Suicide rates among physicians compared with the general population in studies from 20 countries: gender stratified systematic review and meta-analysis

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ABSTRACT

OBJECTIVES
To estimate age standardised suicide rate ratios in male and female physicians compared with the general population, and to examine heterogeneity across study results.

DESIGN
Systematic review and meta-analysis.

DATA SOURCES
Studies published between 1960 and 31 March 2024 were retrieved from Embase, Medline, and PsycINFO. There were no language restrictions. Forward and backwards reference screening was performed for selected studies using Google Scholar.

ELIGIBILITY CRITERIA FOR SELECTING STUDIES
Observational studies with directly or indirectly age standardised mortality ratios for physician deaths by suicide, or suicide rates per 100 000 person years of physicians and a reference group similar to the general population, or extractable data on physician deaths by suicide suitable for the calculation of ratios. Two independent reviewers extracted data and assessed the risk of bias using an adapted version of the Joanna Briggs Institute checklist for prevalence studies. Mean effect estimates for male and female physicians were calculated based on random effects models, with subgroup analyses for geographical region and a secondary analysis of deaths by suicide in physicians compared with other professions.

RESULTS
Among 39 included studies, 38 studies for male physicians and 26 for female physicians were eligible for analyses, with a total of 3303 suicides in male physicians and 587 in female physicians (observation periods 1935-2020 and 1960-2020, respectively). Across all studies, the suicide rate ratio for male physicians was 1.05 (95% confidence interval 0.90 to 1.22). For female physicians, the rate ratio was significantly higher at 1.76 (1.40 to 2.21). Heterogeneity was high for both analyses. Meta-regression revealed a significant effect of the midpoint of study observation period, indicating decreasing effect sizes over time. The suicide rate ratio for male physicians compared with other professions was 1.81 (1.55 to 2.12).

CONCLUSION
Standardised suicide rate ratios for male and female physicians decreased over time. However, the rates remained increased for female physicians. The findings of this meta-analysis are limited by a scarcity of studies from regions outside of Europe, the United States, and Australasia. These results call for continued efforts in research and prevention of physician deaths by suicide, particularly among female physicians and at risk subgroups.

SYSTEMATIC REVIEW REGISTRATION
PROSPERO CRD42019118956.

WHAT IS ALREADY KNOWN ON THIS TOPIC

Many studies reported increased suicide rates for physicians, and a 2004 meta-analysis found significantly increased suicide rates for male and female physicians compared with the general population

Evidence on increased suicide rates for physicians is inconsistent across countries

WHAT THIS STUDY ADDS

Suicide rate ratios for physicians appear to have decreased over time, but are still increased for female physicians

A high level of heterogeneity exists across studies, suggesting that suicide risk varies among different physician populations

Further research is needed to identify physician populations and subgroups at higher risk of suicide

Introduction

In 2019, suicide caused over 700 000 deaths globally, which was more than one in every 100 deaths that year (1.3%). While the worldwide age standardised suicide rate was estimated at 9.0 per 100 000 population, there was great variation between individual countries (from <2 to >80 suicide deaths per 100 000).[1] The overall global decline in suicide rates by 36% since 2000 is not a universal trend because some countries like the United States or Brazil saw an increase of roughly the same magnitude.[1 2] Among many other social and environmental factors, occupation has been shown to influence suicide risk beyond established risk factors such as low socioeconomic status or educational attainment.[3-7]

Physicians are one of several occupational groups linked to a higher risk of death by suicide, and the medical community has a longstanding and often conflicted history in addressing this issue.[8] A *JAMA* editorial from 1903 reviewed annual suicide numbers for US physicians and concluded that their suicide risk is higher compared with the general population.[9] A substantial amount of evidence has been accumulated globally in the 120 years since then, providing more insight on the topic and the challenges involved in its assessment. Most earlier research reported higher suicide rates for male and female physicians compared with the general population, and the mean effect estimates from the first meta-analysis in 2004 indicated a significantly increased standardised mortality ratio (SMR) of 1.41 for male physicians and 2.27 for female physicians.[10] This meta-analysis included 22 studies on suicide in physicians with observation periods between 1910 and 1998 and revealed some heterogeneity among study results, which was partly explained by the decline in risk over time. Similarly, another meta-analysis that included nine studies with observation periods between 1980 and 2015 reported a significantly decreased SMR of 0.68 for male physicians and a significantly increased SMR of 1.46 for female physicians.[11]

In addition to publication year, several other factors could potentially drive heterogeneity between the published studies. Methodological differences in study design, outcome measures, and level of age standardisation could explain heterogeneity between studies. Furthermore, individual countries and world regions have varying levels of stigma about suicide in general and among physicians in particular, associated with different risks of underreporting, access to support systems, and generally different training and working conditions.

In this study, we aimed to perform an appraisal of the currently available evidence on suicide deaths in male and female physicians compared with the general population. We also aimed to explore heterogeneity by considering a broader spectrum of potential covariates. We hypothesise that suicide rate ratios for male and female physicians have declined over time, but gender differences persist and suicide risk remains increased for female physicians.

Methods

Search strategy and study selection

This meta-analysis was conducted based on recommendations of the Cochrane Collaboration,[12] and is reported in accordance with the preferred reporting items for systematic review and meta-analyses (PRISMA) statement.[13] We searched for observational studies with data on suicide rates in physicians compared with the general population or similar using Medline, PsycINFO, and Embase. “Physician,” “mortality,” and “suicide” were entered as MeSH terms and text words and then connected through Boolean operators. The specific search strategy was developed and adapted for each database with the support of librarians from the Medical University of Vienna (supplement table S1). Following Schernhammer and Colditz,[10] we limited the search period to articles published after 1960 but updated it through to 31 March 2024. No constraints were placed on the language in which the reports were written, the region where study participants lived, or their age group. Articles published in languages other than English or German were screened with the help of the translation software DeepL[14] and colleagues fluent in these languages. Screening of the literature was done independently by two reviewers (CZ and SS). We also performed forward and backwards reference screening for the included articles and searched for unpublished data from sources and databases listed in included articles, such as the US National Institute for Occupational Safety and Health, the UK Office for National Statistics, Switzerland’s Federal Statistical Office, and Statistics Denmark.

We excluded studies that reported only on specific suicide methods in physicians, non-fatal suicidal behaviour or thoughts, mental health and burnout, and suicide prevention. We also excluded conference abstracts, editorials, case studies, and letters. Only reports with adequate data about physician deaths by suicide (not attempts) were eligible.

At the full text screening stage, we decided to only include rate based outcome measures that compare the suicide mortality in a physician population with the suicide mortality in a reference population. This includes the indirectly standardised mortality ratio (SMR), directly standardised rate ratio (SRR), and the comparative mortality figure. Even though their formulas and recommended uses differ and might yield slightly different results when calculated for the exact same population,[15] it can be argued that they are comparable estimates for the purpose of meta-analysing suicide deaths in physicians compared with a reference population. We also included rate ratios, even though their level of age standardisation is typically less detailed and only comprises one age group (with lower or upper age cutoff points). However, the proportionate mortality ratio expresses a different concept (the cause specific SMR divided by the all cause SMR, or the rate of suicides in all physician deaths divided by the rate of suicides in all population deaths). This outcome measure is not suitable for calculation of combined estimates with SMRs, especially in target populations with higher general life expectancy like physicians,[16] and was therefore not included. We also excluded studies that reported odds ratios and relative risk calculations because these are not based on rates.

We avoided overlapping time periods of the same geographical regions among included studies so that any physician death by suicide would only be counted once towards the pooled result. In case of overlaps, only one study was included, and the decision of which to include was based on three criteria in sequential order: sample size (higher number of observed suicides); risk of bias (lower risk of bias based on the Joanna Briggs Institute (JBI) checklist for prevalence studies); and recentness (more recent midpoint of observation period). We also excluded studies that only reported overall (and not gender stratified) suicide ratios, only covered physician subgroups (eg, medical specialties), or did not meet minimum requirements for sample size (ie, an expected number of one suicide). When necessary information for inclusion was missing from eligible studies or the source of data was unclear, we contacted the authors. We excluded studies if the necessary information could not be obtained. A detailed list of excluded references including reason for exclusion can be found in the supplement (table S2).

Data extraction and risk of bias

Data extraction was conducted by two reviewers (CZ and SS) using a standardised table in Microsoft Excel. If studies did not include an SMR, but reported the numbers of observed (O) and expected (E) suicides or the necessary information to calculate them, the SMR was calculated by the reviewers (SMR=O/E). If the studies did not include an SRR or rate ratio, but reported (age standardised) suicide rates per 100 000 person years for physicians (R1) and a suitable reference population (R2) for a similar time period, the SRR or rate ratio was calculated (SRR=R1/R2, rate ratio=R1/R2). For one study, R1 and R2 were estimated from graphs.[17] Because not all studies reported confidence limits and the ones that did used different methods, we calculated 95% confidence intervals (CIs) for all studies based on Fisher's exact test using observed and expected suicide numbers. For SRRs or rate ratios, we calculated the expected suicides by treating the SRR as an SMR (E=O/SRR). Standard errors were derived from the calculated 95% CIs by using the formula recommended for ratios in the Cochrane handbook (standard error=(ln upper CI limit – ln lower CI limit)/3.92).[12]

In addition to variables relating to the main outcome, we extracted data on the following study characteristics to be used in sensitivity analyses: geographical location, observation period, age range, level of age standardisation, suicide classification, study design, and reference group. We used duplicate extraction and checked the final extraction table for errors to ensure accuracy.

Because there was no suitable validated scale to assess the quality of observational studies on mortality ratios, we used the JBI checklist for prevalence studies[18] as a critical appraisal tool for risk of bias assessment. Out of nine questions on this checklist, three were deemed not applicable owing to the investigation of mortality rather than morbidity (see supplement table S3a). Two reviewers (CZ and SS) independently evaluated a subsample of the included studies and the JBI checklist was subsequently further specified to achieve clear criteria for risk of bias assessment (see supplement table S3b). The same two reviewers then independently evaluated all studies (supplement table S4a and S4b). Consistency in rating was high, disagreements were resolved through discussion. If all applicable items of the JBI checklist were rated positive, a study was classified as having low risk of bias. If at least one item was rated negative or unclear, a study was classified as having moderate or high risk of bias.

Data analysis

We performed separate meta-analyses of suicide rate ratios for male and female physicians. Random effects models were chosen a priori owing to the assumption that the included studies represent a random sample of different yet comparable physician populations with some heterogeneity in effect size.[19] Random effects models were calculated based on the Hartung-Knapp method (also known as the Sidik-Jonkman method).[20] Cumulative meta-analyses were performed to examine changes in the overall mean effect estimate over time. Heterogeneity was assessed by Q tests, I^2, T^2, and prediction intervals.

Begg and Egger tests were conducted to evaluate the possibility of publication bias, which was also assessed by funnel plot and trim-and-fill analysis. We performed sensitivity analyses using meta-regression (for single covariates and adjusted for study observation period midpoint), including binary variables for several study characteristics (see supplement table S5a and S5b): risk of bias (low risk *v* moderate or high risk studies), study design (registry based studies *v* others), outcome measures (SMR *v* others), level of age standardisation (detailed with several age groups used *v* others), suicide classification (narrow international classification of diseases (ICD) definition without deaths of undetermined intent *v* others), age range (studies with a cutoff point around retirement age *v* others), and reference group (general population *v* similar). We also performed meta-regressions for length of observation period and number of suicides. Subgroup analysis was performed to assess geographical differences in two categorisations: World Health Organization world regions (with studies from the Americas, European Region, and Western Pacific Region for male and female physicians, only one study from the African Region for male physicians, and no studies from the South East Asian and Eastern Mediterranean Region) and most common study origin regions, reflecting the accumulation of reports from certain parts of the world (US, UK, Scandinavia, other European countries, rest of the world). We also used subgroups to calculate mean effect estimates in older and more recent studies. Two groups were formed based on the midpoint of study observation period, with one subgroup consisting of the 10 most recent studies, and another subgroup with the remaining studies. To accommodate for multiple testing, we adapted the level of significance to P<0.01 for all sensitivity analyses.

We conducted a secondary meta-analysis on suicide rates in physicians compared with another reference group that was more similar than the general population in terms of socioeconomic status. Studies were included if they provided data on deaths by suicide in physicians as well as a group of other professions with similar socioeconomic status (all other eligibility criteria remained the same).

All analyses were performed with Stata (version 17). This study was registered at the International Prospective Register of Ongoing Systematic Reviews (PROSPERO) under CRD42019118956.

Patient and public involvement

Several authors of this paper have trained and worked as physicians, and lived through the loss of colleagues to suicide. Their firsthand experiences offered valuable insights similar to those typically provided by patients. Because of the highly methodical nature of a systematic review and meta-analysis, it was difficult to involve

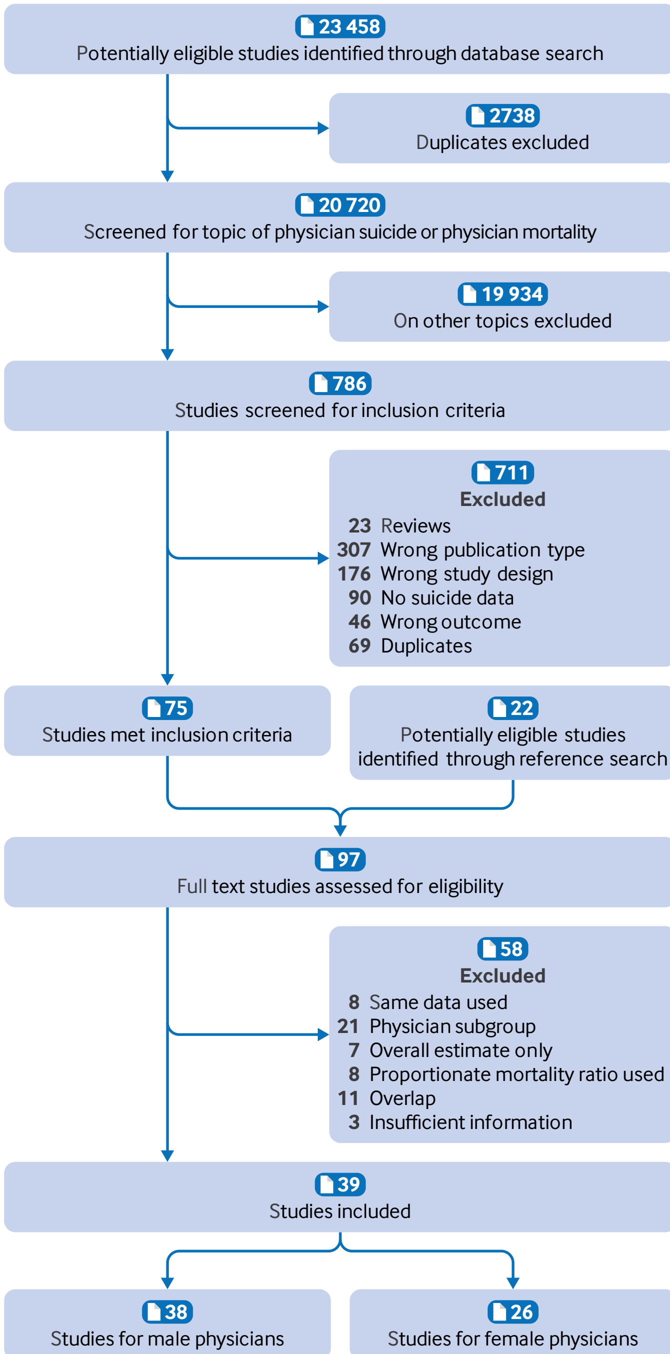


Fig 1 | Flowchart showing study selection

members of the public in most areas of the study design and execution. However, patient and public involvement representatives reviewed the manuscript after submission and offered suggestions on language, dissemination, and general improvements to increase its relevance to those affected by physician deaths by suicide.

Results

Included studies

The initial literature search yielded 23 458 studies. After removing duplicates and screening titles and abstracts, we were left with 786 articles. Application of the inclusion criteria resulted in 75 reports and we found a further 22 potentially eligible studies through reference list and registry based searches. Full text screening resulted in 38 studies for male physicians and 26 for female physicians that were eligible for analyses (fig 1). Because a few studies provided more than one effect estimate,[21 22] a total of 42 datasets (male physicians) and 27 datasets (female physicians) were used for meta-analysis (table 1 and table 2).

Meta-analyses

The meta-analysis on suicide deaths in male physicians (fig 2) produced a mean effect estimate of 1.05 (95% CI 0.90 to 1.22). The Q test was highly significant (Q=460.2, df=41, P<0.001), and the I^2 of 94% indicated that a high proportion of variance in the observed effects was caused by heterogeneity in true effects compared with sampling error. The variance of true effect size estimated with T^2 was 0.216, the standard deviation T was 0.465. The resulting prediction interval ranged from 0.41 to 2.72, which indicates that in 95% of all comparable future studies in male physician populations, the true effect size will fall in this interval. This finding reflects a high level of dispersion, suggesting that the suicide rates are decreased in some male physician populations but increased in others compared with the general population. Meta-regression confirmed calendar time (measured by midpoint of study observation period) as a highly significant covariate (β=−0.015, P<0.001), with an adjusted R^2 indicating an explained proportion of 52% of between-study variance.

The mean effect estimate for suicide deaths in female physicians (fig 3) was 1.76 (95% CI 1.40 to 2.21). The Q test for heterogeneity was highly significant (Q=143.2, df=26, P<0.001), and the I^2 of 84% indicated a high proportion of variance caused by heterogeneity in true effects, with T^2 estimated at 0.278 and T at 0.523. The prediction interval ranged from 0.58 to 5.35, so the dispersion of the true effect size across studies on female physicians was also substantial, ranging from decreased suicide rates in some female physician populations to considerably increased rates in others. The midpoint of study observation period also showed a highly significant association with the pooled estimate in a meta-regression (β=−0.024, P<0.001), explaining 87% of between-study variance.

A decrease in suicide rate ratios over time is shown by cumulative meta-analyses (supplement figure S1a and S1b). A decline in pooled estimates is observed for female physicians throughout all studies, and a decline for studies with midpoints of observation period after 1985 can be seen for male physicians.

Further analyses

We performed sensitivity analyses across all studies using meta-regression. We did not observe any significant (P<0.01) results for male or female physicians, for study design, outcome measures, level of age standardisation, suicide classification,

Table 1 | Characteristics of included studies on male physicians

Study	Location	Time period	Suicides	Effect (95% CI*)	Measure	R1	R2	O	E	SE†
Lindhardt et al (1963)[23]	Denmark	1935-59	67	1.53 (1.18 to 1.94)	SMR‡	—	—	67	43.9	0.126
Craig and Pitts (1968)[24]	US	1965-67	211	1.12 (0.98 to 1.29)	RR‡	38.3	34.1	211	187.9	0.070
Dean (1969)[25]	South Africa	1960-66	22	1.26 (0.79 to 1.90)	SMR‡	—	—	22	17.5	0.225
Rich and Pitts (1979)[26]	US	1967-72	544	1.03 (0.95 to 1.12)	RR‡	35.7	34.6	544	528.7	0.043
Balogh (1981)[27]	Hungary	1960-64	35	1.01 (0.70 to 1.40)	SRR‡	55.0	54.6	35	34.8	0.176
Enstrom (1983)[28]¶	California, US	1950-59	54	1.82 (1.37 to 2.38)	SMR	—	—	54	29.7	0.141
Revicki and May (1985)[29]	North Carolina, US	1978-82	13	1.20 (0.64 to 2.05)	SMR‡	—	—	13	10.9	0.298
Bämayr and Feuerlein (1986)[30]	Upper Bavaria, Germany	1963-78	67	1.50 (1.16 to 1.91)	SMR‡	—	—	67	44.6	0.126
OPCS England and Wales A (1986)[21]§	England and Wales, UK	1949-53	61	2.26 (1.73 to 2.90)	SMR	—	—	61	27.0	0.132
OPCS England and Wales B (1986)[21]§	England and Wales, UK	1959-63	65	1.76 (1.36 to 2.24)	SMR	—	—	65	36.9	0.128
OPCS England and Wales C (1986)[21]§	England and Wales, UK	1970-72	55	3.35 (2.52 to 4.36)	SMR	—	—	55	16.4	0.140
OPCS Great Britain (1986)[21]§	Great Britain, UK	1979-83 (ex. 1981)	65	1.72 (1.33 to 2.19)	SMR	—	—	65	37.8	0.128
Richings et al (1986)[31]¶	England and Wales, UK	1975	6	2.21 (0.81 to 4.81)	SMR	—	—	6	2.7	0.454
Arnetz et al (1987)[32]	Sweden	1961-70	32	1.20 (0.82 to 1.70)	SMR	—	—	32	26.7	0.185
Rimpelä et al (1987)[33]	Finland	1971-80	17	1.28 (0.75 to 2.05)	SRR‡	—	—	17	13.3	0.258
Kono et al (1988)[34]	Japan	1973-83	3	0.15 (0.03 to 0.45)	SMR	—	—	3	19.7	0.676
Schlicht et al (1990)[35]	Australia	1950-86	10	1.13 (0.54 to 2.07)	SMR	—	—	10	8.9	0.343
Stefansson and Wicks (1991)[17]¶	Sweden	1971-85 (ex. 1980)	113	2.03 (1.68 to 2.44)	SRR‡	80.7	39.7	113	55.6	0.096
Shima et al (1992)[36]¶	Chiba prefecture, Japan	1984-88	2	0.36 (0.04 to 1.30)	SMR	—	—	2	5.6	0.866
Herner (1993)[37]	Sweden	1989-91	17	1.10 (0.64 to 1.76)	RR‡	45	40.9	17	15.5	0.258
Lindeman et al (1997)[38]	Finland	1986-93	35	0.90 (0.63 to 1.25)	SMR	—	—	35	38.9	0.176
Rafnsson and Gunnarsdottir (1998)[39]	Iceland	1951-95	7	1.01 (0.41 to 2.08)	SMR‡	—	—	7	6.9	0.417
Juel et al (1999)[40]	Denmark	1973-92	168	1.64 (1.40 to 1.91)	SMR	—	—	168	102.4	0.079
Hawton et al (2001)[41]	England and Wales, UK	1991-95	42	0.67 (0.48 to 0.90)	SMR	—	—	42	62.9	0.160
Hostettler and Minder (2002)[42]	Switzerland	1979-92	39	1.48 (1.05 to 2.02)	SMR	—	—	39	26.4	0.167
Innos et al (2002)[43]	Estonia	1983-98	6	0.58 (0.21 to 1.26)	SMR	—	—	6	10.3	0.454
Shin et al (2005)[44]	South Korea	1992-2002	43	0.51 (0.37 to 0.69)	SMR	—	—	43	84.3	0.158
Meltzer et al (2008)[45]	England and Wales, UK	2001-05	58	0.69 (0.52 to 0.89)	SMR	—	—	58	84.1	0.136
Petersen and Burnett (2008)[46]	26 states, US	1984-92	181	0.80 (0.69 to 0.93)	SRR	—	—	181	226.3	0.076
Skegg et al (2010)[47]	New Zealand	1973-2004 (ex. 1996-97)	25	0.60 (0.39 to 0.89)	SMR	—	—	25	41.7	0.210
Aasland et al (2011)[48 49]	Norway	1960-2000	98	1.77 (1.44 to 2.16)	SRR	—	—	98	55.4	0.104
Palhares-Alves et al (2015)[50]	Sao Paolo, Brazil	2000-09	38	0.65 (0.46 to 0.90)	RR‡	4.9	7.5	38	58.2	0.169
Claessens (2016)[51]	Flanders, Belgium	2004-11	31	0.71 (0.48 to 1.01)	RR‡	25	35.1	31	43.5	0.188
Davis et al A (2021)[22]§¶	16 states, US	2007-08	66	0.86 (0.67 to 1.10)	RR‡	22.9	26.6	66	76.7	0.127
Davis et al B (2021)[22]§¶	33-38 states, US	2017-18	182	0.97 (0.83 to 1.12)	RR‡	31.5	32.6	182	188.4	0.075
Gold et al (2021)[52]	27 states, US	2010-15	307	0.86 (0.77 to 0.96)	SMR‡	—	—	307	356.6	0.058
Ye et al (2021)[53]¶	32 states, US	2016	110	0.70 (0.57 to 0.84)	SRR‡	20.71	29.73	110	157.9	0.098
Herrero-Huertas et al (2022)[54]	Spain	2001-11	55	0.61 (0.46 to 0.80)	SRR‡	—	—	55	89.9	0.140
FSO Switzerland, 2008-20[55 56]**	Switzerland	2008-20	53	0.79 (0.60 to 1.04)	SMR‡	—	—	53	66.7	0.142
ONS England, 2011-20[57]**	England, UK	2011-20	112	0.58 (0.48 to 0.70)	SRR‡	10.85	18.65	112	192.5	0.097
Petrie et al (2023)[58]	Australia	2001-17	90	0.97 (0.78 to 1.19)	SRR‡	15	15.5	90	93.0	0.108
Zimmermann et al (2023)[59]	Austria	1998-2020	98	0.79 (0.64 to 0.96)	SMR	—	—	147	198.6	0.104

E=expected number of suicides; O=observed number of suicides; R1=rate of physician target population; R2=rate of reference population; RR=rate ratio; SMR=standardised mortality ratio; SRR=standardised rate ratio.
*Confidence intervals calculated by reviewers based on Fisher's exact test.[60]
†Standard error calculated by reviewers with formula recommended by Cochrane handbook.[12]
‡Effect estimate calculated by reviewers.
§Effect estimates for different time periods from same study.
¶Not all reported effect estimates from this study are included to avoid time period overlap with other studies from same location.
**Unpublished.

age range, reference group, length of observation period, and number of suicides. We found a significant association between risk of bias and effect size for male (β=−0.475, P=0.001) and female (β=−0.601, P=0.003) physicians, but when adjusting for midpoint of observation period, this association was no longer significant.

Egger test and Begg test gave no evidence of publication bias for studies on male or female physicians. The funnel plots showed no asymmetry, although they did reflect the high heterogeneity between studies (figure S2a and S2b). The non-parametric trim-and-fill analyses imputed no studies for male or female physicians, therefore no difference in effect size was found for observed versus observed plus imputed studies.

We also performed subgroup analyses based on geographical study location in two different categorisations: WHO world regions and most common study origin regions. With both analyses, the decrease in effect sizes over time was visible in most subgroups, and lower effect sizes were observed especially in studies from Asian countries (supplement figures S3a, S3b, S4a, and S4b). This finding translates to lower overall suicide rates for male physicians in the Western Pacific Region of 0.61 (95% CI 0.35 to 1.04),

Table 2 | Characteristics of included studies on female physicians

Study	Location	Time period	Suicides	Effect (95% CI*)	Measure	R1	R2	O	E	SE†
Craig and Pitts (1968)[24]	US	1965-67	17	3.55 (2.07 to 5.69)	RR‡	40.5	11.4	17	4.8	0.258
Pitts et al (1979)[61]	US	1967-72	49	3.57 (2.64 to 4.72)	RR‡	40.7	11.4	49	13.7	0.148
Bämayr and Feuerlein (1986)[30]	Upper Bavaria, Germany	1963-78	27	3.21 (2.12 to 4.67)	SMR‡	—	—	27	8.4	0.202
OPCS England and Wales (1986)[21]	England and Wales, UK	1979-83 (ex. 1981)	14	3.10 (1.70 to 5.20)	SMR	—	—	14	4.5	0.286
Arnetz et al (1987)[32]	Sweden	1961-70	10	5.70 (2.74 to 10.51)	SMR	—	—	10	1.8	0.343
Stefansson and Wicks (1991)[17]¶	Sweden	1971-85 (ex. 1980)	25	2.85 (1.85 to 4.21)	SRR‡	49.3	17.3	25	8.8	0.210
Herner (1993)[37]	Sweden	1989-91	8	2.32 (1.00 to 4.57)	RR‡	39	16.8	8	3.4	0.387
Lindeman et al (1997)[38]	Finland	1986-93	16	2.40 (1.37 to 3.90)	SMR	—	—	16	6.7	0.266
Juel et al (1999)[40]	Denmark	1973-92	26	1.68 (1.10 to 2.46)	SMR	—	—	26	15.5	0.206
Hawton et al (2001)[41]	England and Wales, UK	1991-95	15	2.02 (1.13 to 3.33)	SMR	—	—	15	7.4	0.276
Innos et al (2002)[43]	Estonia	1983-98	5	0.62 (0.20 to 1.45)	SMR	—	—	5	8.1	0.503
Shin et al (2005)[44]	South Korea	1992-2002	3	0.57 (0.12 to 1.67)	SMR	—	—	3	5.3	0.676
Meltzer et al (2008)[45]	England and Wales, UK	2001-05	25	1.52 (0.98 to 2.24)	SMR	—	—	25	16.5	0.210
Petersen and Burnett (2008)[46]	26 states, US	1984-92	22	2.39 (1.50 to 3.62)	SRR	—	—	22	9.2	0.225
Skegg et al (2010)[47]	New Zealand	1973-2004 (ex. 1996-97)	2	0.40 (0.05 to 1.45)	SMR	—	—	2	5.0	0.866
Aasland et al (2011)[48 49]	Norway	1960-2000	13	2.93 (1.56 to 5.01)	SRR	—	—	13	4.4	0.298
Palhares-Alves et al (2015)[50]	Sao Paolo, Brazil	2000-09	12	1.45 (0.75 to 2.53)	RR‡	2.9	2.0	12	8.3	0.311
Claessens (2016)[51]	Flanders, Belgium	2004-11	10	1.68 (0.81 to 3.09)	RR‡	23.7	14.1	10	6.0	0.343
Davis et al A (2021)[22]§¶	16 states, US	2007-08	9	1.04 (0.48 to 1.98)	RR‡	7.2	6.9	9	8.6	0.363
Davis et al B (2021)[22]§¶	33-38 states, US	2017-18	39	1.17 (0.84 to 1.61)	RR‡	10.1	8.6	39	33.2	0.167
Gold et al (2021)[52]	27 states, US	2010-15	50	0.89 (0.66 to 1.17)	SMR‡	—	—	50	56.4	0.146
Ye et al (2021)[53]¶	32 states, US	2016	27	1.22 (0.81 to 1.78)	SRR‡	9.83	8.03	27	22.1	0.202
Herrero-Huertas et al (2022)[54]	Spain	2001-11	16	0.84 (0.48 to 1.36)	SRR‡	—	—	16	19.0	0.266
FSO Switzerland, 2008-2020[55 56]**	Switzerland	2008-20	17	1.23 (0.72 to 1.97)	SMR‡	—	—	17	13.8	0.258
ONS England, 2011-2020[57]**	England, UK	2011-20	56	0.97 (0.74 to 1.26)	SRR‡	5.4	5.55	56	57.6	0.138
Petrie et al (2023)[58]	Australia	2001-17	31	2.55 (1.73 to 3.62)	SRR‡	7.9	3.1	31	12.2	0.188
Zimmermann et al (2023)[59]	Austria	1998-2020	43	1.55 (1.12 to 2.09)	SMR	—	—	43	27.7	0.158

E=expected number of suicides; O=observed number of suicides; R1=rate of physician target population; R2=rate of reference population; RR=rate ratio; SMR=standardised mortality ratio; SRR=standardised rate ratio.
*Confidence intervals calculated by reviewers based on Fisher's exact test.[60]
†Standard error calculated by reviewers with formula recommended by Cochrane handbook.[12]
‡Effect estimate calculated by reviewers.
§Effect estimates for different time periods from same study.
¶Not all reported effect estimates from this study are included to avoid time period overlap with other studies from same location.
**Unpublished.

or similarly, for studies outside of Europe and the US with 0.69 (0.45 to 1.06). This pattern was not observed for female physicians, although the suicide rate ratio for the Western Pacific Region (1.06, 0.34 to 3.32) was also the lowest compared with all other subgroups.

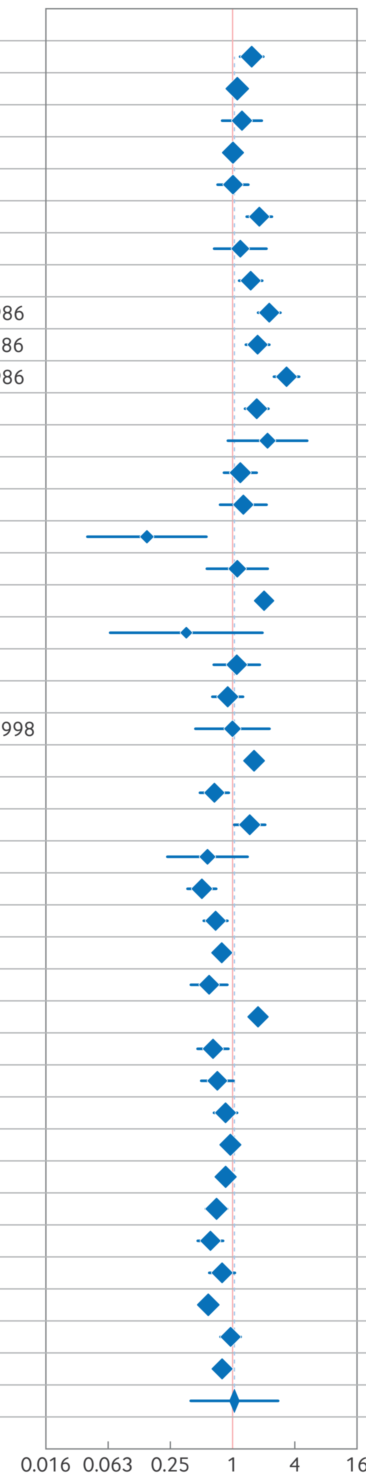
Given that calendar time has been shown to have a strong association with effect size, we also performed a subgroup analysis of the 10 most recent studies versus all older studies. For male physicians (supplement figure S5a), the mean effect estimate in the subgroup of 32 older datasets was increased at 1.17 (0.96 to 1.41), whereas in the subgroup of the 10 most recent studies it was significantly decreased at 0.78 (0.70 to 0.88). For female physicians (supplement figure S5b), the mean suicide rate ratio in the subgroup of 17 older studies was significantly increased at 2.21 (1.63 to 3.01). In the subgroup of the 10 most recent studies, the mean effect was still significantly increased at a lower level of 1.24 (1.00 to 1.55).

Secondary meta-analysis

We conducted another meta-analysis on suicide rates in physicians compared with other professions of similar socioeconomic status and identified eight studies that compared male physicians with a reference group of other academics, other professionals, other health professionals, or members of social class I (supplement figure S6 and table S6). The pooled effect estimate was significantly increased at 1.81 (95% CI 1.55 to 2.12). The Q test (Q=17.6, df=7, P=0.01) was significant, but the I^2 of 58% and the prediction interval of 1.15 to 2.87 indicated a lower level of heterogeneity compared with the main analysis, and a more similar effect size across studies. We found five studies on female physicians (supplement table S6). The results of these studies appeared similar to those for male physicians, but we deemed the number of eligible studies too low for a random effects meta-analysis.[62]

Discussion

In this meta-analysis summarising the available evidence on physician deaths by suicide, we found the rate ratio for female physicians to be significantly raised, but not for male physicians. This result confirmed our hypothesis that mean effect estimates would be lower than in a previous meta-analysis on the subject published in 2004.[10] Calendar time was identified as a significant covariate in both analyses, indicating decreasing suicide rate ratios for physicians over time. The high level of heterogeneity in results from different studies suggests that suicide risk for male and female physicians is not consistent across various physician



Study	Weight (%)	Suicide rate ratio (95% CI)
Lindhardt et al 1963	2.63	1.53 (1.19 to 1.95)
Craig and Pitts 1968	2.76	1.12 (0.98 to 1.29)
Dean 1969	2.29	1.26 (0.81 to 1.95)
Rich and Pitts 1979	2.80	1.03 (0.95 to 1.12)
Balogh 1981	2.47	1.01 (0.71 to 1.42)
Enstrom 1983	2.58	1.82 (1.38 to 2.40)
Revicki and May 1985	2.00	1.20 (0.67 to 2.14)
Bämayr and Feuerlein 1986	2.63	1.50 (1.17 to 1.92)
OPCS England and Wales A 1986	2.61	2.26 (1.74 to 2.93)
OPCS England and Wales B 1986	2.62	1.76 (1.37 to 2.26)
OPCS England and Wales C 1986	2.59	3.35 (2.55 to 4.40)
OPCS Great Britain 1986	2.62	1.72 (1.34 to 2.21)
Richings et al 1986	1.44	2.21 (0.91 to 5.38)
Arnetz et al 1987	2.44	1.20 (0.84 to 1.72)
Rimpelä et al 1987	2.16	1.28 (0.77 to 2.13)
Kono et al 1988	0.91	0.15 (0.04 to 0.56)
Schlicht et al 1990	1.83	1.13 (0.58 to 2.21)
Stefansson and Wicks 1991	2.70	2.03 (1.68 to 2.46)
Shima et al 1992	0.63	0.36 (0.07 to 1.97)
Herner 1993	2.16	1.10 (0.66 to 1.82)
Lindeman et al 1997	2.47	0.90 (0.64 to 1.27)
Rafnsson and Gunnarsdottir 1998	1.56	1.01 (0.45 to 2.29)
Juel et al 1999	2.74	1.64 (1.41 to 1.91)
Hawton et al 2001	2.52	0.67 (0.49 to 0.91)
Hostettler and Minder 2002	2.50	1.48 (1.07 to 2.05)
Innos et al 2002	1.44	0.58 (0.24 to 1.41)
Shin et al 2005	2.53	0.51 (0.37 to 0.70)
Meltzer et al 2008	2.60	0.69 (0.53 to 0.90)
Petersen and Burnett 2008	2.75	0.80 (0.69 to 0.93)
Skegg et al 2010	2.34	0.60 (0.40 to 0.91)
Aasland et al 2011	2.69	1.77 (1.44 to 2.17)
Palhares-Alves et al 2015	2.49	0.65 (0.47 to 0.91)
Claessens 2016	2.42	0.71 (0.49 to 1.03)
Davis et al A 2021	2.63	0.86 (0.67 to 1.10)
Davis et al B 2021	2.75	0.97 (0.83 to 1.12)
Gold et al 2021	2.78	0.86 (0.77 to 0.96)
Ye et al 2021	2.70	0.70 (0.58 to 0.84)
Herrero-Huertas et al 2022	2.59	0.61 (0.47 to 0.81)
FSO Switzerland 2008-2020	2.58	0.79 (0.60 to 1.05)
ONS England 2011-2020	2.70	0.58 (0.48 to 0.70)
Petrie et al 2023	2.68	0.97 (0.78 to 1.20)
Zimmermann et al 2023	2.69	0.79 (0.64 to 0.97)
Overall	100.00	1.05 (0.90 to 1.22)

Fig 2 | Forest plot of suicide rate ratios for male physicians compared with general population

populations. Therefore, the pooled effect estimate is only of limited use in describing the overall suicide risk for physicians compared with the general population. In a secondary meta-analysis, the suicide rate ratio of male physicians was shown to be significantly raised when other professional groups with similar socioeconomic status were used as a reference group, with less heterogeneity across study results.

Strengths and limitations of this study

We did not impose any language restrictions on our search strategy so that relevant studies from different

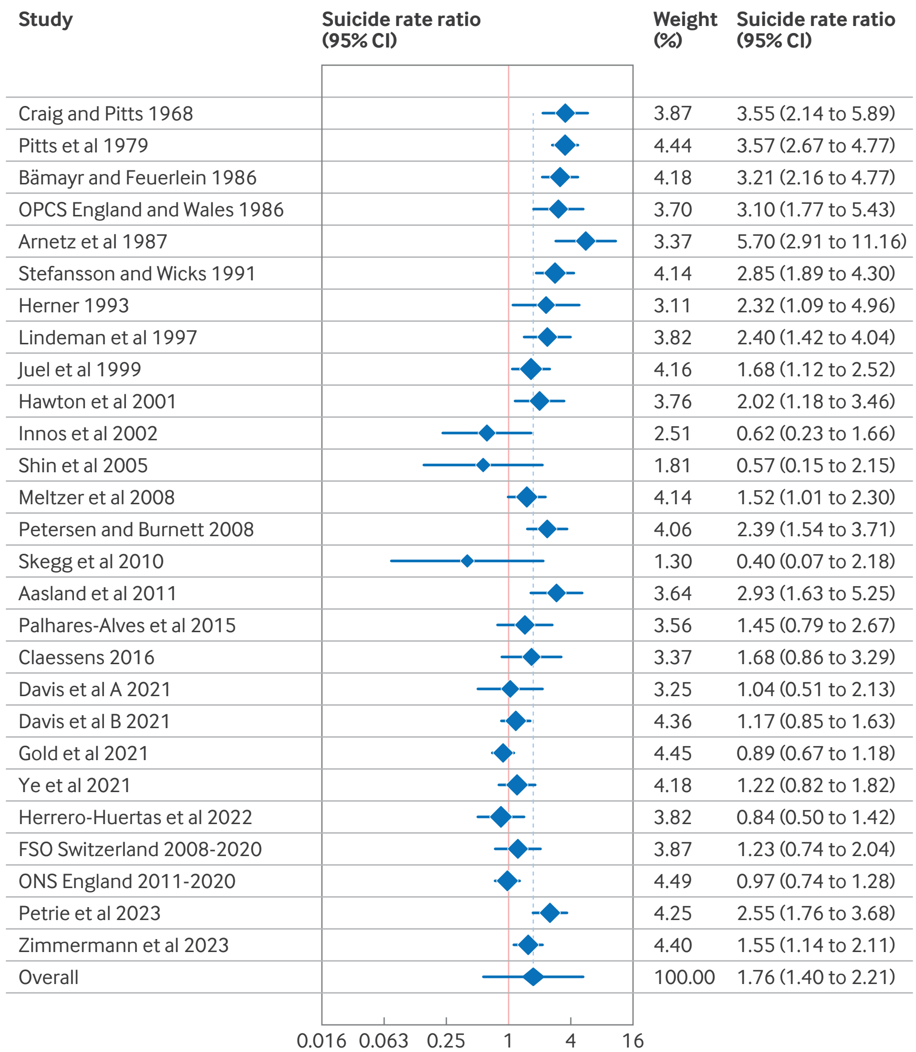


Fig 3 | Forest plot of suicide rate ratios for female physicians compared with general population

geographical regions were found. Consequently, we were able to include a large number of studies from 20 countries providing overall and recent summary estimates based on a complete assessment of the available evidence. This study also explored a range of covariates as potential causes for heterogeneity.

Several weaknesses should also be mentioned. Underreporting of suicide deaths might be more common for physicians compared with the general population,[8] influencing ratios between those two populations in the original studies. Despite the large number of included reports, several geographical regions are still underrepresented in the available evidence, which limits the generalisability of findings.

Comparison with other studies

A systematic review on physician deaths by suicide included a meta-analysis of studies with observation periods between 1980 and 2015,[11] but found only nine eligible studies (a third of which were already included in the first meta-analysis by Schernhammer and Colditz[10]). This analysis was also subject to some methodological limitations, such as using a potentially arbitrary starting point for study observation periods and not accounting for overlap between included studies (therefore counting some physician deaths by suicide twice). Another systematic review and meta-analysis on physician and healthcare worker deaths by suicide included only one new study compared with Schernhammer and Colditz[10] and so did not provide an updated estimate.[63] Additionally, this analysis included a large US study that reported increased proportionate mortality ratios, impacting the pooled estimate for male physicians towards showing an effect.

Meaning of the study

The results of this study suggest that across different physician populations, the suicide risk is decreasing compared with the general population, although it remains raised for female physicians. The causes of this decline are unknown, but several factors might

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play a part. The critical appraisal of the included studies indicated better study quality among more recent studies, which might have contributed to the decrease in effect sizes over time. Meta-regression results by Duarte and colleagues suggested that the decrease in suicide risk in male physicians was driven by a reduction in the rate of suicide deaths in physicians rather than an increase in suicide deaths in the population.[11] This finding could mean that physicians have benefitted more from general or targeted suicide prevention efforts compared with the general population, which is testament to the repeated calls for more awareness and interventions to support the mental health of physicians.[64 65] Furthermore, the proportion of female physicians has increased over recent decades, and the average proportion of female physicians across all OECD (Organisation for Economic Co-operation and Development) countries reached 50% in 2021.[66] This change is likely to affect working conditions in a historically male dominated field that could be relevant to the mental health of workers. Some evidence exists that occupational gender composition affects the availability of workplace support and affective wellbeing, with higher support levels in mixed rather than male dominated occupations.[67 68]

It is important to note, however, that considerable heterogeneity exists in the suicide risk of different physician populations that is still partly unexplained. Working as a physician is probably associated with different risk and protective factors across diverse healthcare systems, as well as training and work environments. Additionally, prevailing attitudes and stigma about mental health and suicide could vary. Societal influences on suicide rates over time might affect physicians differently compared with the general population (eg, mental health stigma might differ for physicians compared with the general population, and change at a different rate). Therefore, it seems plausible that the relation between suicide deaths in physicians compared with the general population differs between regions and countries.

Policy implications

Overall, this study highlights the ongoing need for suicide prevention measures among physicians. We found evidence for increased suicide rates in female physicians compared with the general population, and for male physicians compared with other professionals. Additionally, the decreasing trend in suicide risk in physicians is not a universal phenomenon. An Australian study found a substantial increase in suicide risk for female physicians, which doubled between 2001 and 2017.[58] The recent covid-19 pandemic has put additional strain on the mental health of physicians, potentially exacerbating risk factors for suicide such as depression and substance use.[69 70] Other important risk factors include suicidal ideation and attempted suicide, and their prevalence among physicians was estimated by a recent meta-analysis. The results suggest higher levels of suicidal ideation among physicians compared with the general population, whereas the prevalence of suicide attempts appeared to be lower.[71] This finding could indicate that suicidal intent in physicians is more likely to result in fatal rather than non-fatal suicidal behaviours.[72] A systematic review on mental illness in physicians concluded that a coordinated range of mental health initiatives needs to be implemented at the individual and organisational level to create workplaces that support their mental health.[73] Evidence exists for effective physician directed interventions, but hardly any research on organisational measures to address suicide risk in physicians.[74] Continued advances in organisational strategies for the mental wellbeing of physicians are essential to support individual medical institutions in their efforts to foster supportive environments, combat gender discrimination, and integrate mental health awareness into medical education and training.

Recommendations for future research

In addition to more primary studies from world regions other than Europe, the US, and Australia, future research also needs to systematically look into other factors beyond study characteristics that might explain the heterogeneity in suicide risk in physicians. Such research would help in identifying physicians who are at risk, with targeted prevention measures and ways to adapt them to different clinical and cultural contexts. Because geographical or national differences appear to be important factors, future studies on suicide risk in physicians should bear in mind that the specific settings of any physician population might influence their risk and resilience factors to a much higher degree than previously assumed. Other major events that affect healthcare, such as the covid-19 pandemic, could also have a large impact. Future research is needed to assess any covid-19 related effects on suicide rates in physicians around the world.

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Contributors: CZ, SS, and ES conceived and designed the study, HH and TN contributed and advised on methodological aspects. CZ performed the literature search and was the first reviewer for article screening, data extraction, and risk of bias assessment. SS was the second reviewer for article screening, data extraction, and risk of bias assessment. CZ performed the statistical analyses and SS accessed and verified the underlying study data. CZ, SS, and ES interpreted the data. CZ drafted the manuscript and prepared tables and figures. All authors critically revised the manuscript for intellectual content and approved the final version. ES supervised the study. CZ is the study guarantor. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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can take responsibility for the integrity of the data and the accuracy of the data analysis.

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Ethical approval: Not required.

Data sharing: Additional data are available from the corresponding author at eva.schernhammer@muv.ac.at upon request.

Transparency: The lead author (the manuscript's guarantor) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as originally planned (and, if relevant, registered) have been explained.

Dissemination to participants and related patient and public communities: The authors plan to disseminate the study findings through conference presentations, talks, press releases, social media, and in mandatory courses on mental wellbeing for medical students. The results will also be forwarded to national and international organisations that the authors have had contact with, to be disseminated both within these organisations and through their communication channels. This includes organisations in the field of mental health, public health, suicide prevention, and professional associations (for physicians and medical students); examples include the American Foundation for Suicide Prevention, the International Association for Suicide Prevention and particularly its Special Interest Group on Suicide and the Workplace, the Canadian Medical Association, the Austrian Public Health Association, and the Austrian Medical Chamber. Discussions on how these findings might be used in local and national suicide prevention efforts in Austria will involve physicians, hospital administrators, mental and occupational health professionals, and interested members of the public who are affected by suicidality among physicians.

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Web appendix: Supplement