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MEDICAL STUDENTS' SUICIDES –A SYSTEMATIC REVIEW

ABSTRACT

Objectives: *Suicidal tendencies among physicians have been a subject of research and scientific interest for some time, but less is known about suicides and the factors associated with them in the case of medical students, i.e. future physicians, although some interest has been shown in symptoms of depression and suicidal ideation. The authors' aim was therefore to present an up-to-date systematic review of medical students' suicides and associated factors.* ***Materials and methods:*** *The authors searched for original articles published in English that reported at least one medical student's suicide by consulting several databases in October 2020 and conducting additional searches in recent publications in August 2022 and February 2023. Data on the characteristics of the research, and the numbers of suicides and associated factors were collected from the articles identified. The guidelines of the Meta-analysis Of Observational Studies in Epidemiology (MOOSE) were applied throughout.* ***Results:*** *After the removal of duplicates, the initial search yielded 1,401 articles for further screening, whereupon full-text assessment of 56 of these revealed 17 that met the inclusion criteria. Screening of the references in the accepted articles, together with the additional searches, identified a further 11 eligible articles, making a total of 28, based on 18 populations. The methods used in these articles and the suicide rates reported varied, but based on nine studies, the median of annual suicide rates per 100,000 was 10.1. Being in the last years of studying, having previous mental health problems or problems in personal relationships and academic stress were the most frequently reported associated factors.* ***Conclusions:*** *More systematic research and official medical student death records are needed in order to achieve a better understanding of this subject and improve the wellbeing of medical students.*

KEYWORDS: ACADEMIC STRESS, MEDICAL STUDENT, SUICIDE, SYSTEMATIC REVIEW

BACKGROUND

Suicidal tendencies among physicians are a subject of great interest and have been an object of considerable research. Physicians seem to have higher risks of suicide than many other well-educated professionals such as teachers, veterinarians or academics (1). Earlier studies have shown suicide rates among physicians to be higher than in the general population (2), but lately high suicide rates have been associated particularly with female physicians while rates for males appear to be lower than in a general population (1). Studies concerned with risk factors and interventions have found female gender, young age, being unattached, stress, burnout, long working hours, bullying and harassment at work, access to lethal substances and certain specialties such as anaesthesiology to be risk factors for suicides in the case of physicians (1,3).

Medical students have been reported to have more suicidal ideation and more actual suicide attempts than their peers of the same age (4,5). Medical studies are felt to be burdensome, which might be one reason for the experienced anxiety, depression and suicidal ideation of medical students (6). This may in turn be attributed to the long period of training required and the great amount of knowledge needed, the use of numerical assessments rather than simple pass/fail evaluations, the fear of making mistakes

when treating patients and inadequate preparation for the shift from the preclinical to the clinical phase of medical studies, for example (5,7,8,9).

A systematic review and meta-analysis of the prevalence of depression, depressive symptoms and suicidal ideation among medical students was published in 2016 by Rotenstein et al. (10), who found 195 articles relevant to the analysis, including a total of 129,123 medical students in 47 countries, yielding an overall prevalence of 27.2% for depressive symptoms or depression and 11.1% for suicidal ideation. This prevalence of depressive symptoms in medical students was substantially higher than that reported for the same age group in the general population of the U.S..

In an invited commentary on this topic in 2019, Laitman and Muller reviewed existing studies of suicides among medical students in the U.S., drawing attention to the gap in knowledge of this field, and conducted their own preliminary research into the subject by executing an electronic survey of medical student suicides based on responses from student representatives at 100 medical schools (11). The outcome was a suicide rate of 6.19 per 100,000 among medical students during the years 2008-2018, which was lower than both the age-adjusted suicide rate and the rate for those aged 25-43 years in the U.S. as a whole. The authors called for further research on this topic, urging medical schools to collect information on suicides and calling for such data to be made publicly available.

Blacker et al. (2019) published a systematic review of the historical and international literature on medical student suicides based on a search among studies published before November 2017 without language restrictions (12). They found 12 eligible studies and their main finding was that medical student suicide rates were infrequently reported, and data collection methods were inconsistent. They compared medical student suicide rates to those of contemporaneous general populations, as obtained from public epidemiological data, and found that medical students' suicide rates in the U.S. were generally lower. Finally, the authors concluded that more comprehensive data was needed, and gaps existed in the reported suicide rates and in the knowledge of the risk factors involved and possible interventions.

In a recent study, Hasan et al. (2022) assessed the accessibility, utilization and user responses of a mental health service programme they had developed in Indiana University School of Medicine, the largest medical school in the U.S. (13). This information had been collected in the years 2017-2021. Utilization of the service was significant during the first year and increased over the whole period, so that as many as 38% of the graduating medical students had used the service at some point in their studies by the last year and the users had reported high degrees of satisfaction. These results underline the demand for mental health services among medical students.

Since medical students' suicides are evidently not a well-studied subject, our aim here was to systematically review existing studies worldwide to obtain an up-to-date summary of such research, including suicide rates and factors associated with suicides. The questions we set out to answer were: 1. What is the incidence of suicides among medical students? and 2. What are the risk factors associated with these suicides? Our hypotheses were that medical students have a higher suicide rate than other students in higher education, that female students have a higher risk of suicide than the general population at the same point in time, and that the risk factors/associated factors are similar to those involved in physicians' suicides. This formulation was based on earlier studies on the high suicide rate among physicians as compared with other professions, the generally high suicide risk among female physicians and the high prevalence of suicidal ideation among medical students (1,4,5).

METHODS

We systematically reviewed the literature on medical student suicides in accordance with the Meta-analysis Of Observational Studies in Epidemiology (MOOSE) guidelines (*Supplement 1*).

LITERATURE SEARCH

We performed the search in October 2020 with help of a Senior Information Specialist, using Boolean operators and the keywords (suicide* AND medic* N5 student*) in the PubMed, Scopus, Web of Science, EBSCO databases and the ProQuest databases and limiting the search to articles published in English. We also searched PubMed with the MeSH terms "Suicide" and "Students, Medical". Additional searches for newly published articles were performed in August 2022 and February 2023.

INCLUSION AND EXCLUSION CRITERIA

We included only peer-reviewed original articles published in English that met the following criteria: the population included medical students, the number of suicides was

reported, and at least one suicide in the follow-up cohort studies was committed during medical training.

EVALUATION OF THE ARTICLES AND RESULTING DATA

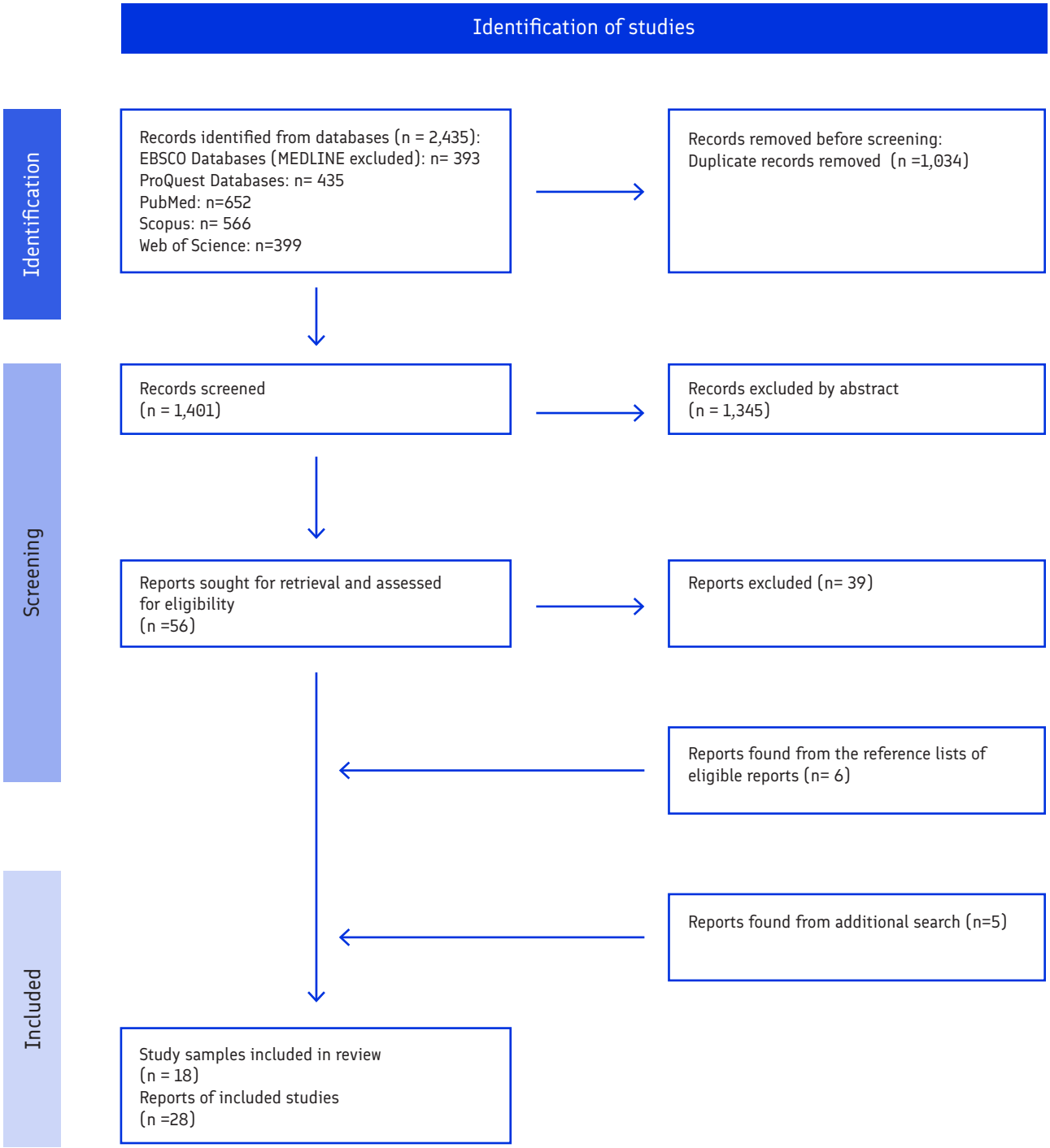
The articles identified were first evaluated on the basis of the title and abstract by at least two independent reviewers: A.M. assessed all of them and the second reader was either A-H.H., E.J. or T.H. The full text of the articles were read by A.M.. Unclear cases were resolved in a consensus discussion. The additional search results were assessed by A.M. and then discussed together. The following were collected from each article by A.M.: 1) basic information (article name, authors, year of publication, country, study design, time of data collection and length of follow-up), 2) population (group sizes, number of women and men, inclusion/exclusion criteria, year of medical school, ethnic background), 3) outcome (number of suicides) and 4) characteristics of the suicides (associated factors, suicide methods). We calculated mean annual suicide rates for the total population and for males and females separately from the information provided in the articles whenever possible, to ensure the optimum comparability of the rates.

RESULTS

SEARCH RESULTS

The initial search of the databases led to the identification of 2,435 articles, or 1,401 articles after duplicates had been removed. These were then systematically assessed on the basis of their title and abstract by two independent reviewers: A.M. and either A-H.H., E. J. or T. H.. In this step 56 articles met our inclusion criteria and their full texts were subsequently assessed by one reviewer, A.M.. In unclear cases a consensus was reached by A.M., A-H.H, E.J. and T.H.. By these means 17 articles were accepted for our review. We also screened the references contained in these articles and found six more eligible ones, in addition to which further searches produced a further five suitable articles. The total number of articles meeting our criteria was thus 28, dealing with 18 individual populations (*Figure 1*). Eight of these studies were also included in the review by Blacker et al. (12).

Figure 1. Flowchart of the study identification process.



CHARACTERISTICS OF THE STUDIES

The main characteristics of the studies included in this material are presented in *Table 1*. Of the 28 articles, only 12 were published after the year 2000 (14,15,16,17,18,19,20, 21,22,23,24,25). There was no general register of medical students' suicides in any country represented in these studies.

Ten of the 28 articles had the Johns Hopkins Precursors Study cohort as their basic population (26,27,28,29,30,31,32 ,33,34,35). This is the cohort used in the follow-up study of the Johns Hopkins Medical School's classes that graduated in 1948-1964, students from which participated in several questionnaires, such as Habits of Nervous Tension (HNT) and regarding psychobiological factors, and were investigated by the Rorschach Inkblot Method during their time at medical school. These subjects were followed up annually for five disease categories: suicide, mental illness, hypertension, coronary heart disease and tumours. The characteristics and associated factors relevant to suicide as reported in that study also included suicides after graduation, so that only two out of the 17 suicides reported in this cohort were actually committed during medical studies (31).

Seven articles were based on retrospective analyses of news reports (14,16,17,18,19,20,22). These were all relatively new and the choice of method was mainly determined by the lack of other sources of information, so that the scientific reliability of these sources must be considered carefully when interpreting the results. However, we wanted to include all the studies published in order to gain a broad view of the state of research into this topic.

Eight articles were based on questionnaires or telephone interviews to medical schools (15,21,24,25,36,37,38,39), one was based on information the U.S. medical schools had provided to the Association of American Colleges (40), one was a cross-sectional survey that also used city suicide records as a source of information (23), and one was a case report (41).

Of all the individual populations included here, seven concerned only medical school students in the U.S., in addition there were three from India, one from Bangladesh, two from Japan and one each from Canada, Italy and Uganda. One study had a population consisting of medical students from both the U.S. and Canada, and one was conducted worldwide. The population sizes varied from a case report of one suicide to a total of 445,809 medical students in Japan monitored during the years 1989-2012.

Some of the populations of included studies (38, 39 and the Johns Hopkins Precursors Study cohort, also 14,18,22) are likely to overlap. Earley et al. (38) used medical students in the U.S. in 1961-1967 as their population, with the inclusion criterion that the medical school must have had the students enrolled in the years 1966-1967, whereas Simon (39) used medical students in 47 U.S. and 3 Canadian medical schools during the period 1947-1967 as the basic population. The Johns Hopkins Precursors Study cohort used classes graduating in 1948-1964 as its population, and the studies from India included news reports from 2010 to 2019 in the case of Chahal et al. (14), from 2016 to 2019 for Kishor et al. (18) and from 2010-2014 for Pruthi et al. (22). The two articles from Bangladesh (19,20) both used the same method, and their populations overlapped for the most part, so that we addressed them as a single population as far as the data on medical students was concerned, i.e. the article covering a shorter time span can be regarded as a subsample of the population described in that wider time window.

Only few studies reported ethnicity or gender of medical students included in the study population (Johns Hopkins Precursors Study cohort, 24,39), but more frequently those features were reported for the medical students who had committed suicide (*Table 1*). In the studies based on questionnaires or interviews with medical schools the results are not entirely comprehensive, for there were a varying number of schools who didn't participate. Reported numbers were between 15 (39) and 47 (24).

Table 1. The main characteristics of the studies included

Authors, country	Setting	Population	Origin of information about suicides and associated factors	Results – numbers of medical students' suicides	Results – mean annual suicide rate per 100,000	Results - Factors associated with suicides	Other information
STUDIES BASED ON NEWS REPORTS							
Chahal et al. 2022, India	Exploratory study based on retrospective news content analysis covering the years 2010-2019	Indian medical students, residents and physicians in 2010-2019	Articles published in 2010-2019 in English or Hindi in leading Indian online news portals, other publicly available sites, and Google database	Total 125: 78 males 47 females	Not reported	Suicide method: hanging 69.6% (87), jumping from a high place 12.8% (16), poisoning 8.8% (11), jumping in front of a train 5.6% (7), other 3.2% (4) Associated factors (n=104): Academic stress (n=47), mental health problems (n= 25), harassment/ humiliation (n=18), failed/ troubled love affair (n=13), more than one reason (n=9), family problems (n=4), financial stress (n=2), legal issues (n=2), marital discord (n=1), physical illness (n=1), recent death of a close friend or relative (n=1)	67 suicides committed in government schools, 57 in private schools Suicide warning signs (n=35): recent changes in behaviour or mood (n=19), absenteeism from work/ classes (n=9), past suicide attempt (n=7), Verbal/written communication about suicidal intent (n=6), More than one warning sign (n=6)
Jahan et al. 2021, worldwide	Case study based on press reports	Healthcare professionals worldwide	Press media reports on healthcare professionals' suicides related to COVID-19, found using Google News search engine	1 female from India	Not reported	Associated factor: probably work-related stress	
Kaggwa et al. 2021, Uganda	Retrospective study based on media reports in 2010-2020	University students in Uganda 2010-2020	Ugandan media reports	1 male	Not reported	Phase of studies (5-year programme): 5th year Suicide method: poisoning Associated factor: end of a relationship	

Authors, country	Setting	Population	Origin of information about suicides and associated factors	Results – numbers of medical students' suicides	Results – mean annual suicide rate per 100,000	Results - Factors associated with suicides	Other information
Kishor et al. 2021, India	Retrospective study based on Indian online newspapers 2016-2019	Physicians and medical students in India 2016-2019	Indian online newspapers published in English	Total 8	Not reported		
Mamun et al. 2020, Bangladesh Subsample: Mamun et al. 2022, Bangladesh	Retrospective study based on Bangladeshi newspaper reports in the period 1/2018-11/2019	Bangladeshi students and medical students in 2018-2019	Online newspaper reports in Bangla and English found via Google search engine	Total 13: 8 females 5 males	Not reported	Phase of studies (5-year programme): 2 during 2nd year, 1 during 3rd year, 1 during 4th year. 5 during 5th year, 1 reported as intern, 3 not reported Suicide method: 12 by hanging, 1 by poisoning Associated factors: academic distress (n=4), mental health problems (n=2), family problems (n=3), medical condition (n=1), blackmail (n=1), not reported (n=2)	Schooling of students who committed suicide: 9 at public medical colleges, and the other 4 at a private medical college, medical technology institute, medical institute or paramedical institute 10/13 suicides reported in the 1st half of the academic year
Pruthi et al. 2015, India	Retrospective study based on Indian online news reports in 2010-2014	Indian medical students in 2010-2014	Indian online newspaper reports	Total 16: 10 males 6 females	Not reported	Associated factors: academic stress or disappointment (n=8), break-up with a partner (n=1), mental health problems (n=1), physical health problems (n=1), nagging/ hazing (n=1), accusation of theft (n=1), unknown (n=3)	
OTHER STUDIES							
Matsubara et al. 2021, Japan	Retrospective survey	Yamaguchi University students in 1992-2017	University accident records	Total 13	Not reported	Phase of studies (6-year programme): 13 during 4th year (no other years mentioned)	

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Authors, country	Setting	Population	Origin of information about suicides and associated factors	Results – numbers of medical students' suicides	Results – mean annual suicide rate per 100,000	Results - Factors associated with suicides	Other information
Tarchi et al. 2021, Italy	Cross-sectional study including an inquiry addressed directly to the medical faculty	Medical students at the University of Pavia, Italy, in 2014-2019, total 1744 medical students, of whom 317 were from abroad	City death records, cross-referenced with medical faculty enrolment numbers	Total 5: 4 males 1 female 2 Italian males, 2 foreign males, 1 foreign female	Total 47.78	Phase of studies (6-year programme): 3 during 1st year (1 native, 2 foreign), 1 during the last years of the course (foreign), 1 during the last year (native) Suicide methods: 2 by suffocation (1 native, 1 foreign), 3 by hanging (1 native, 2 foreign) Associated factor: being a student from abroad	Crude suicide rates: 23.36/100,000 for Italians only and 105.15/100,000 for foreigners only Crude estimated rate for the same-aged general population reported in the WHO mortality database: 3.29/100,000
Zivanovic et al. 2018, Canada	Questionnaire sent to medical faculties	16/17 Canadian medical undergraduate programmes and their students in 2006-2016	Medical schools Estimated mortality rate calculated using publicly available medical school census data obtained from the Canadian Association of Faculties of Medicine Universities	Total 6: 3 males 3 females	Total 5.9	Phase of studies (4-year programme): 5/6 occurred in the last years (third, fourth, or just after graduation)	7 medical undergraduate programmes kept statistics on student deaths, including suicides Suicide rates compared with the general population of Canada: general suicide rates of 11/100,000 at age 20-24, 11.7/100,000 at 25-29 and 12/100,000 at 30-34 are higher than for medical students

Authors, country	Setting	Population	Origin of information about suicides and associated factors	Results – numbers of medical students' suicides	Results – mean annual suicide rate per 100,000	Results - Factors associated with suicides	Other information
Uchida et al. 2017, Japan	Longitudinal serial prevalence study including annual questionnaires sent to universities	College students in Japan in 1989-2012, including a total of 445,809 medical students (332,038 males, 123,771 females) In first year, 48/95 national universities responded, in final year 60/82	Universities	Total 90: 65 males 25 females	Total 20.2: Male 19.6 Female 20.2 (Calculated from information provided in the article)	Associated factors: major subject (pharmacy, veterinary science and medicine vs. others), study phase (final year and holdover students)	Suicide rate among medical students reported as significantly high (p<0,01). They were also most vulnerable to suicide among all major subject groups and significantly more likely to die by suicide Suicide rates of other students: pharmacy 41.3/100,000, veterinary science 25.0/100,000, dentistry 17.7/100,000, sciences 15.1/100,000, humanities 13.7/100,000 No significant differences in suicides between the sexes
Cheng et al. 2014, U.S.	Questionnaire sent to medical faculties	Medical students in 90/133 accredited U.S. allopathic medical schools in 2006-2011 (Puerto Rico excluded)	Medical schools	Total 6: 4 males 2 females 5 Caucasians, 1 Asian	Total 2.3: Male 2.96 Female 1.63	Phase of studies (4-year programme): 2 during 1st year, 2 during 2nd year, 2 during 3rd year Suicide methods: 2 by gunshot, 2 by hanging, 1 overdose, 1 unknown Associated factor: psychiatric morbidity (n=3)	Numbers of suicides in the general population of the U.S. sorted by age and race were higher than for medical students

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Authors, country	Setting	Population	Origin of information about suicides and associated factors	Results – numbers of medical students' suicides	Results – mean annual suicide rate per 100,000	Results - Factors associated with suicides	Other information
Hays et al. 1996, U.S.	Survey by telephone calls to medical faculties	Students at 101/126 medical schools in the U.S. in 1989-1994	Medical schools	Total 15: 14 males 1 female 12 Caucasian, 2 Middle eastern, 1 Hispanic	Total 5.9: Male 8.9 Female 1.0 (Calculated from information provided in the article)	Phase of studies (4-year programme): 3 during 1st year, 2 during 2nd year, 6 during 3rd year, 4 during 4th year Suicide methods: 8 by gunshot, 6 by overdose (of which 2 by injection), 1 by jumping Associated factors: psychiatric history (n=9), of which 3 had alcohol/drug abuse	Marital status of the students: 13 singles, 1 married, 1 divorced 6 students left suicide notes Female students' calculated mean annual suicide rate was lower than compared to the ones of same-aged population of the U.S (1.8-5.8/100,000 depending on age and race), male students' rates were lower than in the general population Total suicide rate for medical students was lower than for the general population
Constantino et al. 1990, U.S.	Case report	-	Not reported.	1 white male	-	Suicide method: Thiamylal injection and hanging	

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Authors, country	Setting	Population	Origin of information about suicides and associated factors	Results – numbers of medical students' suicides	Results – mean annual suicide rate per 100,000	Results - Factors associated with suicides	Other information
Pepitone-Arreola-Rockwell et al. 1981, U.S.	Questionnaire sent to medical faculties	Total of 75,292 students graduating from 88/116 U.S. medical schools in 1974-1981 Suicides committed in 1970–1978	Medical schools	Total 52: 34 males 9 females 9 of unknown gender	Total 18.4: Male 15.6 Female 18.9	Phase of studies (4-year programme): 3 during 1st year, 12 during 2nd year, 7 during 3rd year, 3 during 4th year, 27 unknowns	Male medical students' suicide rates lower than for the general population, female rates higher than for the general population Marital status: 75% of the 32 reported cases were single Less than 30% of the schools provided estimates of the number of students receiving psychiatric treatment, which ranged from 0% to 43% 54 reported suicide attempts
Everson et al. 1975, U.S.	Cross-sectional study	Medical students in USA in 1967-1971, based on attrition reports sent by U.S. medical schools to the Association of American Colleges	Attrition reports sent by U.S. medical schools to the Association of American Colleges	Total 7 (5 known, 2 probable)	Total 10.1 (Calculated from information provided in the article, assuming probable suicides to have been actual suicides and the proportion of suicides in the group with unknown causes of death to have been the same as in the group with known causes)	Not reported	Death rate from all causes 37/100,000 (total 55 deaths, with 26 of known cause)

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Authors, country	Setting	Population	Origin of information about suicides and associated factors	Results – numbers of medical students' suicides	Results – mean annual suicide rate per 100,000	Results - Factors associated with suicides	Other information
Earley et al. 1969, U.S.	Questionnaire sent to medical faculties	All 90 U.S. medical schools, which had students enrolled in 1966-1967 Suicides committed in 1961-1967	Medical schools	Total 21 (18 known, 3 probable)	Not reported	Phase of studies (4-year programme): 8 during 3rd (junior) year, others not reported	A possible increase in suicides in the junior year
Simon 1968, U.S. & Canada	Questionnaire sent to medical faculties	A total of 85,299 students in 50/65 schools of medicine in 1947-1967 3 Canadian schools, 47 American 26 private schools, 24 public More than 90% of the students were males and more than 90% Caucasian	Medical schools	Total 31	Total 1.8 (Calculated from information provided in the article)	Phase of studies (4-year programme): 7 during 1st year, 6 during 2nd year, 11 during 3rd year, 7 during 4th year	Suicide rates reported for 2 periods, with an increasing trend: 39/100 000 in 1950-55 and 59/100 000 in 1960-65 Suicide rate among medical students reported to be significantly higher than in 20-24-year-old white males in the U.S.
JOHNS HOPKINS PRECURSORS STUDY COHORT				Total 2 medical students	Total 37.5		
Graves et al. 1991, U.S.	Cohort Study	Johns Hopkins Precursors Study cohort, 1,046 white males who had completed the HNT questionnaire	Cohort study questionnaires, physician and hospital records, death certificates	Total 13, including 1 during medical school and some graduate physicians, all white males		Associated factors: HNT questionnaire characteristics: irritability, urinary frequency, difficulty in sleeping, loss of appetite, an urge to be alone	

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Authors, country	Setting	Population	Origin of information about suicides and associated factors	Results – numbers of medical students' suicides	Results – mean annual suicide rate per 100,000	Results - Factors associated with suicides	Other information
Thomas et al. 1985, U.S.	Cohort Study	Johns Hopkins Precursors Study cohort, 1,154 students including 1,032 white males, 91 white females, 27 other males and 4 other females, all of whom participated in Rorschach test	Cohort study questionnaires, physician and hospital records, death certificates	Total 16, including possible suicides during medical school and some graduate physicians		Associated factor: the use of 'whirlall' words in Rorschach test (significantly more than in other groups)	
Graves et al. 1981, U.S.	Cohort Study	Johns Hopkins Precursors Study cohort, 319 white male students who participated in the Rorschach test	Cohort study questionnaires, physician and hospital records, death certificates	Total 10, including possible suicides during medical school and some graduate physicians All white males			The most ambivalent Rorchach interaction patterns were found in the mental disorder group (including suicides)
Thomas et al. 1980, U.S.	Cohort Study	Johns Hopkins Precursors Study cohort, total 1,168 medical students who completed the HNT test, including 1,046 white males, 91 white females and 31 classified as "other students"	Cohort study questionnaires, physician and hospital records, death certificates	Total 10, including possible suicides during medical school and some graduate physicians All white males		Associated factors: previous mental health issues (n=4), features in the HNT questionnaire: difficulty in sleeping, high urinary frequency, loss of appetite, an urge to be alone and more irritability (compared with healthy controls)	
Thomas 1976, U.S.	Cohort Study	Johns Hopkins Precursors Study cohort, total 1,337 medical students, including 1,301white and 36 of other races	Cohort study questionnaires, physician and hospital records, death certificates	Total 17: 2 during studies, 2 non-graduates, 13 graduate physicians 13 males 4 females All white		Associated factor: mental health problems (n=11)	

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Authors, country	Setting	Population	Origin of information about suicides and associated factors	Results – numbers of medical students' suicides	Results – mean annual suicide rate per 100,000	Results - Factors associated with suicides	Other information
Harrower et al. 1975, U.S.	Cohort study	Johns Hopkins Precursors Study cohort, experimental group of 102 white male and female students selected from 870 medical students who completed the Figure Drawing Test	Cohort study questionnaires, physician and hospital records, death certificates	Total 9, including possible suicides during medical school and some graduate physicians 6 males 3 females All white		.	No significant differences between the suicide or mental illness groups and their specific control groups
Thomas et al. 1974, U.S.	Cohort Study	Johns Hopkins Precursors Study cohort, total population of 1,337 medical students, including 914 white males with complete closeness-to-parents data	Cohort study questionnaires, physician and hospital records, death certificates, information from the Dean's Office	Total 16, including possible suicides during medical school and some graduate physicians 12 males 4 females All white 11 completed the family attitude questionnaire		Associated factors: significantly older fathers than in the other groups, low emotional demonstrativeness, high matriarchal dominance score, high mother's age	
Thomas et al. 1973, U.S. (Psychobiological characteristics in youth as predictors of five disease states: suicide, mental illness, hypertension, coronary heart disease and tumour)	Cohort Study	Johns Hopkins Precursors Study cohort, 1,130 white males who participated in the Precursors Study, 88 of whom were selected: 44 from 5 disease groups (9 suicide, 9 mental illness, 9 hypertension, 8 coronary heart disease, 9 tumour) and 44 with no major diseases, as a control group	Cohort study questionnaires, physician and hospital records, death certificates	Total 9, including 1 during medical school and 2 non-graduates All white males		Associated factors: youngest age in tests, oldest parents, lowest diastolic pressure, most underweight, highest scores in Rorschach test for D, CF, FT, F-, F, An, P, D%, P% and lowest scores for W, ZFr, (Y), FY, (AnSex), W%	

Authors, country	Setting	Population	Origin of information about suicides and associated factors	Results – numbers of medical students' suicides	Results – mean annual suicide rate per 100,000	Results - Factors associated with suicides	Other information
Thomas et al. 1973, U.S. (A prospective study of the Rorschach tests of suicides: the predictive potential of pathological content)	Cohort Study	Johns Hopkins Precursors Study cohort, 1,154 students who completed the Rorschach test	Cohort study questionnaires, physician and hospital records, death certificates	13 suicides including at least 1 during medical school and some graduate physicians 9 males 4 females All white		Associated factors: certain categories in Rorschach test (crying for help, drowning, cancer, toothless, mental disorder, alcoholic)	Rorschach scores, blind clinical assessment, Martin's signs or Sapolsky's sign failed to show significant predictive potential against suicide Pathological content in Rorschach test has predictive potential
Thomas 1971, U.S.	Cohort Study	Johns Hopkins Precursors Study cohort, total of 1,137 medical students who completed the HNT questionnaire: 1,046 white males and 91 white females	Cohort study questionnaires, physician and hospital records, death certificates	Total 12, of which 2 during medical school and 10 after graduation 8 males, 4 females Also 2 reported suicides among non-participants in the cohort		Suicide methods for both medical students and graduate physicians, including the non-participants: 7 by poisoning (6 barbiturates, 1 other), 3 by firearms, 2 by hanging, 1 by jumping, 1 by a cutting instrument Associated factors: Significantly more habits of nervous tension (significantly more difficulty in sleeping, urinary frequency, loss of appetite, an urge to be alone, irritability and significantly less willingness to confide)	

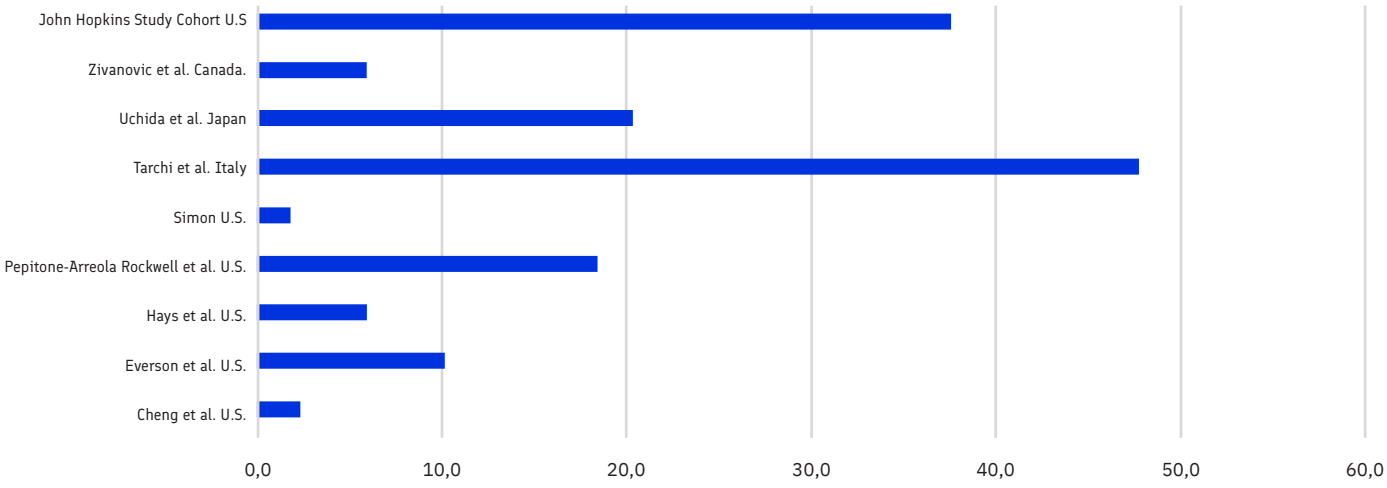
SUICIDE RATES AND CHARACTERISTICS

The total number of medical student suicides reported, in which there might be some overlapping, was 413. Nine of the studies (15,23,24,25,36,37,39,40, Johns Hopkins Precursors Study cohort) reported or provided sufficient information to calculate mean annual suicide rates, which varied from 1.8 per 100,000 (39) to 47.8 per 100,000 (23), the overall mean being 16.7 per 100,000 and the median 10.1 (*Figure 2*). Mean annual suicide rates for males and females separately were provided or calculable in four studies (15,24,36,37), that for males varying from 3.0 to 19.6 per 100,000, with an overall mean of 11.8 per 100,000, and that for females from 1.0 to 20.2 per 100,000, with an overall mean of 10.4 per 100,000.

In three studies the suicide rates for medical students were reported to be lower than in the general population of the same age (15,25,36) and in two they were higher (23,39), while in the cohort study of college students in Japan the suicide rate among medicine-majoring students was significantly high (24). In the two studies in which medical students' suicide rates were compared with those for the general population by gender (36,37), the male medical students were reported to have lower rates than the general population and the female medical students either higher (37) or lower (36) rates.

The methods of committing suicide were reported for the Johns Hopkins Precursors Study cohort, which also included subjects who had graduated as physicians, and for seven other study populations (14,15,17,19,23,36,41), providing a total of 179 suicides for which the method was known. Hanging was the most common method, being used in 106 cases, and was especially common in India, where there were 99 cases of hanging. Intoxication was used as a method in 30 cases and was the most common method in the material from the U.S., while barbiturates were mentioned particularly in the case report of Constantino et al. (41) and in the Johns Hopkins Precursors Study cohort, in which there were a total of eight barbiturate intoxications. 18 suicides were committed by jumping from a high place, firearms were used in 13 cases, seven were brought about by jumping in front of a train, two reportedly committed by suffocation and one with a sharp instrument, while four suicides were categorized as involving "other methods".

Figure 2. Annual suicide rates per 100,000



FACTORS ASSOCIATED WITH MEDICAL STUDENTS' SUICIDES

Ten studies contained at least partial accounts of the phase in the student's studies in which the suicide occurred, and the timings varied (15,17,19,21,23,25,36,37,38,39). In six studies most of the timings reported were in the last two years of medical school (17,19,21,25,36,39), but some in the early years (15,23), while in others they were reported in various phases of medical school (37). Uchida et al. also found a significantly higher risk of suicide in the final year and in "holdover students" (24).

Six studies reported previous mental health problems of those who had committed suicide (14,15,19,22,32,36), the prevalence being 25 out of 125 suicides (14), three out of six (15), nine out of 13 (36), two out of 13 (19), one out of 16 (22) and four out of ten (32). Family or love life problems were reported in four studies (14,17,19,22), and academic stress was mentioned as an associated factor in three: Chahal et al. (14) reported it in 47 out of 125 suicides, Mamun et al. (19) in four out of 13 suicides and Pruthi et al. (22) in eight out of 16. In the material of Tarchi et al. from Italy, three of the five suicides were committed by students from abroad (23). Other factors reported as being associated with suicides were harassment/humiliation, financial stress, legal issues, physical illness, the recent death of a close friend or relative, blackmail and an accusation of theft (*Table 1*).

Four articles of Johns Hopkins Precursors Study cohort assessed the predictive potential of the HNT questionnaire in potential cases of suicide (26,27,32,35), in that there were significantly more positive responses to this questionnaire in the suicide group than among the other subjects, and in particular the suicide group had significantly more irritability, a higher urinary frequency, difficulty in sleeping, loss of appetite, an urge to be alone and significantly less willingness to confide. Also, the predictive potential of the responses of the later suicide-committing subjects to the Rorschach Inkblot Method was studied in four of the Johns Hopkins Precursors Study cohort articles (27, 28, 33,34). The Rorschach Method is a relatively unstructured, performance-based personality assessment instrument, and its interpretation has been developed more recently by introducing the Exner Comprehensive System (CS), in which the Suicide Constellation (S-CON) is reviewed by the interpreter in order to assess whether the respondent has features which are common among individuals who have brought about their own death within a relatively short period of time after administration of the Method (42,43). In one article Thomas et al. (28) found that pathological content in the Rorschach responses can have predictive potential, the most predictive and significant categories with respect to suicide being crying for help, drowning, cancer, toothlessness, mental disorder and alcoholism. The results concerning the significance of Rorschach scores were nevertheless controversial (27,28). In addition, Thomas et al. (34) found that their suicide group used significantly more 'whirlall' words in their Rorschach protocols. Studying the predictive potential of psychobiological factors in young people, Thomas et al. (27) reported that the suicide group had the youngest age at the time of the tests, the oldest parents, the lowest diastolic pressure and they were the most frequently underweight. In another article based on the same cohort, Thomas et al. (29) found that the fathers of the suicide group were indeed significantly older than those of members of the other groups.

DISCUSSION

There are only a limited number of quantitative studies of suicides among medical students, and the difficulty of gaining reliable and comprehensive data may limit exploration of this subject. We found 28 articles involving 18 populations, based on online news reports, surveys carried out for medical faculties, assessments of death records, a cohort study, a longitudinal serial prevalence study and a case report, all of which met our inclusion criteria. One third of these articles were based on the same Johns Hopkins Precursors Study cohort, which took students in the classes graduating from that university's Medical School in 1948-1964 as its population, so that, overall, many of the resulting studies were undeniably outdated. As for the methods used, several studies were based on questionnaires or telephone interviews with medical schools, where the response rate of the schools themselves may have affected the results, while in the case of the studies based on retrospective news content analysis, the method used may detract from the comprehensiveness and scientific reliability of the results.

The reported and calculated mean suicide rates varied considerably, and the fact that we were able to calculate gender-specific rates for only four studies (15,24,36,37) does not give a very reliable representation of the differences between the genders. Thus, no clear differences can be deduced from these sparse results and more research is needed. Likewise, the overall suicide rates among the medical

students were compared with those for the same age groups in five studies, with mixed results (15,23,25,36,39). This is a small number of studies considering that medical students have been reported as having a higher prevalence of depression, suicidal ideation and even suicide attempt than the general population (4,5,10). Two studies (36,37) compared suicide rates with those in the general population by gender and found that male medical students had lower suicide rates than in the general population, which is in line with information on physicians (1). As for female medical students, the results were mixed. Only one study compared medical students' suicide risks with those of students majoring in other subjects (24), and this found the risk to be significantly higher for medical students, although high suicide rates were also reported for veterinary and pharmacy students. These fields are quite close to one another, so that one may ask if there could be some predisposing similarities between these programmes.

According to the National Center for Health Statistics, suicide was the second most prominent cause of death in the age group 25-34 years in the U.S. in 2020 and the third most frequent cause of death in the age group 15-24 years (44). The same authors also reported crude suicide rates per 100,000 for age groups and males and females separately, the rate being 5.8 per 100,000 for females aged 15-24 and 7.2 per 100,000 for those aged 25-34, and 22.4 for males aged 15-24 and 28.3 for those aged 25-34. Thus, the female medical students' mean annual suicide rate of 10.4 in our results seems to be higher than that of the contemporaneous population and that of the male medical students, 11.8 lower. In their study of the incidence of suicide in all university students in England and Wales, Gunnel et al. (45) reported the annual incidence in 2015/16-2016/17 as being 4.7 per 100,000 students, which they claimed was an increase relative to 2009/2010 but lower than the figure for the general population. This reported incidence is nevertheless considerably lower than our mean annual suicide rate of 16.7 per 100,000, which supports the hypothesis that medical students have a greater suicide risk than other students in higher education.

Factors associated with suicides were reported in 15 articles (*Table 1*), but some of these reports also concerned physicians (Johns Hopkins Precursors Study cohort). The most commonly reported factor was the phase in the individual's studies, which was reported in 11 articles. In most cases the suicides were committed during the last years of training, and it is possible that features of the clinical work involved at this stage may predispose students to committing suicide. There were also some suicides reported during the first years of study, however, so that factors predisposing to suicide should be taken into account at every phase of medical studies. Previous psychiatric problems, academic stress and relationship problems were also reported as characteristics in numerous cases, while other associated factors reported in this material were studying abroad, having a large number of positive responses in certain categories in the HNT questionnaire, having certain psychobiological factors in one's youth or pathological content in the Rorschach Method. Also, harassment or humiliation, financial stress, legal issues, physical illness, blackmail, an accusation of theft or the recent death of a close friend or relative were mentioned as factors connected with suicides. The relevance of factors studied in the 1960s or earlier, such as responses to the HNT or more recently the Rorschach Method, can be questioned.

Blacker et al. (12) found, above all in their review, that the reporting of medical student suicide rates is deficient on an international scale, and also that suicide rates for medical students in the U.S. are generally lower than the contemporaneous rates for the general population. Our results regarding this matter are not so clear, however, as three of the five studies comparing medical students' suicide rates with those of the general population reported the rate to be lower (15,25,36). More international studies have been published since that time, however, containing figures from Bangladesh, Canada, India, Italy, Japan and Uganda (14,17,18,19,20,21,22,23,24,25).

The strength of our research is that it is based on peer-reviewed original articles written in English that report the numbers of medical students' suicides with no other exclusion criteria. We had four independent reviewers in the screening process and the search was conducted in five databases with the help of an Information Specialist, which must have increased the probability of finding relevant articles.

The limitations include the fact that the studies meeting our criteria were mostly from the U.S., which makes the results hard to generalize internationally, and there may also be cultural differences and variation in medical training programmes that are not addressed in this review but could have affected the suicide rates, characteristics and associated factors. Also, the limited number of studies available made it difficult to draw any conclusions from the results. Most of the studies involved questionnaires sent out to medical schools, and because there are no official public statistics related to medical student suicides some of the medical schools failed to reply or had not collected sufficient information on suicides. It is therefore impossible to generalize from the data reported in these articles. In addition, the scientific quality of the studies based on online news reports is evidently

defective. Many of the studies were markedly old, so that their results might not be generalizable to the present day, as medical training has evolved with the society in which it has taken place. There is also a risk of publication bias in our results, because only a limited number of studies have been published on this subject. In addition, information bias is possible through the questionnaires, to which only some of the medical schools responded, and through the online news reports, which may not have covered all the suicides that took place.

CONCLUSIONS

This subject has been studied relatively little during recent decades and methods have varied, as also has the reported incidence of medical students' suicides. Mixed results have been reported for comparisons of suicide rates between medical students and the contemporaneous general population, and there is a lack of studies on the suicide risk facing medical students relative to other students in higher education. Our findings have certain implications for medical education, however. In many of the articles the reported suicides occurred during the final years of medical training, at a time when the students are starting to get acquainted with clinical practice as doctors, which can be stressful and could be handled better in medical curricula. On the other hand, some studies also described suicides as occurring in the early phases of medical studies, indicating a need for continuous wellbeing and healthcare programmes for medical students. Another commonly reported factor associated with suicide was previous psychiatric problems. Mental health services should be easily accessible for medical students, and it would be beneficial for medical schools to keep official records of student dropouts and deaths in order to achieve a better understanding of these problems and focus future research correctly. Further systematic studies will be needed to discover more about this phenomenon as a whole and to find means of intervention in order to improve the wellbeing of medical students.

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