; $P < 0.001$; $I^2 = 62.8\%$) and in internships was 2% (95CI 1, 4) (Fig 7).

Meta-regressions demonstrated a higher risk of suicide in general practitioners than internal medicine (0.12; 95CI 0.05, 0.19; $P = 0.001$), than psychiatrists (0.17; 95CI 0.09, 0.24;

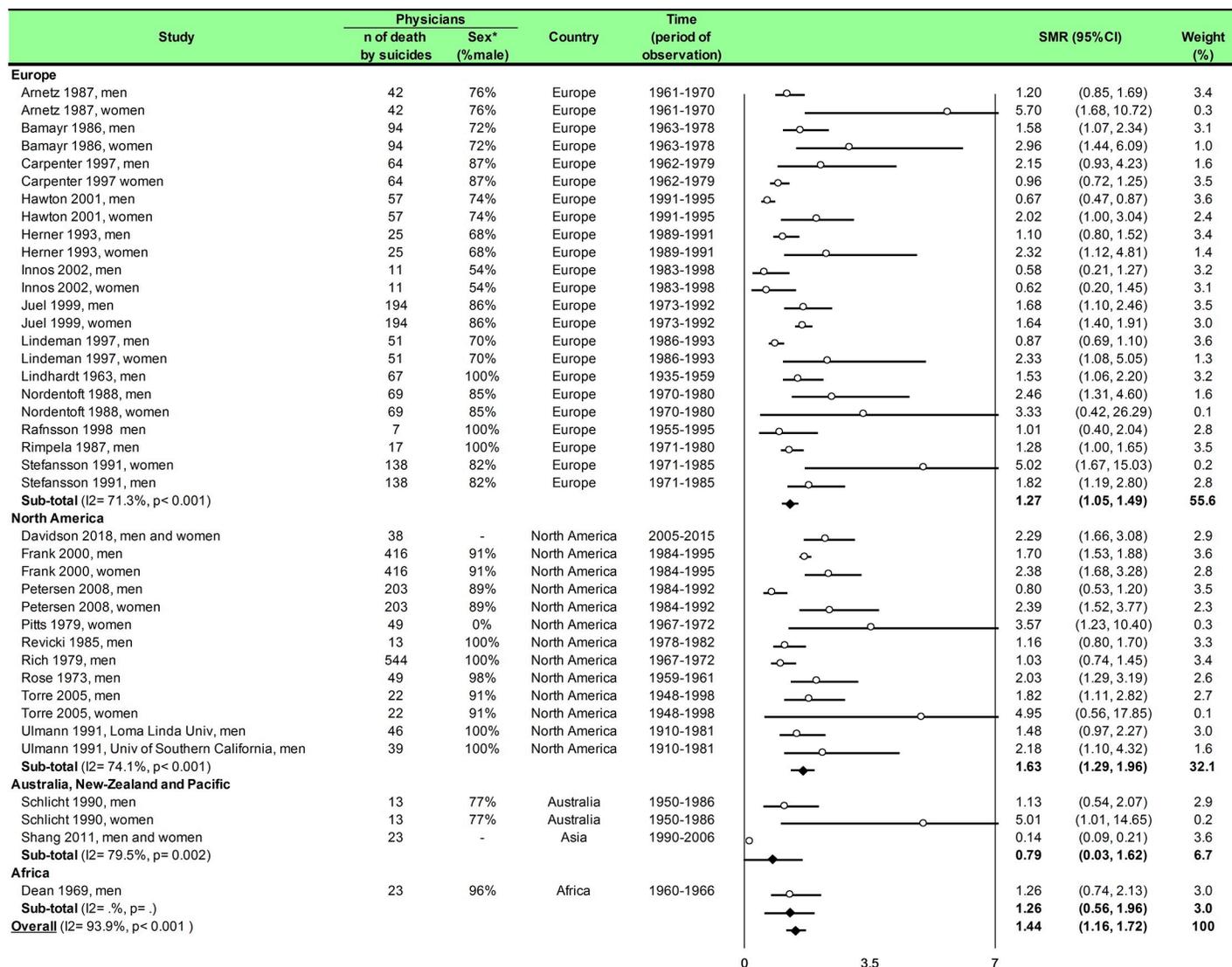


Fig 6. Meta-analysis of standardized mortality rate for suicides by geographic zones.

<https://doi.org/10.1371/journal.pone.0226361.g006>

$P < 0.001$), than other medical specialties (0.24; 95CI 0.18, 0.30; $P < 0.001$), than surgeons (0.25; 95CI 0.19, 0.30; $P < 0.001$) and then internships (0.24; 95CI 0.15, 0.34; $P < 0.001$). Moreover, a higher risk of suicide in internal medicine than in other medical specialties (0.12; 95CI 0.08, 0.17; $P < 0.001$), than surgeons (0.13; 95CI 0.08, 0.18; $P < 0.001$), and than internships (0.13; 95CI 0.03, 0.22; $P = 0.008$). Finally, we demonstrated a higher risk of suicide in psychiatrists than other medical specialties (0.07; 95CI 0.02, 0.13; $P = 0.009$) and than surgeons (0.08; 95CI 0.02, 0.13; $P = 0.005$) (S1 Fig).

Meta-analysis of percentages of suicide in physicians by category of surgical specialties

We included six studies [15,16,43,47,51,83]. The percentage of suicide in general surgeons was 6% i.e. (95CI 4, 9; $I^2 = 64.5%$, $P = 0.04$), in obstetricians was 4% (95CI 2, 5; $I^2 = 0$, $P =$

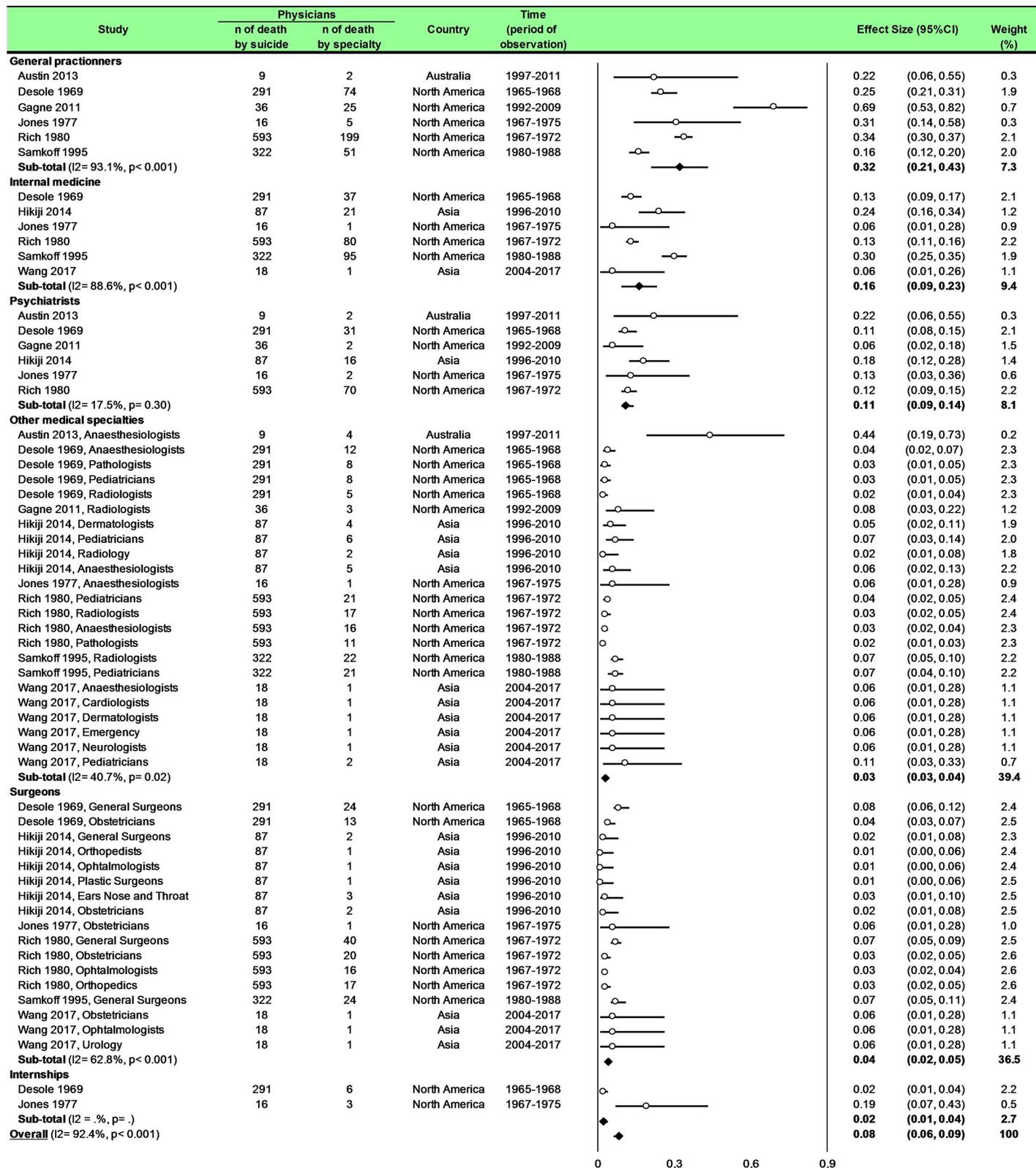


Fig 7. Meta-analysis of percentages of suicide in physicians by group of specialties.

<https://doi.org/10.1371/journal.pone.0226361.g007>

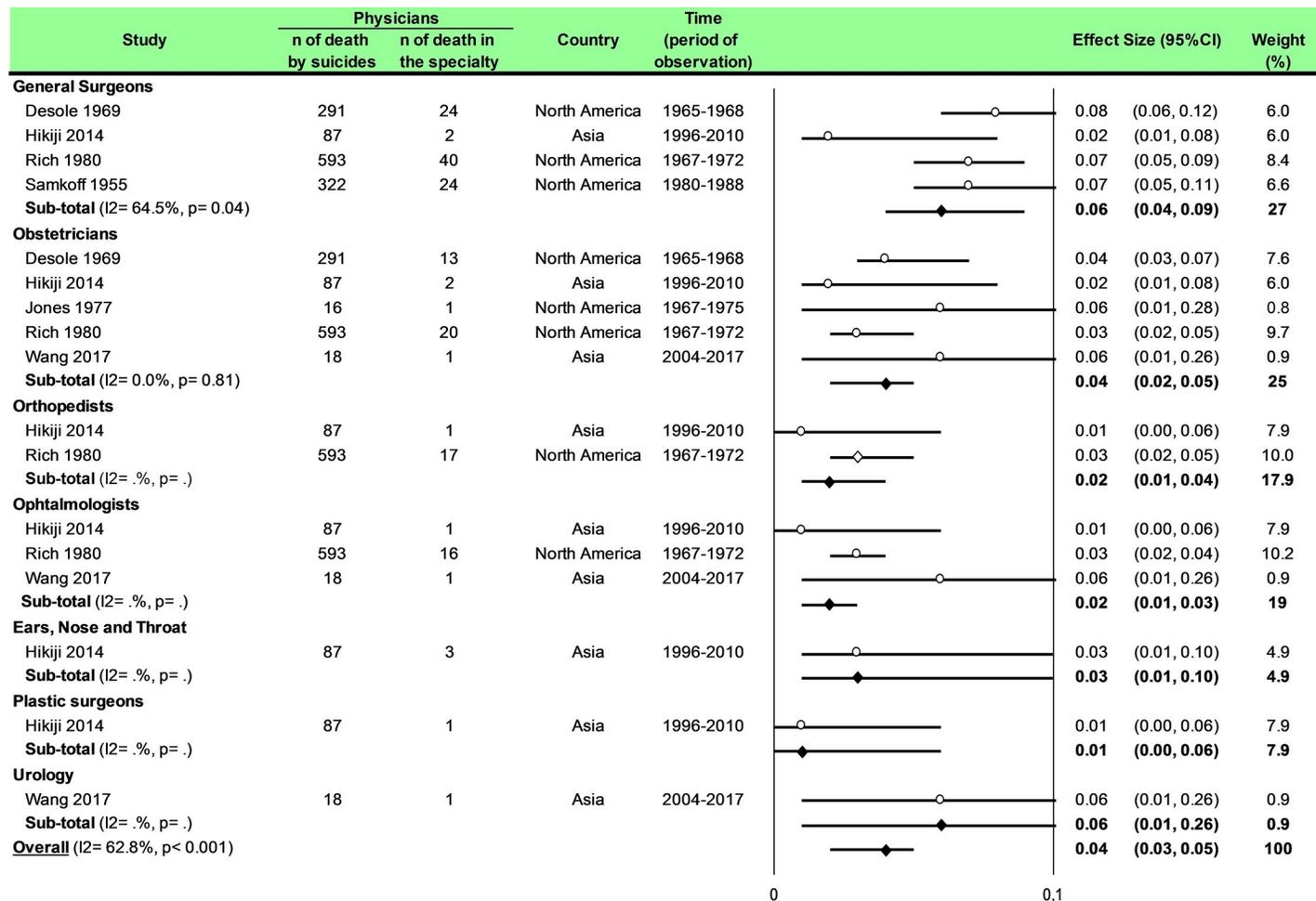


Fig 8. Meta-analysis of percentages of suicide in physicians by category of surgical specialties.

<https://doi.org/10.1371/journal.pone.0226361.g008>

0.81), in orthopaedists was 2% (95CI 1, 4), in ears, nose and throat was 3% (95CI 0, 3) and in plastic surgeons was 1% (95CI 0, 6) (Fig 8).

Meta-regressions demonstrated a higher risk of suicide in general surgeons than obstetricians (0.03; 95CI 0.01, 0.05; $P = 0.035$), than orthopedists (0.04; 95CI 0.01, 0.07; $P = 0.006$), than ophthalmologists (0.04; 95CI 0.02, 0.07; $P = 0.006$) and than plastic surgeons (0.05; 95CI 0.01, 0.09; $P = 0.010$) (S2 Fig).

Meta-analysis of percentages of suicide in physicians by category of medical specialties

Eight studies were included [15, 16, 40, 43, 45, 47, 51, 83]. The percentage of suicide in internal medicine was 16% (95CI 9, 23; $I^2 = 88.6\%$, $P < 0.001$), in psychiatrists was 11% (95CI 9, 14; $I^2 = 17.5\%$, $P = 0.30$), in anaesthesiologists was 4% (95CI 2, 6; $I^2 = 43.6\%$, $P = 0.11$), in radiologists was 3% (95CI 2, 5; $I^2 = 66.0\%$, $P = 0.02$), in paediatricians was 4% (95CI 3, 6; $I^2 = 46.4\%$, $P = 0.11$), in pathologists was 2% (95CI 1, 3), in dermatologists was 5% (95CI 1, 9), in cardiologists was 6% (95CI 1, 26), in neurologists was 6% (95CI 1, 26) and in emergency physicians was 6% (95CI 1, 26) (Fig 9). Meta-regressions demonstrated a higher risk of suicide in internal medicine than anesthesiologists (0.12; 95CI 0.06, 0.18; $P = 0.001$) than radiologists (0.13; 95CI

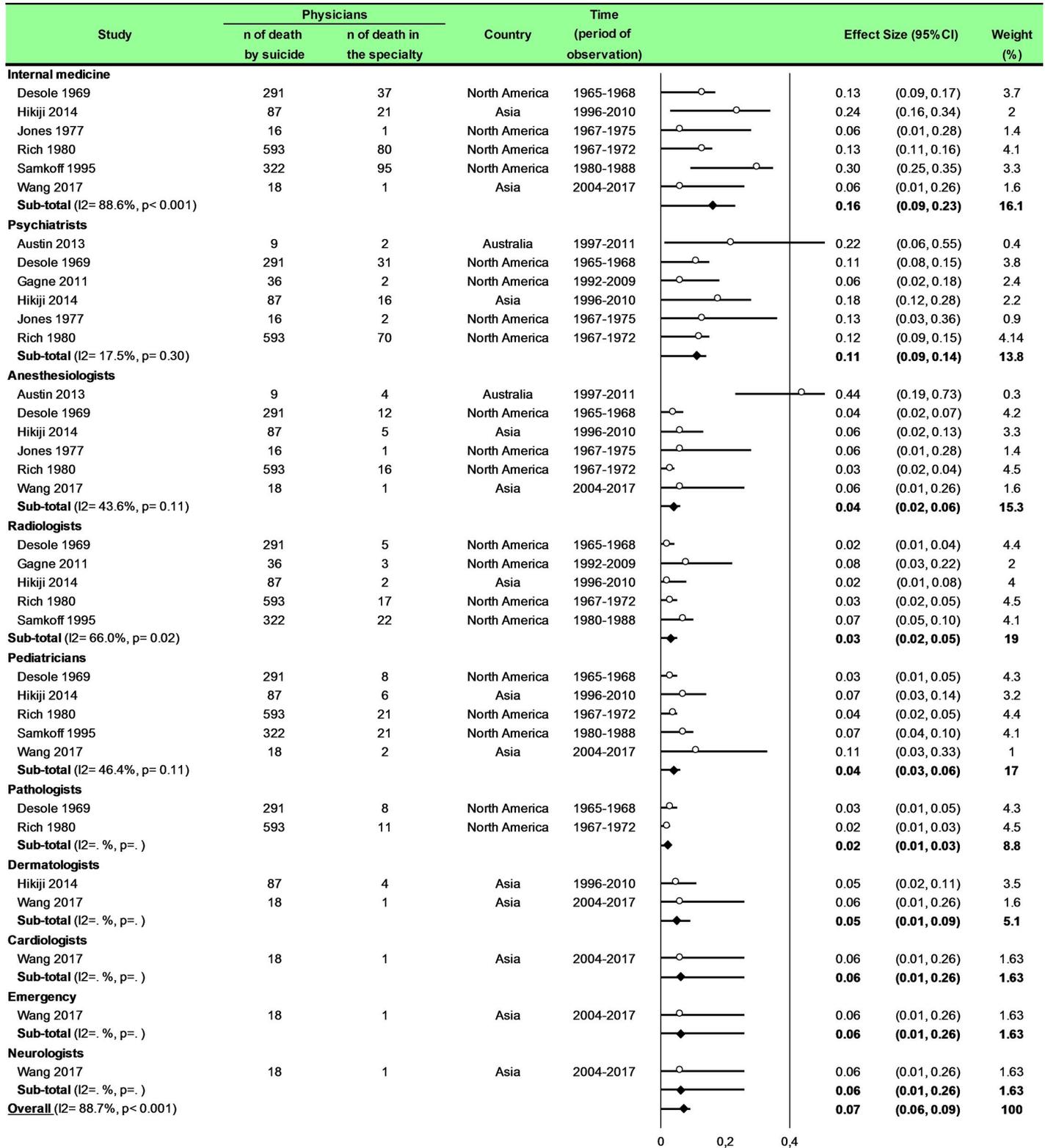


Fig 9. Meta-analysis of percentages of suicide in physicians by category of medical specialties.

<https://doi.org/10.1371/journal.pone.0226361.g009>

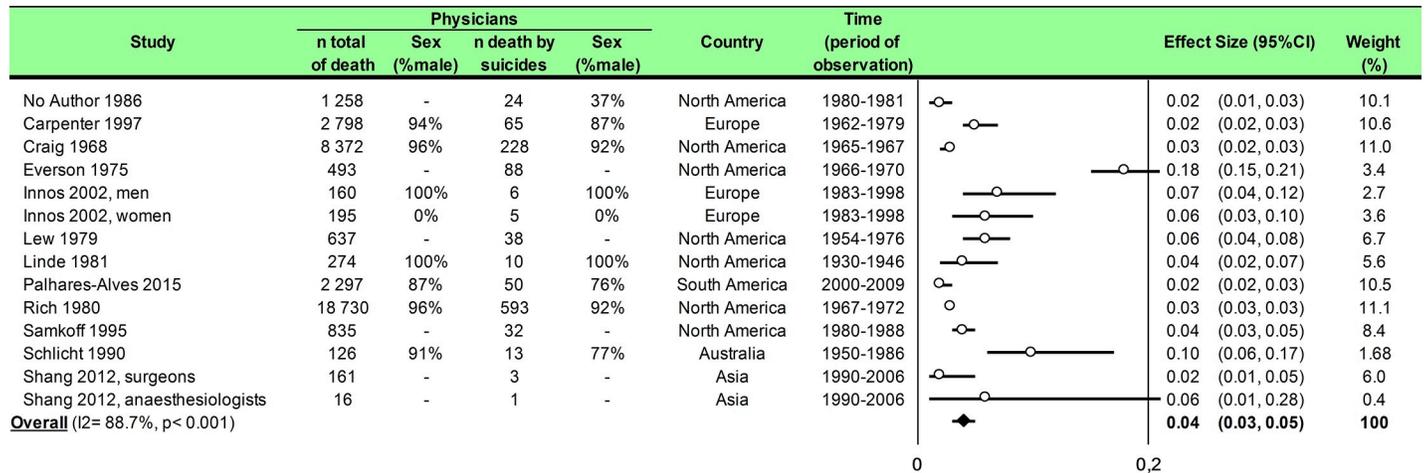


Fig 10. Meta-analysis of prevalence of physicians died by suicide among all deaths in physicians.

<https://doi.org/10.1371/journal.pone.0226361.g010>

0.07, 0.19; $P < 0.001$), than pediatricians (0.12; 95CI 0.06, 0.18; $P = 0.001$) than pathologists (0.14; 95CI 0.07, 0.21; $P < 0.001$) and than dermatologists (0.12; 95CI 0.03, 0.21; $P = 0.13$). Moreover, the risk of suicide was higher in psychiatrists than anesthesiologists (0.07; 95CI 0.01, 0.13; $P = 0.038$), than radiologists (0.08; 95CI 0.02, 0.14; $P = 0.014$), than pediatricians (0.07; 95CI 0.01, 0.13; $P = 0.038$) and than pathologists (0.09; 95CI 0.02, 0.17; $P = 0.014$) (S3 Fig).

Meta-analysis of prevalence of physicians dead by suicide among all deaths in physicians

We included 12 studies [16,39,41,42,44,46,48,49,50,51,52,53], and we demonstrated a prevalence of 4% (95CI 3, 5) with an important heterogeneity ($I^2 = 88.7%$) (Fig 10).

Meta-regression on geographic zones did not retrieves any significant result. Moreover, insufficient data did not permit other meta-regression.

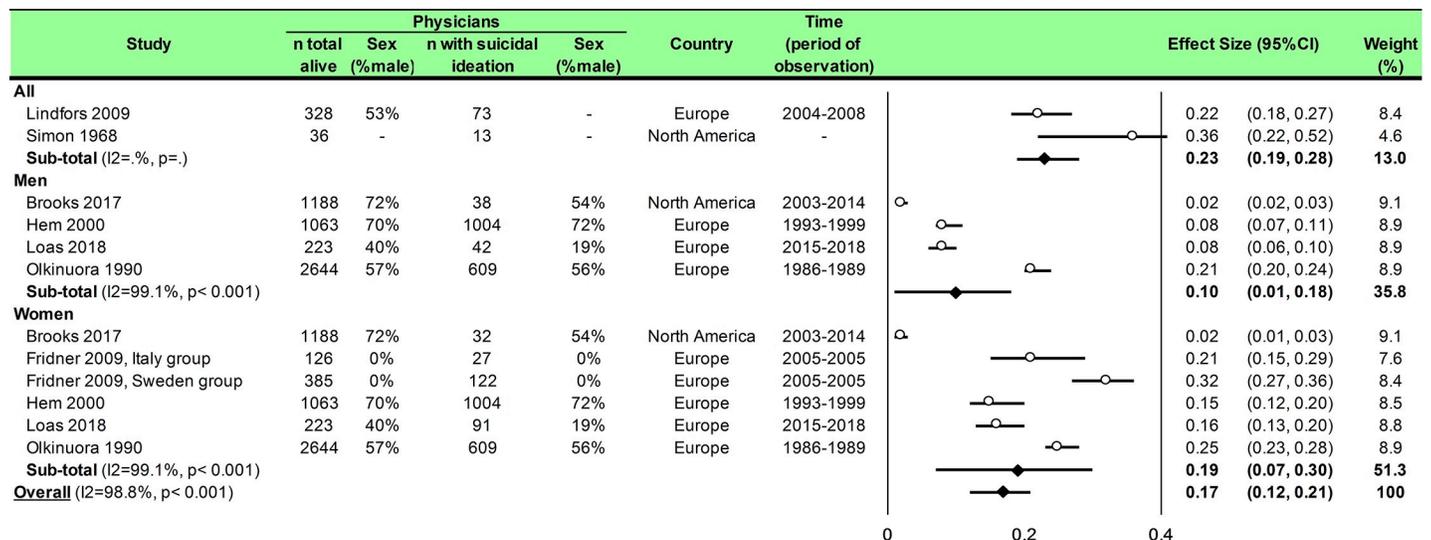


Fig 11. Meta-analysis of prevalence of physicians with suicidal ideation among all the physicians.

<https://doi.org/10.1371/journal.pone.0226361.g011>

Table 1. Characteristics of included studies. CI, Confidence Interval; n, Number; SMR, Standardized Mortality Ratio; USA, United States of America.

Study	Country	Continent	Time Period	Total		Suicides								Specialities		
				Physicians—n (%)		Death—n (%)		Mortality—SMR (95CI)		Attempts—n		Thoughts—n				
				Men	Women	Men	Women	Men	Women	Men	Women	Men	Women			
Aasland 2001	Norway	Europe	1960–1993			73 (89)	9 (11)									No specified
Aasland 2011	Norway	Europe	1960–2000													No specified
Arnetz 1987	Sweden	Europe	1961–1970			32 (76)	10 (24)	1,2 (0.85, 1.69)	5,7 (1.68, 10.7)							No specified
Austin 2013	Australia	Australia, New-Zealand and Pacific	1997–2011			6 (66)	3 (34)									Anaesthesiologists, psychiatrists, general practitioners, general surgeons
Bamayr 1986	Germany	Europe	1963–1978			67 (71)	27 (29)	1,58 (1.07, 2.34)	2,96 (1.44, 6.09)							No specified
Brooks 2017	USA	North America	2003–2014	1188 (72)	544 (28)							38	32			No specified
Carpenter 1997	Great Britain	Europe	1962–1979			56 (87)	8 (13)	0,96 (0.72, 1.25)	2,15 (0.93, 4.23)							No specified
Craig 1968	USA	North America	1965–1967			211	17									No specified
Davidson 2018	USA	North America	2005–2015					2,29 (1.66, 3.08)	2,29 (1.66, 3.08)							No specified
Dean 1969	South Africa	Africa	1960–1966			22 (96)	1 (4)	1,26 (0.74, 2.13)								No specified
Desole 1969	USA	North America	1965–1968													General practitioners, general surgeons, internal medicine, psychiatrists, obstetricians, anaesthesiologists, pathology, paediatrics, radiology, internships
Everson 1975	USA	North America	1966–1970													No specified
Frank 1999	USA	North America	1993–1994	0	4501 (100)							61				No specified
Frank 2000	USA	North America	1984–1995			379 (91)	37 (9)	1,7 (1.53, 1.88)	2,38 (1.69, 3.28)							No specified
Fridner 2009	Sweden and Italy	Europe	2005–2005	0	385 (100)								122			No specified
Gagne 2011	Quebec	North America	1992–2009			29 (80)	7 (20)									General practitioners, radiology, psychiatrists
Gold 2013	USA	North America	2003–2008													No specified
Gunnarsdottir 1995	Iceland	Europe	1920–1979													No specified
Hawton 2001	Great Britain	Europe	1991–1995			42 (74)	15 (26)	0,67 (0.47, 0.87)	2,02 (1.00, 3.04)							No specified

(Continued)

Table 1. (Continued)

Study	Country	Continent	Time Period	Total		Suicides								Specialities	
				Physicians—n (%)		Death—n (%)		Mortality—SMR (95CI)		Attempts—n		Thoughts—n			
				Men	Women	Men	Women	Men	Women	Men	Women	Men	Women		
Hawton 2002	England and Wales	Europe	1994–1997												No specified
Hawton 2011	Danish	Europe	1981–2006			131 (80)	32 (20)								No specified
Hem 2000	Norway	Europe	1993–1999	722 (72)	282 (28)					7	9	61	43		No specified
Hem 2005	Norway	Europe	1960–1990			98 (88)	13 (22)								No specified
Hemenway 1993	USA	North America	1976–1988												No specified
Herner 1993	Sweden	Europe	1989–1991			17 (68)	8 (32)	1.1 (0.8, 1.52)	2.32 (1.12, 4.81)						No specified
Hikiji 2014	Japan	Asia	1996–2010			68 (79)	19 (21)								Internal medicine, dermatologists, paediatrics, psychiatrists, general surgeons, orthopaedists, ophthalmology, plastic surgeons, ENT, obstetricians, radiology, anaesthesiologists
Hubbard 1922	USA	North America	1921												No specified
Innos 2002	Estonia	Europe	1983–1998			6 (54)	5 (46)	0.58 (0.21, 1.27)	0.62 (0.20, 1.45)						No specified
Jones 1977	USA	North America	1967–1975							11	5				General practitioners, anaesthesiologists, internal medicine, obstetricians, psychiatrists, general surgeons, internships
Juel 1999	Danish	Europe	1973–1992			168 (86)	26 (14)	1.64 (1.40, 1.91)	1.68 (1.10, 2.46)						No specified
Lew 1976	USA	North America	1954–1976												No specified
Linde 1981	USA	North America	1930–1946	274 (100)	0	10	0								No specified
Lindeman 1997	Finland	Europe	1986–1993												No specified
Lindeman 2007	Finland	Europe	1987–1988			2 (28)	5 (72)								No specified
Lindfors 2009	Finland	Europe	2004–2008	175 (53)	153 (47)										No specified
Lindhardt 1963	Denmark	Europe	1935–1959					1.53 (1.06, 2.20)							No specified
Loas 2018	Belgium	Europe	2015–2018	223 (40)	334 (60)					5	9	42	91		No specified
No Author 1986	USA	North America	1980–1981												No specified

(Continued)

Table 1. (Continued)

Study	Country	Continent	Time Period	Total		Suicides								Specialities
				Physicians—n (%)		Death—n (%)		Mortality—SMR (95CI)		Attempts—n		Thoughts—n		
				Men	Women	Men	Women	Men	Women	Men	Women	Men	Women	
Nordentoft 1988	Netherlands	Europe	1970–1980			59 (85)	10 (15)	2.46 (1.02, 3.42)	3.33 (0.42, 26.3)					No specified
Olkinuora 1990	Finland	Europe	1986–1989	1582 (59)	1062 (41)					10	6	340	269	No specified
Palhares-Alves 2015	Brazil	South America	2000–2009			38 (76)	12 (24)							No specified
Petersen 2008	USA	North America	1984–1992			181 (89)	22 (11)	0.8 (0.53, 1.20)	2.39 (1.52, 3.77)					No specified
Pitts 1979	USA	North America	1967–1972		751		49		3.57 (1.23, 10.4)					No specified
Rafnsson 1998	Island	Europe	1955–1995			7 (100)		1.01 (0.40, 2.04)						No specified
Revicki 1985	USA	North America	1978–1982			13		1.16 (0.80, 1.70)						No specified
Rich 1979	USA	North America	1967–1972	17979		544		1.03 (0.74, 1.45)						No specified
Rich 1980	USA	North America	1967–1972			544 (92)	49 (8)							General practitioners, internal medicine, general surgeons, psychiatrists, obstetricians, paediatrics, radiology, anaesthesiologists, pathology, ophthalmology, orthopaedists
Rimpela 1987	Finland	Europe	1971–1980			17		1.28 (1.01, 1.65)						No specified
Rose 1973	USA	North America	1959–1961			48 (98)	1 (2)	2.03 (1.29, 3.19)						No specified
Roy 1985	USA	North America	1981–1974											No specified
Samkoff 1995	USA	North America	1980–1988											General practitioners, internal medicine, general surgeons, radiology, paediatrics
Schlicht 1990	Australia	Australia, New-Zealand and Pacific	1950–1986	1279 (88)	174 (12)	10	3	1.13 (0.54, 2.07)	5.01 (1.01, 14.7)					No specified
Shang 2011	Taiwan	Australia, New-Zealand and Pacific	1990–2006											No specified

(Continued)

Table 1. (Continued)

Study	Country	Continent	Time Period	Total		Suicides								Specialities	
				Physicians—n (%)		Death—n (%)		Mortality—SMR (95CI)		Attempts—n		Thoughts—n			
				Men	Women	Men	Women	Men	Women	Men	Women	Men	Women		
Shang 2012	Taiwan	Asia	1990–2006												No specified
Simon 1968	USA	North America	1947–1967												No specified
Stefansson 1991	Sweden	Europe	1971–1985			113 (82)	25 (19)	1.82 (1.19, 2.80)	5.02 (1.67, 15.0)						No specified
Torre 2005	USA	North America	1948–1998	183 (91)	18 (11)	20 (90)	2 (10)	1.82 (1.11, 2.82)	4.95 (0.56, 17.9)						No specified
Ullmann 1991	USA	North America	1910–1981			46		1.48 (0.97, 2.27)							No specified
Wang 2017	China	Asia	2004–2017			6 (33)	8 (44)								Dermatologists, emergency, internal medicine, obstetricians, paediatrics, cardiology, neurology, urology, ophthalmology, anaesthesiologists

<https://doi.org/10.1371/journal.pone.0226361.t001>

Meta-analysis of the prevalence of deaths by suicide in physicians among all deaths by suicide in the general population

We included nine studies [1, 5, 15, 34, 35, 36, 37, 38, 82], and we demonstrated a prevalence of 1% (95CI 1, 1) with an important heterogeneity ($I^2 = 98.0\%$) (S4 Fig). Insufficient data did not permit meta-regression.

Meta-analysis of the number of physicians having done suicide attempt among all the physicians

We included five studies [47, 57, 75, 77, 85]. The overall effect size was 0.01 (95CI 0.01, 0.02; $p < 0.01$) with an important heterogeneity ($I^2 = 82.6\%$) (S5 Fig). Insufficient data did not permit meta-regression.

Meta-analysis of the number of physicians with suicidal ideation among all the physicians

We included seven studies [74, 75, 76, 77, 78, 84, 85]. The overall effect size was 0.17 (95CI 0.12, 0.21; $p < 0.001$) with an important heterogeneity ($I^2 = 98.8\%$) (Fig 11). Insufficient data did not permit meta-regression.

Other health care workers

As there are few exploitable studies about dental surgeons, nurses and other health-care workers, we didn't treat them in that meta-analysis.

Discussion

Physicians were an at-risk profession (1.44, 95CI 1.16, 1.72), particularly women-physician (0.67, 95CI 0.19, 1.14; $p = 0.007$). Some countries had a high risk of suicide (USA vs Rest of the world: 1.34, 95CI 1.28, 1.55; $p < 0.001$) and rate of suicide in physicians decreased over time, especially in Europe (-0.18, 95CI -0.37, -0.01; $p = 0.044$). Some specialties were higher risk such as anesthesiologists, psychiatrists, general practitioners and general surgeons. The prevalence of physicians having done suicide attempt among all the physicians were significant (0.01, 95CI 0.01, 0.02; $p < 0.001$) as the prevalence of physicians with suicidal ideation among all the physicians (0.17, 95CI 0.12, 0.21; $p < 0.001$). Finally, there were not enough exploitable data about dental surgeons, nurses and other health-care workers which are however some at-risk professions.

An at-risk profession

The high risk of suicide in physicians might be explained by several putative factors such as psychosocial working environment [18], or specific personality traits of physicians. Psychosocial work environment has been shown in the literature as an important risk factor, doctors being confronted to conflicts with colleagues, lack of cohesive teamwork and social support, leading them individually [88]. Physicians must also routinely face with breaking bad news [89], and are in frequent contact with illness, anxiety, suffering and death. Perfectionism, compulsive attention to detail, exaggerated sense of duty, excessive sense of responsibility, desire to please everyone are appreciated qualities in workplace [90,91] but increased stress and depression [92] and imprison physicians in vicious circle without seek help. They also prevent themselves to ask for help because of the culture of medical education [90,91]. In particular, we demonstrated that women physicians were particularly exposed to suicide, which might be explained by the additional strain imposed on them because of their social roles [11]. In most countries, women still have more at-home responsibilities (education of children, nursing, household care, etc) than men. Combining a full-time job as a physician and those at-home responsibilities might be particularly difficult to manage [11]. Although income gender-inequalities have not been reported in physicians [93,94], some authors suggested that the medical field was mainly dominated by the male gender and reported a poor status integration of women physicians within the profession [7]. It has been shown that female physicians/internships react by imposing themselves an additional pressure to demonstrate their male counterparts that they are as strong, self-sufficient and worthy as them [95].

Depending on countries

We showed that the risk of suicide was not homogeneous between countries, in line with inequality of job satisfaction among physicians in many countries [96,97]. Indeed, some countries such as Switzerland and Canada reported a high level of job satisfaction for physicians (>75%) [98,99]. In the United States, most obstetrician gynecologists only rated their job satisfaction as moderate [100]. Physician job satisfaction is essential for ensuring the quality and sustainability of health care provision [101,102]. Moreover, career dissatisfaction was associated with burnout and prolonged fatigue among physicians [103]. In most countries, physicians' work conditions underwent frequent mutations, with multiple healthcare reforms initiatives promoting by local governments. Reforms are a necessary compromise between best outcomes on deliveries of care, health economics, and quality of work environment [104,105].

With a time effect

There are few data on the evolution of the rate of suicide over time and we were the first to demonstrate that, in some countries such as in Europe the suicide rate among physicians decreased significantly with time but not in the USA. During the past decade, a confluence of forces has changed the practice of medicine in unprecedented ways. Indeed, physicians have seen their autonomy reduced by increased administrative tasks and time pressure [106,107,108]. In USA, a survey showed that physicians' satisfaction declined over the last 10 years, with less time spent per patient and for private life [13]. US physicians might also be particularly stressed [109] because of medical errors that are the third leading cause of death in US [110,111] in a context of economic pressure and relationships with pharmaceutical companies [112,113], religious beliefs [114], access care difficulties for some patients [115], and legal procedure intended against physicians [116] leading them to practice a more defensive medicine [117] misleading patients in overdiagnosis [118]. The World Health Organization global strategy on human resources for health (workforce 2030) promoted the personal and professional rights of health-care workers, including safe and decent working environments [119]. Particularly in Europe, working hours of physicians decreased significantly over the last decades following official instructions such as the European Working Time Directive (EWTD) [14], which may have contributed to a decreased risk of suicides.

Some specialties are more at-risk

We showed some of the most at-risk specialties were anaesthesiologists, psychiatrists, general practitioners and general surgeons. The high risk of suicides in anaesthesiologists [16,41,48,76] could be explained by an easy access to potentially lethal drugs, a high prevalence of burn-out [120], a high workload with fear of harming patients and organizational burden with poor autonomy, and conflicts with colleagues [121]. For psychiatrists, the high risk of suicides has been linked by stressful and traumatic experiences such as, paradoxically, dealing with suicides of patient [16]. Next to those medical specialties, the general practitioners were an historical at-risk occupation, with moral loneliness, job interfering with family life, constant interruptions both at home and at work, increasing administrative constraints, and high levels of patients' expectations, leading to a low job satisfaction and poor mental health [122,123]. Finally, specialties with life-and-death emergencies, like surgery, are particularly stressful [124,125,126,127]. For example, it has been shown that intra-operative death increased morbidity in patients operated by the same surgeon in the subsequent 48 hours, with a more pronounced whether the death occurring during emergency surgery [128].

Suicide attempts and suicidal ideation

Suicide could be regarded as a lengthy process. Little is known about causes and transitions between suicidal ideation / attempted suicide and suicide, as well as about the factors that precipitate or protect against these transitions [129]. Because physicians might be more aware of these characteristics than the general population [75], having suicidal thoughts should be taken particularly seriously in this profession. Suicidal ideation are considered a sensitive and specific indicator of suicide risk [130,131]. Preventive strategies may include improved management of psychiatric disorders, the recognition and treatment of depression and substances abuse [65], but also measures to reduce occupational stress, and restriction of access to means of suicide when doctors are depressed [4,132]. Medical school curriculum should also include programs to increase students' self-confidence, to express their emotional needs, and to teach that anyone may be suicidal—regardless of his status [133]. The preventive approach may

consist of screening, assessment, referral and education, and to destigmatize help-seeking at-risk medical students/physicians [134].

Suicides in other health-care workers

We highlighted the lack of studies providing data on deaths by suicide and on suicidal risks in nurses and in other health-care workers. However, nurses remained at high-risk of suicide with various stressful factors comparable to those previously described for physicians, such as patients cares, team's conflicts, heavy workload, lack of autonomy, and work-family conflicts [135,136]. As for physicians, some occupational settings were described as particularly stressful, such as working in emergency departments [137], with a high prevalence of shift work [138], exposure to aggressive and violent behavior from patients [139] and from situation relating to trauma, alcohol and intoxications [140]. Our study demonstrated the lack of data on other health-care workers such as pharmacists, dental surgeons, midwives, caregivers and hospital maids. We believe that such data are needed.

Limitations

Our study has however some limitations. Meta-analyses inherit the limitations of the individual studies of which they are composed: varying quality of studies and multiple variations in study protocols and evaluation. We highlighted that general practitioners were prone to suicide. However, comparisons between specialties may suffer from a major bias such as different number of physicians within each specialty (not the same denominator in statistical analyses—there are more suicides among general practitioners because there are more general practitioners than other individual specialties). All included studies on death by suicide in physicians were retrospective and based on health registers, and thus few studies reported details on occupation such as seniority or characteristics of practice, precluding further analyses necessary for effective preventive strategies. The studies on suicide attempts and suicidal ideation that were based on self-report questionnaire [73,74,75,77] may lack of standardized interviews or specific criteria for diagnoses psychiatric disorders [125,141]. Most cross-sectional studies included in our meta-analyses described a bias of self-report such as skipping questions and incomplete information, nondisclosure, and uncertainty regarding timing of questionnaire. Percentage of respondents within those studies may seem low, from 45% [74] to 76% [77], however the response rate was higher than usual [142,143,144,145,146]. The language used in countries with two official languages may also have influenced responses [74]. Only one study questioned physicians on their antidepressant treatment [121], and only one study questioned about a psychiatric disorder [74]. More data is needed regarding physician's health. Finally, none of the studies included specified whether some physicians were retired or not.

Conclusion

Preventive strategies on the risk of suicides in physicians are strongly needed. Physicians are an at-risk profession of suicide, with a global SMR of 1.44 (95CI 1.16, 1.72), and an important heterogeneity between studies. Women were particularly at risk compared to male physicians. In addition, some countries were with a higher risk of suicide such as USA. Interestingly, the rate of suicide in physicians decreased over time, especially in Europe, suggesting improvements of working conditions of physicians. Some specialties might be at higher risk such as anesthesiologists, psychiatrists, general practitioners and general surgeons. The high prevalence of physicians who committed suicide attempts as well as those with suicidal ideation should benefits for preventive strategies at the workplace. Public health policies must aim at improving social work environment and contribute to screening, assessment, referral, and

destigmatization of suicides in physicians. Finally, the lack of data on other health-care workers suggest implementing studies investigating those occupations who might also be at risk of suicide.

Supporting information

S1 Appendix. Details on study characteristics, quality of articles (Figs 2 and 3), method of sampling for markers analysis, inclusion and exclusion criteria, characteristics of participants, outcomes and aims of the studies, and study designs of included articles.

(DOCX)

S2 Appendix. PRISMA checklist.

(DOCX)

S1 Fig. Meta-regression of percentages of suicide in physicians by group of specialties.

(TIF)

S2 Fig. Meta-regression of percentages of suicide in physicians by category of surgical specialties.

(TIF)

S3 Fig. Meta-regression of percentages of suicide in physicians by category of medical specialties.

(TIF)

S4 Fig. Meta-analysis of prevalence of physicians died by suicide among all the deaths by suicide in the general population.

(TIF)

S5 Fig. Meta-analysis of prevalence of physicians having done suicide attempt among all the physicians.

(TIF)

Acknowledgments

We wish to thank Richard May for providing assistance in improving the manuscript.

Author Contributions

Conceptualization: Frédéric Dutheil, Claire Aubert, Valentin Navel.

Data curation: Frédéric Dutheil, Claire Aubert, Bruno Pereira, Michael Dambrun, Valentin Navel.

Formal analysis: Frédéric Dutheil, Claire Aubert, Michael Dambrun, Martial Mermillod.

Investigation: Claire Aubert, Valentin Navel.

Methodology: Frédéric Dutheil, Claire Aubert, Bruno Pereira, Michael Dambrun, Martial Mermillod, Julien S. Baker, Valentin Navel.

Project administration: Frédéric Dutheil, Claire Aubert, Fares Moustafa.

Resources: Claire Aubert, Michael Dambrun, Valentin Navel.

Software: Frédéric Dutheil, Bruno Pereira.

Supervision: Frédéric Dutheil, François-Xavier Lesage.

Validation: Frédéric Dutheil, Bruno Pereira, Michael Dambrun, Fares Moustafa, Martial Mermillod, Julien S. Baker, Marion Trousselard, François-Xavier Lesage.

Visualization: Frédéric Dutheil, Claire Aubert, Julien S. Baker, Marion Trousselard.

Writing – original draft: Frédéric Dutheil, Claire Aubert, Valentin Navel.

References

1. Hawton K, Agerbo E, Simkin S, Platt B, Mellanby RJ (2011) Risk of suicide in medical and related occupational groups: a national study based on Danish case population-based registers. *J Affect Disord* 134: 320–326. <https://doi.org/10.1016/j.jad.2011.05.044> PMID: 21676470
2. Hawton K, Simkin S, Rue J, Haw C, Barbour F, Clements A, et al. (2002) Suicide in female nurses in England and Wales. *Psychol Med* 32: 239–250. <https://doi.org/10.1017/s0033291701005165> PMID: 11866319
3. Katz RM (1983) Causes of death among registered nurses. *J Occup Med* 25: 760–762. <https://doi.org/10.1097/00043764-198310000-00017> PMID: 6631561
4. Agerbo E, Gunnell D, Bonde JP, Mortensen PB, Nordentoft M (2007) Suicide and occupation: the impact of socio-economic, demographic and psychiatric differences. *Psychol Med* 37: 1131–1140. PMID: 17445281
5. Hem E, Haldorsen T, Aasland OG, Tyssen R, Vaglum P, Ekeberg O (2005) Suicide rates according to education with a particular focus on physicians in Norway 1960–2000. *Psychol Med* 35: 873–880. <https://doi.org/10.1017/s0033291704003344> PMID: 15997607
6. Schernhammer ES, Colditz GA (2004) Suicide rates among physicians: a quantitative and gender assessment (meta-analysis). *Am J Psychiatry* 161: 2295–2302. <https://doi.org/10.1176/appi.ajp.161.12.2295> PMID: 15569903
7. Hawton K, Clements A, Sakarovitch C, Simkin S, Deeks JJ (2001) Suicide in doctors: a study of risk according to gender, seniority and specialty in medical practitioners in England and Wales, 1979–1995. *J Epidemiol Community Health* 55: 296–300. <https://doi.org/10.1136/jech.55.5.296> PMID: 11297646
8. Lindeman S, Laara E, Hirvonen J, Lonqvist J (1997) Suicide mortality among medical doctors in Finland: are females more prone to suicide than their male colleagues? *Psychol Med* 27: 1219–1222. <https://doi.org/10.1017/s0033291796004680> PMID: 9300526
9. Bachmann S (2018) Epidemiology of Suicide and the Psychiatric Perspective. *Int J Environ Res Public Health* 15.
10. Lindeman S, Laara E, Hakko H, Lonqvist J (1996) A systematic review on gender-specific suicide mortality in medical doctors. *Br J Psychiatry* 168: 274–279. <https://doi.org/10.1192/bjp.168.3.274> PMID: 8833679
11. Notman MT, Nadelson CC (1973) Medicine: a career conflict for women. *Am J Psychiatry* 130: 1123–1127. <https://doi.org/10.1176/ajp.130.10.1123> PMID: 4728905
12. Bertolote JM, De Leo D (2012) Global suicide mortality rates—a light at the end of the tunnel? *Crisis* 33: 249–253. <https://doi.org/10.1027/0227-5910/a000180> PMID: 22935272
13. Murray A, Montgomery JE, Chang H, Rogers WH, Inui T, Safran DG (2001) Doctor discontent. A comparison of physician satisfaction in different delivery system settings, 1986 and 1997. *J Gen Intern Med* 16: 452–459. <https://doi.org/10.1046/j.1525-1497.2001.016007452.x> PMID: 11520382
14. Temple J (2014) Resident duty hours around the globe: where are we now? *BMC Medical Education* 14: S8. <https://doi.org/10.1186/1472-6920-14-S1-S8> PMID: 25559277
15. Hikiji W, Fukunaga T (2014) Suicide of physicians in the special wards of Tokyo Metropolitan area. *J Forensic Leg Med* 22: 37–40. <https://doi.org/10.1016/j.jflm.2013.12.022> PMID: 24485419
16. Rich CL, Pitts FN Jr. (1980) Suicide by psychiatrists: a study of medical specialists among 18,730 consecutive physician deaths during a five-year period, 1967–72. *J Clin Psychiatry* 41: 261–263. PMID: 7400103
17. Roberts SE, Jaremin B, Lloyd K (2013) High-risk occupations for suicide. *Psychol Med* 43: 1231–1240. <https://doi.org/10.1017/S0033291712002024> PMID: 23098158
18. Patterson PD, Weaver MD, Frank RC, Warner CW, Martin-Gill C, Guyette FX, et al. (2012) Association between poor sleep, fatigue, and safety outcomes in emergency medical services providers. *Prehosp Emerg Care* 16: 86–97. <https://doi.org/10.3109/10903127.2011.616261> PMID: 22023164
19. Hawton K, Clements A, Simkin S, Malmberg A (2000) Doctors who kill themselves: a study of the methods used for suicide. *QJM* 93: 351–357. <https://doi.org/10.1093/qjmed/93.6.351> PMID: 10873184

20. (2012).
21. Puthran R, Zhang MW, Tam WW, Ho RC (2016) Prevalence of depression amongst medical students: a meta-analysis. *Med Educ* 50: 456–468. <https://doi.org/10.1111/medu.12962> PMID: 26995484
22. Rotenstein LS, Ramos MA, Torre M, Segal JB, Peluso MJ, Guille C, et al. (2016) Prevalence of Depression, Depressive Symptoms, and Suicidal Ideation Among Medical Students: A Systematic Review and Meta-Analysis. *Jama* 316: 2214–2236. <https://doi.org/10.1001/jama.2016.17324> PMID: 27923088
23. Witt K, Boland A, Lamblin M, McGorry PD, Veness B, Cipriani A, et al. (2019) Effectiveness of universal programmes for the prevention of suicidal ideation, behaviour and mental ill health in medical students: a systematic review and meta-analysis. *Evid Based Ment Health* 22: 84–90. <https://doi.org/10.1136/ebmental-2019-300082> PMID: 30918000
24. Zeng W, Chen R, Wang X, Zhang Q, Deng W (2019) Prevalence of mental health problems among medical students in China: A meta-analysis. *Medicine (Baltimore)* 98: e15337.
25. da Costa BR, Cevallos M, Altman DG, Rutjes AW, Egger M (2011) Uses and misuses of the STROBE statement: bibliographic study. *BMJ Open* 1: e000048. <https://doi.org/10.1136/bmjopen-2010-000048> PMID: 22021739
26. Vandembroucke JP, von Elm E, Altman DG, Gotsche PC, Mulrow CD, Pocock SJ, et al. (2007) Strengthening the Reporting of Observational Studies in Epidemiology (STROBE): explanation and elaboration. *Ann Intern Med* 147: W163–194. <https://doi.org/10.7326/0003-4819-147-8-200710160-00010-w1> PMID: 17938389
27. Wells GA, Shea B, O'Connell D, Peterson J, Welch V, Losos M, et al. (2017) The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses.
28. Benoist d'Azy C, Pereira B, Naughton G, Chiambaretta F, Duthheil F (2016) Antibiotrophylaxis in Prevention of Endophthalmitis in Intravitreal Injection: A Systematic Review and Meta-Analysis. *PLoS One* 11: e0156431. <https://doi.org/10.1371/journal.pone.0156431> PMID: 27257676
29. Courtin R, Pereira B, Naughton G, Chamoux A, Chiambaretta F, Lanhers C, et al. (2016) Prevalence of dry eye disease in visual display terminal workers: a systematic review and meta-analysis. *BMJ Open* 6: e009675. <https://doi.org/10.1136/bmjopen-2015-009675> PMID: 26769784
30. Ollier M, Chamoux A, Naughton G, Pereira B, Duthheil F (2014) Chest CT scan screening for lung cancer in asbestos occupational exposure: a systematic review and meta-analysis. *Chest* 145: 1339–1346. <https://doi.org/10.1378/chest.13-2181> PMID: 24480869
31. Lanhers C, Pereira B, Naughton G, Trousselard M, Lesage FX, Duthheil F (2017) Creatine Supplementation and Upper Limb Strength Performance: A Systematic Review and Meta-Analysis. *Sports Med* 47: 163–173. <https://doi.org/10.1007/s40279-016-0571-4> PMID: 27328852
32. DerSimonian R, Laird N (1986) Meta-analysis in clinical trials. *Control Clin Trials* 7: 177–188. [https://doi.org/10.1016/0197-2456\(86\)90046-2](https://doi.org/10.1016/0197-2456(86)90046-2) PMID: 3802833
33. Citrome L, Magnusson K (2014) Paging Dr Cohen, Paging Dr Cohen . . . An effect size interpretation is required STAT!: visualising effect size and an interview with Kristoffer Magnusson. *Int J Clin Pract* 68: 533–534. <https://doi.org/10.1111/ijcp.12435> PMID: 24750523
34. Aasland OG, Ekeberg O, Schweder T (2001) Suicide rates from 1960 to 1989 in Norwegian physicians compared with other educational groups. *Soc Sci Med* 52: 259–265. [https://doi.org/10.1016/s0277-9536\(00\)00226-4](https://doi.org/10.1016/s0277-9536(00)00226-4) PMID: 11144782
35. Aasland OG, Hem E, Haldorsen T, Ekeberg O (2011) Mortality among Norwegian doctors 1960–2000. *BMC Public Health* 11: 173. <https://doi.org/10.1186/1471-2458-11-173> PMID: 21426552
36. Gold KJ, Sen A, Schwenk TL (2013) Details on suicide among US physicians: data from the National Violent Death Reporting System. *Gen Hosp Psychiatry* 35: 45–49. <https://doi.org/10.1016/j.genhosppsych.2012.08.005> PMID: 23123101
37. Hubbard SD (1922) Suicide Among Physicians. *Am J Public Health (N Y)* 12: 857.
38. Lindeman S, Heinanen H, Väisänen E, Lönnqvist J (2007) Suicide among medical doctors: Psychological autopsy data on seven cases. *Archives of Suicide Research* 4: 135–141.
39. (1986) Physician Mortality and Suicide. Results and Implication of the AMA-APA Pilot Study. *Connecticut Medicine* 50.
40. Austin AE, van den Heuvel C, Byard RW (2013) Physician suicide. *J Forensic Sci* 58 Suppl 1: S91–93.
41. Carpenter LM, Swerdlow AJ, Fear NT (1997) Mortality of doctors in different specialties: findings from a cohort of 20000 NHS hospital consultants. *Occup Environ Med* 54: 388–395. <https://doi.org/10.1136/oem.54.6.388> PMID: 9245944
42. Craig AG, Pitts FN Jr. (1968) Suicide by physicians. *Dis Nerv Syst* 29: 763–772. PMID: 5717292

43. DeSole DE, Singer P, Aronson S (1969) Suicide and role strain among physicians. *Int J Soc Psychiatry* 15: 294–301. <https://doi.org/10.1177/002076406901500407> PMID: 5381279
44. Everson RB, Fraumeni JF Jr. (1975) Mortality among medical students and young physicians. *J Med Educ* 50: 809–811. <https://doi.org/10.1097/00001888-197508000-00009> PMID: 1152010
45. Gagne P, Moamai J, Bourget D (2011) Psychopathology and Suicide among Quebec Physicians: A Nested Case Control Study. *Depress Res Treat* 2011: 936327. <https://doi.org/10.1155/2011/936327> PMID: 21822488
46. Innos K, Rahu K, Baburin A, Rahu M (2002) Cancer incidence and cause-specific mortality in male and female physicians: a cohort study in Estonia. *Scand J Public Health* 30: 133–140. <https://doi.org/10.1080/14034940210133735> PMID: 12028862
47. Jones RE (1977) A study of 100 physician psychiatric inpatients. *Am J Psychiatry* 134: 1119–1123. <https://doi.org/10.1176/ajp.134.10.1119> PMID: 900265
48. Lew EA (1979) Mortality experience among anesthesiologists, 1954–1976. *Anesthesiology* 51: 195–199. <https://doi.org/10.1097/0000542-197909000-00003> PMID: 475020
49. Linde HW, Mesnick PS, Smith NJ (1981) Causes of death among anesthesiologists: 1930–1946. *Anesth Analg* 60: 1–7. PMID: 7192942
50. Palhares-Alves HN, Palhares DM, Laranjeira R, Nogueira-Martins LA, Sanchez ZM (2015) Suicide among physicians in the state of Sao Paulo, Brazil, across one decade. *Rev Bras Psiquiatr* 37: 146–149. PMID: 26083813
51. Samkoff JS, Hockenberry S, Simon LJ, Jones RL (1995) Mortality of young physicians in the United States, 1980–1988. *Acad Med* 70: 242–244. <https://doi.org/10.1097/00001888-199503000-00018> PMID: 7873015
52. Schlicht SM, Gordon IR, Ball JR, Christie DG (1990) Suicide and related deaths in Victorian doctors. *Med J Aust* 153: 518–521. PMID: 2233473
53. Shang TF, Chen PC, Wang JD (2012) Disparities in mortality among doctors in Taiwan: a 17-year follow-up study of 37 545 doctors. *BMJ Open* 2: e000382. <https://doi.org/10.1136/bmjopen-2011-000382> PMID: 22337815
54. Arnetz BB, Horte LG, Hedberg A, Theorell T, Allander E, Malker H (1987) Suicide patterns among physicians related to other academics as well as to the general population. Results from a national long-term prospective study and a retrospective study. *Acta Psychiatr Scand* 75: 139–143. <https://doi.org/10.1111/j.1600-0447.1987.tb02765.x> PMID: 3494382
55. Bamayr A, Feuerlein W (1986) [Incidence of suicide in physicians and dentists in Upper Bavaria]. *Soc Psychiatry* 21: 39–48. <https://doi.org/10.1007/bf00585321> PMID: 3486483
56. Dean G (1969) The causes of death of South African doctors and dentists. *S Afr Med J* 43: 495–500. PMID: 5793577
57. Frank E, Biola H, Burnett CA (2000) Mortality rates and causes among U.S. physicians. *Am J Prev Med* 19: 155–159. [https://doi.org/10.1016/s0749-3797\(00\)00201-4](https://doi.org/10.1016/s0749-3797(00)00201-4) PMID: 11020591
58. Herner B (1993) [High frequency of suicide among younger physicians. Unsatisfactory working situations should be dealt with]. *Lakartidningen* 90: 3449–3452. PMID: 8231488
59. Juel K, Mosbech J, Hansen ES (1999) Mortality and causes of death among Danish medical doctors 1973–1992. *Int J Epidemiol* 28: 456–460. <https://doi.org/10.1093/ije/28.3.456> PMID: 10405848
60. Lindhardt Marie EF, Hamtoft Henry and Mosbech Johannes (1963) Causes of death among the medical profession in Denmark. *Danish Medical Bulletin* 10.
61. Nordentoft M (1988) [Suicide among physicians]. *Ugeskr Laeger* 150: 2440–2443. PMID: 3206633
62. Petersen MR, Burnett CA (2008) The suicide mortality of working physicians and dentists. *Occup Med (Lond)* 58: 25–29.
63. Pitts FN Jr., Schuller AB, Rich CL, Pitts AF (1979) Suicide among U.S. women physicians, 1967–1972. *Am J Psychiatry* 136: 694–696. <https://doi.org/10.1176/ajp.136.5.694> PMID: 434249
64. Rafnsson G (1998) Causes of death and cancer among doctors and lawyers in Iceland. *Nordisk Medicin* 6.
65. Revicki DA, May HJ (1985) Physician suicide in North Carolina. *South Med J* 78: 1205–1207. <https://doi.org/10.1097/00007611-198510000-00016> PMID: 4049039
66. Rich CL, Pitts FN Jr., (1979) Suicide by male physicians during a five-year period. *Am J Psychiatry* 136: 1089–1090. <https://doi.org/10.1176/ajp.136.8.1089> PMID: 464142
67. Rimpela AH, Nurminen MM, Pulkkinen PO, Rimpela MK, Valkonen T (1987) Mortality of doctors: do doctors benefit from their medical knowledge? *Lancet* 1: 84–86. [https://doi.org/10.1016/s0140-6736\(87\)91919-2](https://doi.org/10.1016/s0140-6736(87)91919-2) PMID: 2879184

68. Rose KD, Rosow I (1973) Physicians who kill themselves. *Arch Gen Psychiatry* 29: 800–805. <https://doi.org/10.1001/archpsyc.1973.04200060072011> PMID: 4751819
69. Shang TF, Chen PC, Wang JD (2011) Mortality of doctors in Taiwan. *Occup Med (Lond)* 61: 29–32.
70. Stefansson CG, Wicks S (1991) Health care occupations and suicide in Sweden 1961–1985. *Soc Psychiatry Psychiatr Epidemiol* 26: 259–264. <https://doi.org/10.1007/bf00789217> PMID: 1792556
71. Torre DM, Wang NY, Meoni LA, Young JH, Klag MJ, Ford DE (2005) Suicide compared to other causes of mortality in physicians. *Suicide Life Threat Behav* 35: 146–153. <https://doi.org/10.1521/suli.35.2.146.62878> PMID: 15843332
72. Ullmann D, Phillips RL, Beeson WL, Dewey HG, Brin BN, Kuzma JW, et al. (1991) Cause-specific mortality among physicians with differing life-styles. *JAMA* 265: 2352–2359. PMID: 2016831
73. Frank E, Dingle AD (1999) Self-reported depression and suicide attempts among U.S. women physicians. *Am J Psychiatry* 156: 1887–1894. <https://doi.org/10.1176/ajp.156.12.1887> PMID: 10588401
74. Fridner A, Belkic K, Marini M, Minucci D, Pavan L, Schenck-Gustafsson K (2009) Survey on recent suicidal ideation among female university hospital physicians in Sweden and Italy (the HOUPE study): cross-sectional associations with work stressors. *Gend Med* 6: 314–328. <https://doi.org/10.1016/j.genm.2009.04.006> PMID: 19467527
75. Hem E, GrLnvold NT, Aasland OG, Ekeberg O (2000) The prevalence of suicidal ideation and suicidal attempts among Norwegian physicians. Results from a cross-sectional survey of a nationwide sample. *Eur Psychiatry* 15: 183–189. [https://doi.org/10.1016/s0924-9338\(00\)00227-3](https://doi.org/10.1016/s0924-9338(00)00227-3) PMID: 10881215
76. Lindfors PM, Meretoja OA, Luukkonen RA, Elovainio MJ, Leino TJ (2009) Suicidality among Finnish anaesthesiologists. *Acta Anaesthesiol Scand* 53: 1027–1035. <https://doi.org/10.1111/j.1399-6576.2009.02014.x> PMID: 19572941
77. Olkinuora M, Asp S, Juntunen J, Kauttu K, Strid L, Aarimaa M (1990) Stress symptoms, burnout and suicidal thoughts in Finnish physicians. *Soc Psychiatry Psychiatr Epidemiol* 25: 81–86. <https://doi.org/10.1007/bf00794986> PMID: 2336581
78. Simon W, Lumry GK (1968) Suicide among physician-patients. *J Nerv Ment Dis* 147: 105–112. <https://doi.org/10.1097/00005053-196808000-00002> PMID: 4386438
79. Gunnarsdottir H, Rafnsson V (1995) Mortality among Icelandic nurses. *Scand J Work Environ Health* 21: 24–29. <https://doi.org/10.5271/sjweh.4> PMID: 7784860
80. Hemenway D, Solnick SJ, Colditz GA (1993) Smoking and suicide among nurses. *Am J Public Health* 83: 249–251. <https://doi.org/10.2105/ajph.83.2.249> PMID: 8427332
81. Roy A (1985) Suicide in doctors. *Psychiatr Clin North Am* 8: 377–387. PMID: 3895198
82. Davidson JE, Stuck AR, Zisook S, Proudfoot J (2018) Testing a Strategy to Identify Incidence of Nurse Suicide in the United States. *J Nurs Adm* 48: 259–265. <https://doi.org/10.1097/NNA.0000000000000610> PMID: 29672372
83. Wang Y, Liu L, Xu H (2017) Alarm bells ring: suicide among Chinese physicians: A STROBE compliant study. *Medicine (Baltimore)* 96: e7790.
84. Brooks E, Gendel MH, Early SR, Gundersen DC (2017) When Doctors Struggle: Current Stressors and Evaluation Recommendations for Physicians Contemplating Suicide. *Arch Suicide Res* 22: 519–528. <https://doi.org/10.1080/13811118.2017.1372827> PMID: 28990863
85. Loas G, Lefebvre G, Rotsaert M, Englert Y (2018) Relationships between anhedonia, suicidal ideation and suicide attempts in a large sample of physicians. *PLoS One* 13: e0193619. <https://doi.org/10.1371/journal.pone.0193619> PMID: 29584785
86. Zeng HJ, Zhou GY, Yan HH, Yang XH, Jin HM (2018) Chinese nurses are at high risk for suicide: A review of nurses suicide in China 2007–2016. *Arch Psychiatr Nurs* 32: 896–900. <https://doi.org/10.1016/j.apnu.2018.07.005> PMID: 30454635
87. Suzanne MP (1999) U.S. psychologists' suicide rates have declined since the 1960s. *Archives of Suicide Research*: 11–26.
88. Firth-Cozens J (2000) New stressors, new remedies. *Occup Med (Lond)* 50: 199–201.
89. Schildmann J, Cushing A, Doyal L, Vollmann J (2005) Breaking bad news: experiences, views and difficulties of pre-registration house officers. *Palliat Med* 19: 93–98. <https://doi.org/10.1191/0269216305pm996oa> PMID: 15810746
90. Bressler B (1976) Suicide and drug abuse in the medical community. *Suicide Life Threat Behav* 6: 169–178. PMID: 996917
91. Carr GD (2008) Physician suicide—a problem for our time. *J Miss State Med Assoc* 49: 308–312. PMID: 19297920

92. McManus IC, Keeling A, Paice E (2004) Stress, burnout and doctors' attitudes to work are determined by personality and learning style: a twelve year longitudinal study of UK medical graduates. *BMC Med* 2: 29. <https://doi.org/10.1186/1741-7015-2-29> PMID: 15317650
93. Smith SJ (1990) Income, Housing Wealth and Gender Inequality. *Urban Studies* 27: 67–88.
94. Finch N (2014) Why are women more likely than men to extend paid work? The impact of work-family life history. *Eur J Ageing* 11: 31–39. <https://doi.org/10.1007/s10433-013-0290-8> PMID: 28804312
95. Pospos S, Tal I, Iglewicz A, Newton IG, Tai-Seale M, Downs N, et al. (2019) Gender differences among medical students, house staff, and faculty physicians at high risk for suicide: A HEAR report. *Depress Anxiety*.
96. Janus K, Amelung VE, Gaitanides M, Schwartz FW (2007) German physicians "on strike"—shedding light on the roots of physician dissatisfaction. *Health Policy* 82: 357–365. <https://doi.org/10.1016/j.healthpol.2006.11.003> PMID: 17137674
97. Landon BE, Reschovsky JD, Pham HH, Blumenthal D (2006) Leaving medicine: the consequences of physician dissatisfaction. *Med Care* 44: 234–242. <https://doi.org/10.1097/01.mlr.0000199848.17133.9b> PMID: 16501394
98. Bovier PA, Perneger TV (2003) Predictors of work satisfaction among physicians. *Eur J Public Health* 13: 299–305. PMID: 14703315
99. Jenkins K, Wong D (2001) A survey of professional satisfaction among Canadian anesthesiologists. *Can J Anaesth* 48: 637–645. <https://doi.org/10.1007/BF03016196> PMID: 11495869
100. Bell DJ, Bringman J, Bush A, Phillips OP (2006) Job satisfaction among obstetrician-gynecologists: a comparison between private practice physicians and academic physicians. *Am J Obstet Gynecol* 195: 1474–1478. PMID: 16996467
101. Sibbald B, Bojke C, Gravelle H (2003) National survey of job satisfaction and retirement intentions among general practitioners in England. *BMJ* 326: 22. <https://doi.org/10.1136/bmj.326.7379.22> PMID: 12511457
102. Leigh JP, Kravitz RL, Schembri M, Samuels SJ, Mobley S (2002) Physician career satisfaction across specialties. *Arch Intern Med* 162: 1577–1584. <https://doi.org/10.1001/archinte.162.14.1577> PMID: 12123400
103. Wada K, Arimatsu M, Yoshikawa T, Oda S, Taniguchi H, Higashi T, et al. (2008) Factors on working conditions and prolonged fatigue among physicians in Japan. *Int Arch Occup Environ Health* 82: 59–66. <https://doi.org/10.1007/s00420-008-0307-3> PMID: 18330593
104. Khim K (2016) Are health workers motivated by income? Job motivation of Cambodian primary health workers implementing performance-based financing. *Glob Health Action* 9: 31068. <https://doi.org/10.3402/gha.v9.31068> PMID: 27319575
105. Hung LM, Shi L, Wang H, Nie X, Meng Q (2013) Chinese primary care providers and motivating factors on performance. *Fam Pract* 30: 576–586. <https://doi.org/10.1093/fampra/cmt026> PMID: 23788201
106. Kassirer JP (1998) Doctor discontent. *N Engl J Med* 339: 1543–1545. <https://doi.org/10.1056/NEJM199811193392109> PMID: 9819454
107. Linzer M, Konrad TR, Douglas J, McMurray JE, Pathman DE, Williams ES, et al. (2000) Managed care, time pressure, and physician job satisfaction: results from the physician worklife study. *J Gen Intern Med* 15: 441–450. <https://doi.org/10.1046/j.1525-1497.2000.05239.x> PMID: 10940129
108. Konrad TR, Williams ES, Linzer M, McMurray J, Pathman DE, Gerrity M, et al. (1999) Measuring physician job satisfaction in a changing workplace and a challenging environment. SGIM Career Satisfaction Study Group. *Society of General Internal Medicine. Med Care* 37: 1174–1182. <https://doi.org/10.1097/00005650-199911000-00010> PMID: 10549620
109. Leape LL (1994) Error in medicine. *Jama* 272: 1851–1857. PMID: 7503827
110. Makary MA, Daniel M (2016) Medical error—the third leading cause of death in the US. *Bmj* 353: i2139. <https://doi.org/10.1136/bmj.i2139> PMID: 27143499
111. Anderson JG, Abrahamson K (2017) Your Health Care May Kill You: Medical Errors. *Stud Health Technol Inform* 234: 13–17. PMID: 28186008
112. Mitchell AP, Winn AN, Lund JL, Dusetzina SB (2019) Evaluating the Strength of the Association Between Industry Payments and Prescribing Practices in Oncology. *Oncologist* 24: 632–639. <https://doi.org/10.1634/theoncologist.2018-0423> PMID: 30728276
113. Wazana A (2000) Physicians and the pharmaceutical industry: is a gift ever just a gift? *Jama* 283: 373–380. <https://doi.org/10.1001/jama.283.3.373> PMID: 10647801
114. Korup AK, Sondergaard J, Lucchetti G, Ramakrishnan P, Baumann K, Lee E, et al. (2019) Religious values of physicians affect their clinical practice: A meta-analysis of individual participant data from 7 countries. *Medicine (Baltimore)* 98: e17265.

115. Dickman SL, Himmelstein DU, Woolhandler S (2017) Inequality and the health-care system in the USA. *Lancet* 389: 1431–1441. [https://doi.org/10.1016/S0140-6736\(17\)30398-7](https://doi.org/10.1016/S0140-6736(17)30398-7) PMID: 28402825
116. Berlin L (2017) Medical errors, malpractice, and defensive medicine: an ill-fated triad. *Diagnosis (Berl)* 4: 133–139.
117. Studdert DM, Mello MM, Sage WM, DesRoches CM, Peugh J, Zapert K, et al. (2005) Defensive medicine among high-risk specialist physicians in a volatile malpractice environment. *Jama* 293: 2609–2617. PMID: 15928282
118. Chiolero A, Paccaud F, Aujesky D, Santschi V, Rodondi N (2015) How to prevent overdiagnosis. *Swiss Med Wkly* 145: w14060. <https://doi.org/10.4414/smw.2015.14060> PMID: 25612105
119. (2006) World Health Organization. Global strategy on human resources for health: workforce.
120. Kuhn CM, Flanagan EM (2017) Self-care as a professional imperative: physician burnout, depression, and suicide. *Can J Anaesth* 64: 158–168. <https://doi.org/10.1007/s12630-016-0781-0> PMID: 27910035
121. Lindfors PM, Nurmi KE, Meretoja OA, Luukkonen RA, Viljanen AM, Leino TJ, et al. (2006) On-call stress among Finnish anaesthetists. *Anaesthesia* 61: 856–866. <https://doi.org/10.1111/j.1365-2044.2006.04749.x> PMID: 16922752
122. Rosado-Bartolome A (2014) [The moral loneliness of the General Practitioner]. *Rev Clin Esp (Barc)* 214: 49–50.
123. Cooper CL, Rout U, Faragher B (1989) Mental health, job satisfaction, and job stress among general practitioners. *BMJ* 298: 366–370. <https://doi.org/10.1136/bmj.298.6670.366> PMID: 2493939
124. Dutheil F, Boudet G, Perrier C, Lac G, Ouchchane L, Chamoux A, et al. (2012) JOBSTRESS study: comparison of heart rate variability in emergency physicians working a 24-hour shift or a 14-hour night shift—a randomized trial. *Int J Cardiol* 158: 322–325. <https://doi.org/10.1016/j.ijcard.2012.04.141> PMID: 22608270
125. Dutheil F, Marhar F, Boudet G, Perrier C, Naughton G, Chamoux A, et al. (2017) Maximal tachycardia and high cardiac strain during night shifts of emergency physicians. *Int Arch Occup Environ Health*.
126. Dutheil F, Trousselard M, Perrier C, Lac G, Chamoux A, Duclos M, et al. (2013) Urinary Interleukin-8 Is a Biomarker of Stress in Emergency Physicians, Especially with Advancing Age—The JOBSTRESS* Randomized Trial. *PLoS One* 8: e71658. <https://doi.org/10.1371/journal.pone.0071658> PMID: 23977105
127. Hufnagel C, Chambres P, Bertrand PR, Dutheil F (2017) The Need for Objective Measures of Stress in Autism. *Frontiers in Psychology* 8.
128. Goldstone AR, Callaghan CJ, Mackay J, Charman S, Nashef SA (2004) Should surgeons take a break after an intraoperative death? Attitude survey and outcome evaluation. *BMJ* 328: 379. <https://doi.org/10.1136/bmj.37985.371343.EE> PMID: 14734519
129. Diekstra RF, Garnefski N (1995) On the nature, magnitude, and causality of suicidal behaviors: an international perspective. *Suicide Life Threat Behav* 25: 36–57. PMID: 7631374
130. Galfalvy HC, Oquendo MA, Mann JJ (2008) Evaluation of clinical prognostic models for suicide attempts after a major depressive episode. *Acta Psychiatr Scand* 117: 244–252. <https://doi.org/10.1111/j.1600-0447.2008.01162.x> PMID: 18321353
131. Gyorffy Z, Adam S, Csoboth C, Kopp M (2005) [The prevalence of suicide ideas and their psychosocial backgrounds among physicians]. *Psychiatr Hung* 20: 370–379. PMID: 16428812
132. Hawton K, Malmberg A, Simkin S (2004) Suicide in doctors. A psychological autopsy study. *J Psychosom Res* 57: 1–4. [https://doi.org/10.1016/S0022-3999\(03\)00372-6](https://doi.org/10.1016/S0022-3999(03)00372-6) PMID: 15256288
133. Preven DW (1981) Physician suicide. *Hillside J Clin Psychiatry* 3: 61–70. PMID: 6927186
134. Moutier C, Norcross W, Jong P, Norman M, Kirby B, McGuire T, et al. (2012) The suicide prevention and depression awareness program at the University of California, San Diego School of Medicine. *Acad Med* 87: 320–326. <https://doi.org/10.1097/ACM.0b013e31824451ad> PMID: 22373625
135. Alderson M, Parent-Rochelleau X, Mishara B (2015) Critical Review on Suicide Among Nurses. *Crisis*: 1–11. <https://doi.org/10.1027/0227-5910/a000315>
136. Hawton K, Vislisset L (1999) Suicide in nurses. *Suicide Life Threat Behav* 29: 86–95.
137. Healy S, Tyrrell M (2011) Stress in emergency departments: experiences of nurses and doctors. *Emerg Nurse* 19: 31–37. <https://doi.org/10.7748/en2011.07.19.4.31.c8611> PMID: 21877616
138. Shao MF, Chou YC, Yeh MY, Tzeng WC (2010) Sleep quality and quality of life in female shift-working nurses. *J Adv Nurs* 66: 1565–1572. <https://doi.org/10.1111/j.1365-2648.2010.05300.x> PMID: 20492021
139. Chapman R, Styles I (2006) An epidemic of abuse and violence: nurse on the front line. *Accid Emerg Nurs* 14: 245–249. <https://doi.org/10.1016/j.aeen.2006.08.004> PMID: 17064902

140. Patton R, Smythe W, Kelsall H, Selemo FB (2007) Substance use among patients attending an accident and emergency department. *Emerg Med J* 24: 146.
141. Hopwood CJ, Morey LC, Edelen MO, Shea MT, Grilo CM, Sanislow CA, et al. (2008) A comparison of interview and self-report methods for the assessment of borderline personality disorder criteria. *Psychol Assess* 20: 81–85. <https://doi.org/10.1037/1040-3590.20.1.81> PMID: 18315403
142. Trousselard M, Dutheil F, Naughton G, Cosserant S, Amadon S, Duale C, et al. (2016) Stress among nurses working in emergency, anesthesiology and intensive care units depends on qualification: a Job Demand-Control survey. *Int Arch Occup Environ Health* 89: 221–229. <https://doi.org/10.1007/s00420-015-1065-7> PMID: 26112796
143. Dutheil F, Delaire P, Boudet G, Rouffiac K, Djeriri K, Souweine B, et al. (2008) [Cost/effectiveness comparison of the vaccine campaign and reduction of sick leave, after vaccination against influenza among the Clermont-Ferrand University Hospital staff]. *Med Mal Infect* 38: 567–573. <https://doi.org/10.1016/j.medmal.2008.09.019> PMID: 19008061
144. Dutheil F, Kelly C, Biat I, Provost D, Baud O, Laurichesse H, et al. (2008) [Relation between the level of knowledge and the rate of vaccination against the flu virus among the staff of the Clermont-Ferrand University hospital]. *Med Mal Infect* 38: 586–594. <https://doi.org/10.1016/j.medmal.2008.09.017> PMID: 18976872
145. Kelly C, Dutheil F, Haniez P, Boudet G, Rouffiac K, Traore O, et al. (2008) [Analysis of motivations for antinflu vaccination of the Clermont-Ferrand University Hospital staff]. *Med Mal Infect* 38: 574–585. <https://doi.org/10.1016/j.medmal.2008.09.018> PMID: 18954950
146. Lopez V, Chamoux A, Tempier M, Thiel H, Ughetto S, Trousselard M, et al. (2013) The long-term effects of occupational exposure to vinyl chloride monomer on microcirculation: a cross-sectional study 15 years after retirement. *BMJ Open* 3.