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REVIEW

Eating disorders risk among medical students: a global systematic review and meta-analysis

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Abstract

Purpose Medical students appear to be a high-risk group to develop psychological problems including eating disorders (ED). The prevalence estimates of ED risk vary greatly between studies. This systematic review and meta-analysis was done to estimate the prevalence of ED risk among medical students.

Methods An electronic search of EMBASE, MEDLINE, ProQuest and Google Scholar was conducted. Studies that reported the prevalence of ED risk among medical students and were published in English peer-reviewed journals between 1982 and 2017 were included. Information about study characteristics and the prevalence of ED risk were extracted by four investigators. Each article was reviewed independently by at least two investigators. Estimates were pooled using random-effects meta-analysis using the DerSimonian–Laird method. The main outcome of interest was the prevalence of ED risk in medical students.

Results The prevalence of ED risk among medical students was extracted from nineteen cross-sectional studies across nine countries (total participants $n=5722$). The overall pooled prevalence rate of ED risk was 10.4% (497/5722 students, 95% CI 7.8–13.0%), with statistically significant evidence between-study heterogeneity ($Q=295$, $\tau 2=0.003$, $I2=94.0\%$, $P<0.001$). Prevalence estimates between studies ranged from 2.2 to 29.1%.

Conclusion In this systematic review and meta-analysis, the summary prevalence of ED risk among medical students was 10.4%. Further research is needed to identify and prevent ED in this population. Studies are also needed to investigate concurrent pathologies associated with ED risk.

Level of evidence Level I, systematic review and meta-analysis.

Keywords Eating disorder risk · EAT-26 · Medical students · University students

Introduction

Eating disorders (ED) are disorders of eating behaviors, associated thoughts, attitudes and emotions, and their resulting impairments [1]. ED are becoming an area of concern due to their increasing prevalence in all age, ethnic and socioeconomic cohorts [2, 3]. ED are associated with several physiological impairments, comorbidities, and increased risk for mortality [4]. The mortality rate for persons with ED is the highest among all psychiatric illnesses [5], and is estimated to be twelve times higher than the rate from other causes for women of 15–24 years old [6].

Individuals with ED often do not seek medical help, or only seek help in the later stages after a long period of illness [7]. According to the National Eating Disorders Collaboration of Australia there is a mean delay of 4 years between the start of ED symptomology and first treatment, and this delay can be for 10 or more years [8]. Thus, there is a legitimate need to identify individuals at risk of ED to provide timely treatment.

There are numerous tools available to screen for ED risk; however, only limited ones have been used repeatedly in the literature. The top four screening instruments are: Eating

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Attitudes Test-26 (EAT-26) [9], Eating Disorder Inventory (EDI) [10], Eating Disorder Examination Questionnaire (EDE-Q) [11], and SCOFF Questionnaire [12].

Previous studies have suggested that medical students can be considered as a high-risk group for developing mental health problems including ED due to academic stress, extremely high workloads, the need for continuous learning, and exposure to illnesses and death during their medical education [13–15]. Being a young adult also increases the risk for developing ED due to the transitional nature of this phase of life in term of relationships, self-concept and goals for future [16]. The stigma associated with mental health disorders and ED may lead to denial, self-medication, delayed diagnosis and treatment resulting in more severe and persistent presentation of ED [17].

Estimates of the prevalence of ED risk among medical students vary across studies from 2 to 30% [18, 19]. Conflicting findings in the variation by sex, year of study and ethnicity are reported [19, 20]. Obtaining reliable estimates for ED risk during medical education are crucial to identify, treat and prevent such disorders in this specific population. Accordingly, the following global systematic review and meta-analysis was executed to (1) obtain a stable estimate of ED risk among medical students, and (2) to examine variability between studies and assess the generalizability of the results.

Methods

This systematic review and meta-analysis used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [21] statement as a guideline for reporting.

Database searches

In November 2017, three reviewers HJ, MS and MF conducted an electronic search using EMBASE, MEDLINE, ProQuest and Google Scholar from 1982 to 2017. The search team developed a list of search strategies, including the following keywords: medical students, eating disorder(s), feeding disorder(s), eating problem(s), eating attitude(s), and eating behavior(s). No limitations were applied during the initial search. Furthermore, the review team manually screened the references of the identified papers for potential inclusion in the review.

Inclusion criteria

We included all observational studies that aimed to study the prevalence of ED risk among medical students. The studies should have satisfied the following criteria: (1) published in the English language; (2) date of publication was between January 1982 and November 2017; (3) assessed medical students as a target population and (4) reported the prevalence of disordered eating risk. ED risk was defined in this review as significant changes in eating patterns with associated psychological changes. Disordered eating risk in previous studies is often measured using the most common screening tools of EAT-26, SCOFF and EDI (Fig. 1).

Exclusion criteria

Exclusion criteria were: (1) studies that included medical students with non-medical students in the same group, without providing a subgroup analysis; (2) studies in which the prevalence of ED was not the main focus of the research, e.g., studying "mental health problems" in general; (3) lack of availability of the study, and inability to obtain the full text after contacting the authors (Fig. 1).

Main outcomes and measures

The principal outcome of this review is to report the prevalence of ED risk among medical students using pre-established cut-off scores of continuous measures of eating pathology risk. These cut-off scores were established by the developers of measurement scales for example a score of ≥ 20 points on EAT26 or a score of ≥ 2 points on SCOFF indicate risk of ED. The secondary outcomes were comparisons of the variability between studies reporting the prevalence of ED risk according to the: sex of participants, country of the study, and used research tool.

The five review team members independently screened titles and abstracts and assessed studies for eligibility criteria. Authors AA, MS, AB performed initial data extraction, which was later confirmed by another review member HJ or MF. Any conflicts in study appropriateness for inclusion in the review were resolved through dialogue with the senior reviewer/expert clinician AA and panel consensus. To standardize data extraction, the review team agreed to collect the following variables: study characteristic, e.g., name, year, sample size, country, participants characteristics, e.g., age, sex, body mass index (BMI) (kg/m^2) and the main findings of the prevalence of ED risk. Missing data from the included studies were requested from the original authors as necessary using email correspondence.

Data synthesis and statistical analyses

The data were pooled in this meta-analysis using random-effects model according to the DerSimonian–Laird method, reporting the pooled prevalence and the corresponding 95% confidence interval. Data were presented graphically using the Forest plot. When two or more studies reported the same dataset, the first publication was included in the

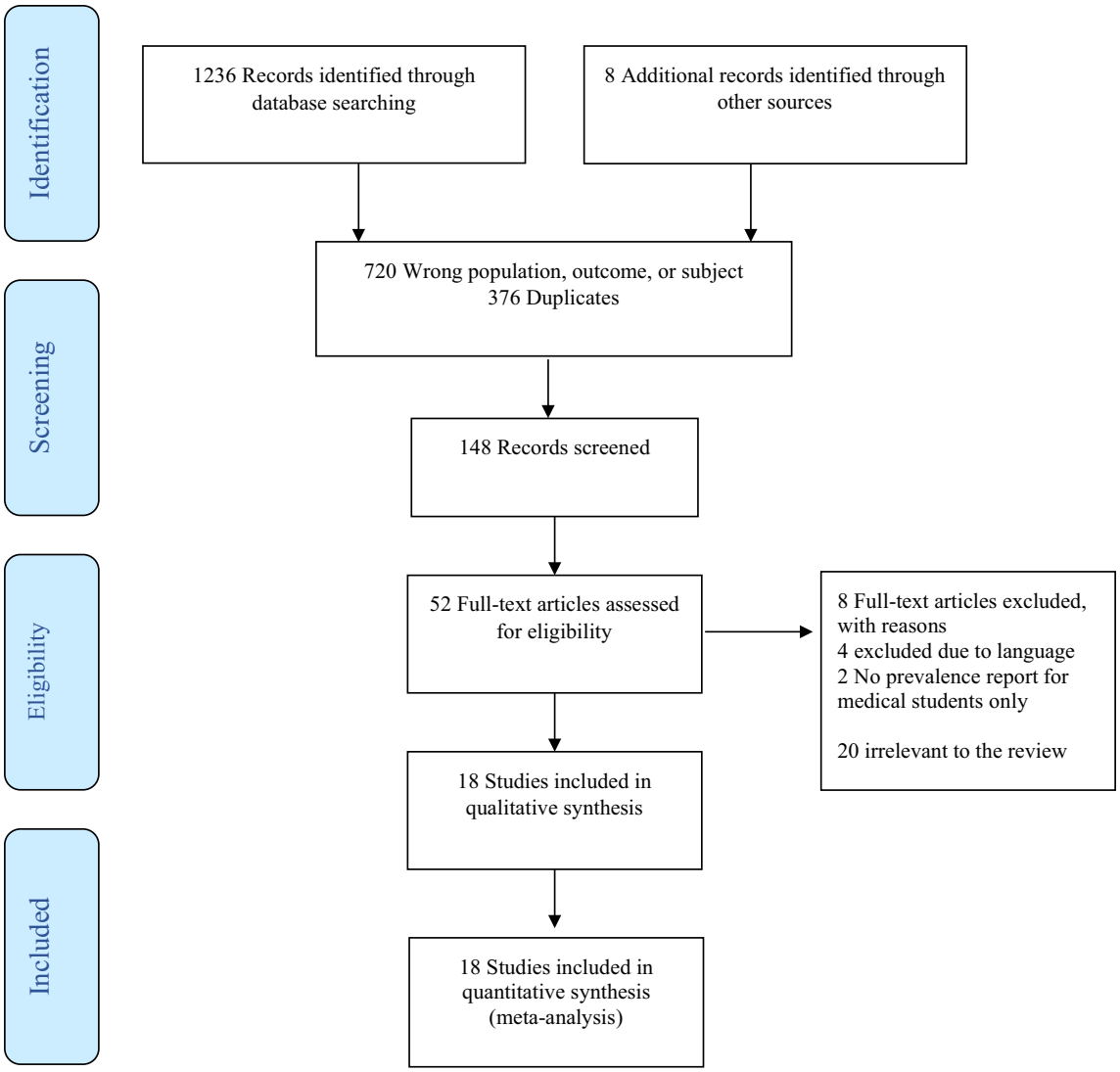

Fig. 1 Flow diagram of study inclusion

meta-analysis. Three studies reported the prevalence of ED risk using two different screening tools [19, 22, 23]; EAT-26 and SCOFF (Table 2). For these three studies, the results of the prevalence estimates of EAT-26 entered the initial meta-analysis, whereby each study contributed with only one prevalence rate. The decision to include EAT-26 scores in the initial analysis was based on the fact that it was the most common tool used among all studies. However, to avoid any reporting bias and to enable comparison between screening tools all reported prevalence rates per study were made available for secondary analysis.

An assessment of studies heterogeneity using the I^2 statistic was performed; the value of 75–100% was considered to represent high heterogeneity. Between-study heterogeneity was also assessed in this review by the Quoran (Q) statistic test and tau^2 (τ^2).

A leave-one-out sensitivity analysis was performed by iteratively removing one study at a time to confirm that our findings were not driven by any single study.

Meta-analyses were performed using OpenMetaAnalyst software [24, 25] provided by the Centre for Evidence Synthesis in Health/Center for Evidence-Based Medicine, the School of Public Health at Brown University. Other descriptive statistical analyses were performed using STATA 13.1.

Ethical considerations

As this review assessed data from publications that are indexed and available in the public domain, no ethical approval nor informed consent was applicable.

Results

Study characteristics

Eighteen studies, involving a total of 5722 respondents in nine countries were included in the analysis (Table 1). The median number of respondents per study was 223 (range 75–1107). All of the eighteen studies used a cross-sectional research design to report the prevalence of ED risk among medical students. Approximately 73% of the respondents were females. The median age of the respondents was 21 years (range 18.5–25 years), and the median BMI was 21 kg/m^2 (range 20–23 kg/m^2).

Prevalence of ED risk in medical students

Meta-analytic pooling of the point prevalence estimates of ED risk yielded a prevalence rate of 10.4% (497/5722 students, 95% CI 7.8–13.0%), with statistically significant evidence of between-study heterogeneity ($Q = 295$, $\tau^2 = 0.003$, $I^2 = 94.0\%$, $P < 0.001$) (Fig. 2). The details of the systematic review findings are presented in Table 2. The raw prevalence estimates reported by individual studies ranged from 2.2 to 29.1%. Sensitivity analysis demonstrated that individual study affected the overall pooled point prevalence estimate by $< 1\%$ (Fig. 3).

Prevalence of ED among female medical students

Out of the eighteen studies, seven studies only included female medical students. To control for the confounding effect of sex, the meta-analysis was repeated for studies that only included female students. The meta-analytic pooling of the point prevalence estimates of ED risk reported by female medical students yielded a prevalence rate of 13.7% (144/1849 students, 95% CI 6.6–20.7%), with statistically significant evidence of between-study heterogeneity ($Q = 104.5$, $\tau^2 = 0.008$, $I^2 = 94.3\%$, $P < 0.001$).

The raw prevalence estimates reported by individual studies focused on female medical students ranged from 2.2 to 29.1%. Sensitivity analysis demonstrated that individual study affected the overall pooled point prevalence estimate by $\leq 2\%$.

Prevalence of ED by country

When there were three or more studies from the same country, a pooled prevalence estimate of ED risk among medical students was calculated. The following countries had three or more publications: India ($n = 4$), Pakistan ($n = 3$) and China ($n = 3$).

Studies from India yielded a prevalence rate of 11% (81/775 students, 95% CI 4.2–17.8%), with statistically significant evidence of study heterogeneity ($Q = 38$, $\tau^2 = 0.004$,

Table 1 Selected characteristics of the studies examined ED risk amongst medical students included in the systematic review and meta-analysis

Study number	References	Year	Country	Sample size *n*	Age[a] (years)	BMI[a] (kg/m^2)	% Male
1	Fidan et al. [20]	2010	Turkey	878	21.3 ± 2.1	22.4 ± 2.99	53
2	Gupta et al. [26]	2017	India	250	20.15 ± 1.32	NR	55
3	Vijayalakshmi et al. [22]	2017	India	241	20 ± 2	23.06 ± 4.34	38
4	Memon et al. [23]	2012	Pakistan	435	20.5 ± 1.67	20.1 ± 3.3	21
5	Szweda and Thorne [27]	2002	UK	95	19.03 ± 2	21.2 ± 2.2	0
6	Chang et al. [28]	2015	China	1107	21 ± 1	19.91 ± 2.1	0
7	Liao et al. [18]	2010	China	484	18.47 ± 0.85	20.16 ± 2.47	37
8	Shashank et al. [19]	2016	India	134	21.4 ± 2.2	22.38 ± 3.3	0
9	Ngan et al. [29]	2017	Malaysia	263	22.8 ± 1.1	22 ± 3.8	35
10	Bosi et al. [17]	2016	Brazil	202	21.8 ± 2.8	22.2 ± 3.3	0
11	Babar et al. [30]	2002	Pakistan	94	21 ± 2.08	20.83 ± 2.88	0
12	Hamburg and Herzog [31]	1985	USA	121	25.1 ± 2	NR	0
13	Futch et al. [32]	1988	USA	96	24.4 ± 1.9	20.8 ± 2.2	0
14	Liao et al. [33]	2013	China	500	NR	20.2 ± 2.2	40
15	Manaf et al. [34]	2016	Malaysia	206	NR	NR	34
16	Alberton et al. [35]	2013	Brazil	391	20 ± NR	NR	49
17	Panchami and Samuel [36]	2016	India	150	20 ± NR	NR	9
18	Haroon et al. [37]	2016	Pakistan	75	NR	NR	32

NR not reported

[a]Mean ± SD

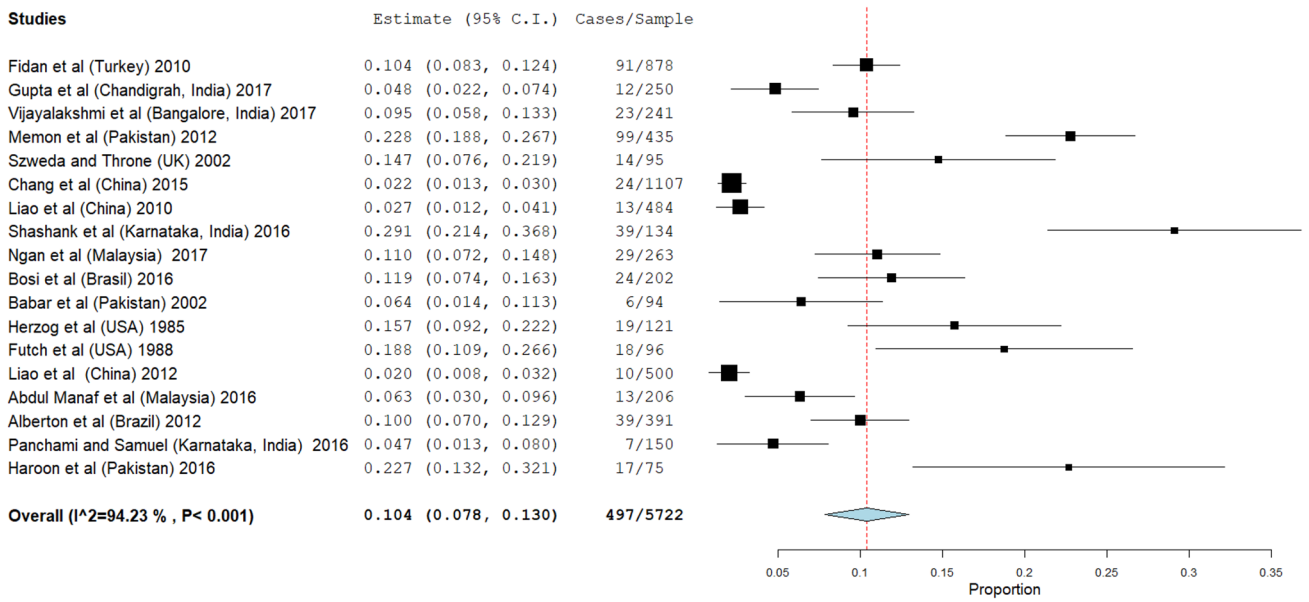

Fig. 2 Summarized prevalence rates of ED risk in medical students

$I^2 = 92.1\%$, $P < 0.001$). Studies from Pakistan yielded a prevalence rate of 17.1% (122/604 students, 95% CI 5.1–29.0%), with evidence of between study heterogeneity ($Q = 27.3$, $\tau^2 = 0.01$, $I^2 = 92.7\%$, $P < 0.001$). Finally, studies from China yielded a prevalence rate of 2.2% (47/2091 students, 95% CI 1.6–2.9%), with no evidence of between study heterogeneity ($Q = 0.54$, $\tau^2 = 0.001$, $I^2 = 0\%$, $P < 0.77$).

Heterogeneity within ED screening instruments

To identify potential sources of heterogeneity of the screening instruments used within the studies; results from surveys with the same instrument only were meta-analyzed.

Fourteen out of the eighteen studies (78%) used the EAT-26 [17–19, 22, 23, 26, 27, 29, 30, 33–37]. The meta-analytic pooling of the prevalence estimates of ED risk yielded a prevalence rate of 10.5% (345/3520 students, 95% CI 8.7–16.4%), with statistically significant evidence of between-study heterogeneity ($Q = 204.8$, $\tau^2 = 0.003$, $I^2 = 93.6\%$, $P < 0.001$).

Three out of the eighteen studies (17%) used the SCOFF [19, 22, 23]. The meta-analytic pooling of the prevalence estimates of ED yielded a prevalence rate of 21.9% (174/810 students, 95% CI 12.6–31.2%), with statistically significant evidence of between-study heterogeneity ($Q = 19.3$, $\tau^2 = 0.006$, $I^2 = 89.7\%$, $P < 0.001$). In addition to SCOFF, these three studies also used the EAT-26, thus a repeat meta-analytic pooling of the prevalence estimates of ED risk was conducted. Results showed a prevalence rate of 20.1% (161/810 students, 95% CI 9–31.3%), with statistically significant evidence of between-study heterogeneity ($Q = 33.3$, $\tau^2 = 0.009$, $I^2 = 94\%$, $P < 0.001$).

Two out of the eighteen studies (11%) used the EDI-1 only [28, 32]. The meta-analytic pooling of the prevalence estimates of ED risk yielded a prevalence rate of 10% (42/1203 students, 95% CI 0–2.6%), with statistically significant evidence of between-study heterogeneity ($Q = 17.2$, $\tau^2 = 0.01$, $I^2 = 94.2\%$, $P < 0.001$).

Discussion

This systematic review and meta-analysis of eighteen research studies involved 5722 medical students in nine countries and demonstrated that 10.4% of the students screened were positive/at risk for ED. The prevalence rate of ED risk among medical students obtained by this meta-analysis was higher than that reported in the general population which is estimated to be about 5% [38]. It must be acknowledged here that none of the studies included in this meta-analysis actually presented data about diagnosed ED. Rather, each of the eighteen studies presented descriptive statistics based on pre-established cut-off scores of screening instruments. As these continuous measures of eating pathology were not meant to be used as diagnostic tools, but rather as indicators of ED risk, results from this study cannot be interpreted as providing prevalence rates of ED.

Nevertheless, a comparison between the pooled prevalence rate of ED risk among medical students with the reported estimates of ED among university students reveals that both groups have comparable ED risk of approximately

Table 2 Systematic summary of the studies of eating disorders risk amongst medical students included in the review

S. no.	Study	Country	Sample size/response	Research design	Research tools	Major findings
1	Fidan et al. (2010) [20]	Turkey	895 medical students 878 responses (98.1%)	Cross-sectional study Convenient sampling	ORTO-11 Eating Attitudes Test 40 (EAT-40) Demographics anthropometrics/BMI	The prevalence of ED risk according to EAT-40 was 10.4% More tendency toward orthorexia nervosa in males Increased risk of ED is associated with younger age and higher BMI
2	Gupta et al. (2017) [26]	India	250 medical students 250 responses (100%)	Cross-sectional study Convenient sampling	Body Shape Questionnaire (BSQ) Eating Attitudes Test 26 (EAT-26) Demographics	The prevalence of ED risk according to EAT-26 was 4.8% Male students had a high BMI Female students had higher dieting scores EAT-26 scores correlate with BSQ score
3	Vijayalakshmi et al. (2017) [22]	India	494 students 454 Responses (92%) 241 medical students and 213 nursing students	Cross-sectional study Convenient sampling	EAT-26 The Sick, Control, One Stone, Fat, Food (SCOFF) Questionnaire Patient Health Questionnaire-9 items (PHQ-9) Demographics	The prevalence of ED risk according to EAT-26 was 9.5% The prevalence of ED risk according SCOFF was 32% Male students had a significantly higher BMI compared to female Female students had a higher tendency to perceive themselves as overweight and a higher tendency to not be satisfied about their weight Male students had a higher score on ED behaviors on both EAT-26 and SCOFF compared to female students Binge eating was more common in female students compared to male students Male students had a higher tendency to exercise for more than 60 min to control their weight compared to the female students

Table 2 (continued)

S. no.	Study	Country	Sample size/response	Research design	Research tools	Major findings
4	Memon et al. (2012) [23]	Pakistan	495 medical students 435 responses (87.8%)	Cross-sectional study Random sampling method Multi-centre: (1) Dow Medical college, (2) Sindh Medical college, (3) Aga Khan university	EAT-26 SCOFF Demographics anthropometrics/BMI	79% females and 21% males The prevalence of ED risk according to EAT-26 was 22.75% The prevalence of ED risk according to SCOFF was 17% The BMI results showed that 9% were severely underweight, 41.4% underweight, 41.1% normal, 7.6% overweight and 0.9% obese
5	Szweda and Thorne (2002) [27]	United Kingdom	532 first year students (112 medical 185 students of other specialties, 235 nursing students) The response rate was 90% for nursing students, 95% for medical students and 75% for students of other specialties	Cross-sectional study Convenient sampling Only females	EAT-26 Bulimic Investigatory Test, Edinburgh (BITE) Demographics anthropometrics/BMI	There was no significant difference between the three groups The prevalence rate of ED risk (13.7% for the nurse students, 14.7% for the medical students and 20.9% for the control group), according to EAT-26 There was a significant difference between the three groups in terms of ethnic origin and age and social class On the BITE symptom score, there was significant difference between the three groups, the medical students and the control group had higher scores compared to the nursing students

Table 2 (continued)

S. no.	Study	Country	Sample size/response	Research design	Research tools	Major findings
6	Chang et al. (2015) [28]	China	1135 medical female students from Wannan Medical College from freshmen, sophomore and third year students. 1107 responses (97.5%)	Cross-sectional study Convenient sampling Only females	Eating Disorder Inventory (EDI-1) Self-rating Depression Scale (SDS) Self-rating Anxiety Scale (SAS) Demographics anthropometrics/BMI	The prevalence rate of ED risk was 2.17% according to EDI-1 BMI results were as follows: 73.1% were normal, 23.9% were underweight and 3% were overweight Factors that were found to be related with ED risk were the mainly poor social relationships Higher levels of depressive symptoms, anxiety symptoms and higher BMI were all found to have more ED risk
7	Liao et al. (2010) [18]	China	500 medical students 487 responses (97.4%)	Cross-sectional study Convenient sampling	EAT-26 BSQ for females only Eating Disorders Assessment Questionnaire (CETCA) Swansea Muscularity Attitudes Questionnaire (SMAQ) for males only Social Interaction Anxiety Scale (SIAS) Self-Rating Depression Scale (SDS) Demographics anthropometrics/BMI	63% female and 37% male students The prevalence of ED risk 2.5% according to EAT-26 ED risk more prevalent in females No student fulfilled the criteria for anorexia nervosa, only four female students fulfilled the criteria for bulimia nervosa according to CETCA Only 3 females exhibited greater than average weight and shape concerns according to BSQ Only give males displayed extreme concern regarding muscle size and shape according to SMAQ On SDS, 26 students got scores indicative of minimal to mild depression, there was no significant gender difference On the SIAS, there was no significant gender difference and only four participants had significant anxiety scores

Table 2 (continued)

S. no.	Study	Country	Sample size/response	Research design	Research tools	Major findings
8	Shashank et al. (2016) [19]	India	134 medical students 134 responses (100%)	Cross-sectional study Convenient sampling Only females	EAT-26 SCOFF Demographics anthropometrics/BMI	The prevalence of ED risk was 29.2% according to EAT-26 The prevalence of ED risk was 17.2% according to SCOFF 58.9% had a normal BMI, 21.6% were underweight and 17.9% were overweight, 1.5% were obese
9	Ngan et al. (2017) [29]	Malaysia	320 medical students 263 responses (82%)	Cross-sectional study Convenient sampling	EAT-26 Cohen Perceived Stress Scale (CPSC) Demographics anthropometrics/BMI	Females were 65% and males were 35% The prevalence of ED risk was 29.2% according to EAT-26 No significant difference between both genders 41.4% of the students exhibited high stress according to CPSC BMI results were as follows: 57.4% normal, 8.3% underweight, 23.5% overweight 10.6% obese Higher BMI is significantly more associated with ED risk
10	Bosi et al. (2016) [17]	Brazil	202 medical students 202 responses (100%)	Cross-sectional study Random sampling Only females	EAT-26 BSQ BITE Demographics anthropometrics/BMI	The prevalence of ED risk was 9.9% according to EAT-26 20.2% showed body dissatisfaction according to BSQ Higher BMI is significantly more associated with ED risk
11	Babar et al. (2002) [30]	Pakistan	185 students were the 180 responses (97.5%) 94 were medical students, 86 were nursing students	Cross-sectional study Multi-staged sampling Only females	EAT-26 Demographics anthropometrics/BMI	The prevalence of ED risk was 21.7% according to EAT-26 Prevalence of ED risk among medical students was 8, 7.1 and 20% in first, second and third years respectively Cumulative proportion of ED risk in medical students is 6.4% Higher BMI is significantly more associated with ED risk Past psychiatric history is predictive for ED risk

Table 2 (continued)

S. no.	Study	Country	Sample size/response	Research design	Research tools	Major findings
12	Hamburg and Herzog (1985) [31]	United States of America	212 medical students 121 responses (57.1%)	Cross-sectional study Convenient sampling Only females	Researchers developed questionnaire to screen for ED Social Adjustment Scale Self-Report (SAS-SR) Demographics	The prevalence of ED risk was 15% ED risk is associated with significant social maladjustment
13	Futch et al. (1988) [32]	United States of America	132 medical students and 219 graduate students 96 responses (73%) from medical students and 118 responses (54%) from graduate students	Cross-sectional study Convenient sampling Only females	EDI-1 Demographics	ED risk is significantly more common in medical students compared to graduate students (18.7 versus 12.9%; $P < 0.05$)
14	Liao et al. (2013) [33]	China	500 medical students, 486 responses (97.2%) *NB This study was designed to measure the change of ED among medical students, see previous paper by Liao	Cross-sectional study Convenient sampling	EAT-26 CETCA Demographics	The prevalence of ED risk was 2.47% according to EAT-26 Male students kept lower ED risk attitudes and behaviors than female students Female students kept a lower BMI than male students No statistically significant changes in ED risk over follow up time
15	Manaf et al. (2016) [34]	Malaysia	206 medical students 206 responses (100%)	Cross-sectional study Convenient sampling Only females Private University	EAT-26 Body Image Acceptance and Action (BI-AAQ) PHQ-9 Demographics	The prevalence of ED risk was 6.3% according to EAT-26 The prevalence of depression was 65.5% according to PHQ-9 There was a significant positive relationship between depression and ED risk There was and a negative relationship between body image and depression as well as between body image and ED risk
16	Alberton et al. (2016) [35]	Brazil	419 students enrolled 391 responses (93.3%)	Cross-sectional study Convenient sampling	EAT-26 Demographics anthropometrics/BMI	The prevalence of ED risk was 10% according to EAT-26 ED risk was positively associated with females, high BMI, young age ≤ 20, and being freshman student

Table 2 (continued)

S. no.	Study	Country	Sample size/response	Research design	Research tools	Major findings
17	Panchami and Samuel (2016) [36]	India	150 medical students 150 responses (100%)	Cross-sectional study Random sample of medical students	EAT-26 Beck Anxiety Inventory (BAI) Rosenberg Self-Esteem Scale (RSES) Demographics anthropometrics/BMI	The prevalence of ED risk was 4.7% according to EAT-26 All cases with ED risk were females Positive correlation between EAT-26 and BAI ($P=0.001$). Positive correlation between EAT-26 score and RSES ($P=0.001$) No significant relationship between EAT-26 score and BMI ($P=0.294$)
18	Haroon et al. (2016) [37]	Pakistan	75 medical students 75 responses (100%)	Cross-sectional study Convenient sampling	EAT-26 demographics	The prevalence of ED was 22.6% according to EAT-26 ED was more prevalent females 15% than males 8%

10% [16, 39, 40]. This finding highlights that ED risk are pervasive among university age students with some variation across student characteristics.

The prevalence rate finding of 10.4% is alarming given the fact that ED have the potential to lead to other serious physical or mental health problems. Previous research shows that more than 80% of individuals with ED risk have at least one comorbid psychiatric disorder including anxiety disorders (> 50%), affective disorders (> 40%), deliberate self-harm (> 20%), and substance use (> 10%) [41–43]. Individuals with diagnosed ED may develop physical health issues including skeletal complications [44], edema [1], cardiac failure [45], pancreatitis [46], and infertility [47]. Thus, it is clearly evident that ED have severe and persistent health consequences; and therefore, early identification and treatment is important.

The median age of the respondents was 21 years (range 18.5–25 years). This finding related to the peak age at onset; late adolescence and young adulthood have been identified as important developmental periods for the development of ED risk and related conditions [16]. During the transitions to adulthood, young individuals face many stressors to become independent, and begin to look at the future in terms of relationships, schooling, career, etc. The first year as an undergraduate university student can be significantly stressful [39, 48]. The major stressors among university students are changes in environment, academic workload, new relationships and time management issues [49].

Female medical students appeared to be at more risk for ED with a prevalence rate of 13.7% (95% CI 6.6–20.7%) compared to the prevalence rate of eating disorders among medical students. No data were available to analyze prevalence among male medical students only and this perhaps an area for future research to address. Nonetheless, given the prevalence rate for ED risk and the females only prevalence rate of ED risk, it appears that there is a difference between men and women when it comes to ED. Eating disorders have been predominantly presenting in young females [50]. Young women have specific attitudes toward food and body weight, aiming to achieve and maintain a slim body shape; great importance is given to thinness as requisite for self-esteem [16, 42]. Recent research suggests that the prevalence and manifestations of ED among young men is increasing in community samples [51]. The male body image; the great importance given to low body fat and pronounced muscles to achieve muscular physique, has emerged as an important factor for increasing the prevalence of ED among men [18].

Three countries had a significant number of publications. Pooling the results of the same country showed mixed results. Studies from India and Pakistan showed evidence of between-study heterogeneity with prevalence of 11.0% ($I^2=92.1\%$, $P<0.001$) and 17.1% ($I^2=92.3\%$, $P<0.001$) for India and Pakistan, respectively.

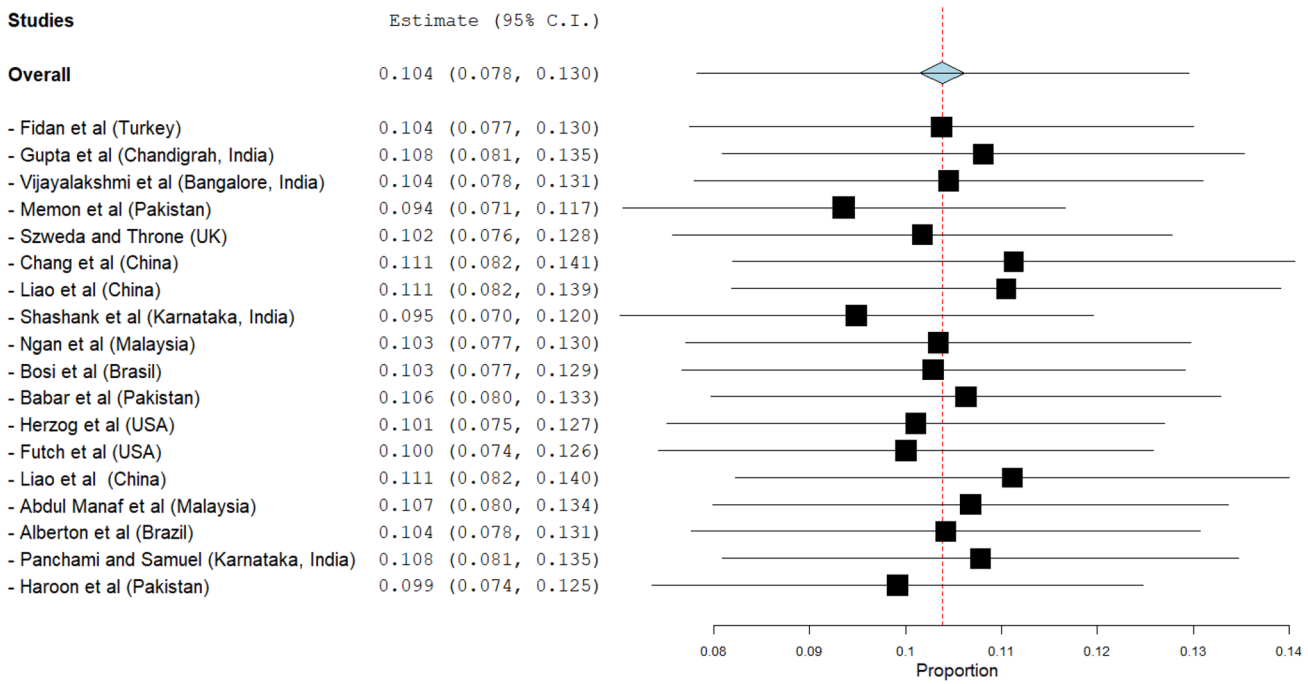

Fig. 3 Summarized prevalence rates of ED risk in medical students if one study is deleted

However, studies from China showed no significant evidence of between-study heterogeneity ($I^2 = 0\%$, $P < 0.77$). This may be due to the different ethnic and cultural contexts in defining and measuring ED. Culture has been documented as significant to the cause and presentation of ED [52]. The large variety within the same country might be also explained by socio-economic factors and difference in sample characteristics.

When interpreting the findings from this systematic review and meta-analysis, it is very important to acknowledge that these were primarily self-reported. Self-report questionnaires measure symptoms and risk behaviors for ED and do not provide a specific clinical diagnosis. Although these self-report tools of ED have limitations, they are very important to screen subclinical or threshold symptoms for ED risk. They will identify subjects with eating behaviors that are not considered normal, but they may not yet have disordered enough to qualify for a formal diagnosis. Furthermore, it must also be acknowledged that from a research perspective the use of self-report tools is the only way to protect the anonymity of the medical students during data collection.

To control for the possible differences between the different screening tools, a decision was taken to meta-analyses studies using the EAT-26. Results of this analysis showed a point prevalence rate of ED risk 10.5% (95% CI 7.3–13.7%), with statistically significant evidence of between-study heterogeneity ($I^2 = 93.6\%$, $P < 0.001$). A similar point prevalence rate of ED risk 10% (95% CI 0–2.6%), with statistically significant evidence of between-study heterogeneity ($I^2 = 94.2\%$, $P < 0.001$) was obtained using EDI-1.

Three studies used both EAT-26 and SCOFF and yielded a prevalence rate of eating disorders 20.1% (95% CI 9–31.3%) and of 21.9% (95% CI 12.6–31.2%) for EAT-26 and SCOFF, respectively.

These findings are perhaps suggestive that EAT-26 can adequately screen ED at risk cases.

Limitations

This review has two main limitations. First, the data were collated from studies that had different screening instruments and with some variations in the quality of design, specifically sample size and the reliance on one study site. This perhaps can explain the heterogeneity between studies and therefore pooled estimates must be interpreted with caution. Second, the prevalence rates are based on self-report instruments using cross-sectional designs without interviews to determine congruence with ED diagnostic criteria. Nonetheless, these questionnaires are cost-effective, specific and demonstrate good psychometric properties. Results from this study cannot be interpreted as providing prevalence rates of ED, however, these results are very useful as an indicator of ED risk.

Implications and future research directions

The high prevalence of ED risk among medical students requires ongoing monitoring, accurate diagnosis and management interventions to reduce these disorders. There is a legitimate need for further research in the field particularly in parts of the world where the prevalence of ED is under investigated among medical students, e.g., the Middle East and North Africa. Future epidemiological studies are encouraged to follow a prospective study design so that the same students can be assessed over time. Multiple tools to measure ED risk will provide information on superiority in detecting cases and will allow specificity and sensitivity comparisons. The use of additional tools to screen for comorbidities such as anxiety or depressive symptoms will provide an opportunity to understand the association between ED risk and other pathologies. The association between stress and ED risk needs to receive more attention. Epidemiological research is also urged to follow the Strengthening the Reporting of Observational Studies in Epidemiology guidelines to completely and accurately report data. Related comparison groups, e.g. medical interns or residents, can be also used to determine if medical students will carry the ED risk after transition to residency. Finally, future reviews are encouraged to utilize meta-regression techniques to analyze the moderating effect of some covariates on ED risk among medical students.

Conclusion

In this systematic review and meta-analysis, the summary estimate of the prevalence of ED risk among medical students was 10.4%. Future studies are needed to identify and prevent ED in this population.

Author contributions HJ and AA designed the study. MS, MF, HJ, AB coordinated data search, data entry and data cleaning. HJ performed statistical analyses and wrote the first draft. AA and MF provided intellectual contributions to strengthening the manuscript and suggested additional data analyses. All authors provided critical revisions of manuscript and approved the final version.

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Compliance with ethical standards

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

Ethical approval This article does not contain any studies with human participants performed by any of the authors.

Informed consent For this type of study formal consent is not required.

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