



The prevalence of feeding and eating disorders symptomology in medical students: an updated systematic review, meta-analysis, and meta-regression

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Received: 18 September 2021 / Accepted: 20 December 2021 / Published online: 24 January 2022
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Abstract

Purpose Medical students have a higher risk of developing psychological issues, such as feeding and eating disorders (FEDs). In the past few years, a major increase was observed in the number of studies on the topic. The goal of this review was to estimate the prevalence risk of FEDs and its associated risk factors in medical students.

Methods Nine electronic databases were used to conduct an electronic search from the inception of the databases until 15th September 2021. The DerSimonian–Laird technique was used to pool the estimates using random-effects meta-analysis. The prevalence of FEDs risk in medical students was the major outcome of interest. Data were analyzed globally, by country, by research measure and by culture. Sex, age, and body mass index were examined as potential confounders using meta-regression analysis.

Results A random-effects meta-analysis evaluating the prevalence of FEDs in medical students ($K=35$, $N=21,383$) generated a pooled prevalence rate of 17.35% (95% CI 14.15–21.10%), heterogeneity [$Q=1528$ (34), $P=0.001$], $\tau^2=0.51$ (95% CI 0.36–1.05), $\tau=0.71$ (95% CI 0.59–1.02), $I^2=97.8\%$; $H=6.70$ (95% CI 6.19–7.26). Age and sex were not significant predictors. Body mass index, culture and used research tool were significant confounders.

Conclusion The prevalence of FEDs symptoms in medical students was estimated to be 17.35%. Future prospective studies are urgently needed to construct prevention and treatment programs to provide better outcomes for students at risk of or suffering from FEDs.

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

Keywords Body image · Body mass index · Eating disorders · Feeding and eating disorders · Medical students

Introduction

The Diagnostic and Statistical Manual of Mental Disorders, 5th Edition defined Feeding and Eating Disorders (FEDs) as enduring disruption of eating or eating-related behavior that results in altered food consumption or absorption and substantially affects physical or psychosocial functioning [1]. Diagnostic criteria are provided for pica, rumination disorder, avoidant/restrictive food intake disorder, anorexia nervosa, bulimia nervosa, and binge-eating disorder [1].

Psychopathologically, FEDs represent heterogeneous variety of problems that are underpinned by body appearance and weight concerns [2].

Environmental risk factors were found to focus on most of the previous research on FEDs [3]; and were consequently held responsible for the development of FEDs. This is evident by events and influences in a person's life, including diet culture, the media, trauma, and weight teasing, as examples of environmental variables [3]. Previous studies showed multiple biopsychosocial influences implicated in FEDs and/or disordered feeding and eating symptoms [4]. Among other risk factors are a sociocultural idealization of thinness variables, personality traits, and chronic stress [5].

Symptoms of FEDs are significantly comorbid with many other mental health problems, such as depression,

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post-traumatic stress disorder, and anxiety [6–9]. Studies previously found an increasing prevalence of FEDs crossing age, gender, and culture [10–12]. Sociodemographic factors were found to be associated with FEDs [4, 13]. The most consistent factors linked to higher FEDs prevalence and incidence were as follows: female sex, younger age, sexual and physical abuse, participation in esthetic or weight-oriented sports, and heritability [13]. Mortality ratios are the highest in persons with FEDs compared to other mental disorders, with higher ratios among anorexia nervosa patients [5, 14–16]. Suicidal attempts and suicide ideation are also high in patients with FEDs [16, 17].

Many studies reported a high prevalence of mental health problems in medical students [18–20]. In their systematic review and meta-analysis published in 2018, Jahrami and colleagues found that the summary prevalence of eating disorders risk in medical students was 10.4% [21]. This review has shown that eating disorders symptoms were more prevalent in female medical students [21]. Other past studies reported high FEDs risks and prevalence in medical students because of the academic requirements and high workload, their young age, elevated BMI, body image, self-image, and exposure to sicknesses and death during their medical studies [21–24]. Moreover, earlier literature reports found increased prevalence of FEDs in Western countries, suggesting that despite globalization, Western culture could be a potential factor impacting the development of feeding and eating problems [25].

Mental health stigma is one of the major barriers to seeking help and in medical students in particular, because of social attitudes towards people with mental disorders and self-image and social expectations from them as future physicians [26–29]. The high prevalence of mental health problems and mental health stigma in medical students call for further studies to understand the prevalence and seeking help moods for each mental health disorder. This systematic review and meta-analysis aimed (1) to pool results of the global prevalence of FEDs symptoms in medical students, and (2) to assess whether this prevalence varies as a function of sex, age, BMI, or culture. Given that reported stress levels and mental health symptoms have been increasing slightly over the past years among students [30–32], we hypothesized to find an increased prevalence of FEDs symptoms in our target population. Additionally, we hypothesized that prevalence of FEDs symptoms would be higher among females, students with higher BMI and those from Western countries. Our review efforts have focused on examining the cumulative prevalence rate of FEDs symptoms in medical students of a variety of age groups, genders, and cultural and ethnic backgrounds. We acknowledge that FEDs encompass a large variety of heterogeneous symptoms and we are interested in assessing whether they meet threshold levels and also those who are

at risk of developing them. This is analogous to the new eating disorder category was introduced in the DSM-5, Unspecified Feeding and Eating Disorders (UFED), within which symptoms are neither diagnosis-specific nor clinically significant.

Methods

Prior the start of the project the protocol was registered on PROSPERO CRD42021275637. The population or problem/intervention or exposure/comparison and outcome (PICO) approach was used to define the review problem. The problem was eating disorders symptoms. The Intervention/exposure was being a medical student. The comparison was within group analysis by age, gender, research tool, country and culture. The outcome was prevalence rate [33]. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 (PRISMA 2020) statement was used as a guide for conducting and reporting this review [34]. The Data extraction for complex meta-analysis (DECIMAL) guide was used to extract all data [35]. The systematic review was screened and coded using RAYYAN, a free online tool of digital technologies such as natural language processing, artificial intelligence, and machine learning [36]. WebPlotDigitizer v4.5, an open-source web-based tool, was used to extract numerical data from plot images [37]. References were managed using EndNote 9.3.3.

Database searches

Reviewers FFR and HJ conducted an electronic search using nine electronic academic databases (1-American Psychological Association PsycINFO; Cumulative Index to Nursing and Allied Health Literature (CINAHL); EBSCOhost Research Platform; Embase; MEDLINE; ProQuest; ScienceDirect; Scopus; and Web of Science). These databases were searched from the inception of each source to 15th September 2021.

Crossmatching keywords chosen based on key phrases and the Medical Subjects Headings was part of the search strategy. In a (All Fields) search, the Boolean logic operators [(OR) within lists], [(AND) between lists] were utilized to create the search. The lists were as follows: List A: medical student (OR) medical intern (OR) student doctor (OR) medical trainee (OR) medical pupil. (AND) List B: eating disorder (OR) feeding disorder (OR) eating problem (OR) eating attitude (OR) eating symptoms (OR) eating behavior.

We did not apply any limitations during our initial search. Manual screening of the references of the identified papers was also conducted by the review team.

Inclusion and exclusion criteria

Observational studies examining the prevalence rate of FEDs symptoms in undergraduate medical students were included. Specific inclusion criteria included: (1) studies must have been published in the English language; (2) published before 15th September 2021; (3) focused on undergraduate medical students, and (4) revealed the prevalence of FEDs symptoms/risk in the target population. In this review, FEDs risk was defined as significant changes in feeding or eating patterns along with psychological changes. Included studies should have used any validated, standardized tools to screen for FEDs risk, including Eating Attitudes Test-26 (EAT-26) [38], SCOFF Questionnaire [39], Eating Disorder Examination Questionnaire (EDE-Q) [40], and Eating Disorder Inventory (EDI) [41]. Thus, we reported estimates for FEDs symptoms/risk based on self-report questionnaires that cannot qualify for a specific clinical diagnosis. After symptoms screening, a structured interview by a clinician is needed to confirm the diagnosis. Detailed description of the clinical scales involved in the systematic review and meta-analysis of FEDs among medical students, psychometric properties, cut-off points and full citation presented in Table 1.

Specific exclusion criteria were: (1) studies that combined medical and non-medical students in the same group without analyzing subgroup data; (2) studies that assessed mental health problems rather than the prevalence of FEDs; (3) inability to get the full text even after contacting the authors. In case of duplication of dataset in the literature, the first publication was included in the meta-analysis.

Outcomes and measures

For each study, we reported the total sample size and the event rate. The event rate was categorized using pre-defined cut-off scores from continuous measures of eating pathology risk, to determine FEDs risk in medical students as a primary outcome. Cut-off scores were established by the developers of these tools to indicate a risk of FEDs (e.g., a score of ≥ 20 points on EAT-26 or a score of ≥ 2 points on SCOFF). As secondary outcomes, the studies were compared concerning variability in the prevalence of FEDs risk based on age and sex of participants, country of study, Western vs non-Western culture, and tool used in the study.

Two members of the review team independently evaluated studies for eligibility and screened titles, abstracts, and full-texts. Two independent members of the team performed initial data extraction and assessed quality. In case of disagreement, discussion with the senior reviewer/expert clinician, HJ and a consensus by the panel resolved any conflicts regarding the appropriateness of the study to include in the review.

Data extraction was standardized by collecting the following variables: study characteristics, including author name, year, sample size, country (Western/non-Western), and measure used. Participant characteristics including mean age (years), sex (proportion of female participants), mean body mass index (BMI) (kg/m^2), and the main findings of the event rate of FEDs symptoms in medical students in each study. Western countries were those defined by the United Nations as members of the Western European and Other States group (Andorra, Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland Ireland, Israel, Italy, Liechtenstein, Luxembourg, Malta, Monaco, Netherlands, New Zealand, Norway, Portugal, San Marino, Spain, Sweden, Switzerland, Turkey, United Kingdom of Great Britain and Northern Ireland, and United States of America) [42]. Email communication was used to request missing data from the corresponding author of the included studies.

Quality assessment using the Newcastle–Ottawa Scale (NOS)

Quality assessment was performed using the NOS [43]. Three elements were examined using the NOS checklist (participant's selection, comparability, and outcome and statistics). NOS is based on a star rating system, with each study receiving a maximum of nine stars (cross-sectional and cohort studies) or ten stars (case-control studies) [43]. In this review, a study with a score ≥ 8 has good quality and low risk of bias, a score of 5–7 has a moderate quality and moderate risk of bias, and a score of 0–4 has low quality and high risk of bias.

Data synthesis and statistical analyses

In this meta-analysis, data were pooled in accordance to the DerSimonian-Laird method [44], with the pooled prevalence and the 95% confidence interval having been reported. Random-effects Meta-analysis is a technique for synthesizing data based on the assumption that actual effects vary across studies [45]. The random-effects model assumes that each study estimates a different true effect, and that this true effect has a distribution (usually a normal distribution) [45]. The choice of a model must be based exclusively on whatever model best fits the distribution of effect sizes and takes into consideration the relevant source(s) of error. When a research is taken from the published literature, the random effects model is usually a better fit [46]. Data were displayed graphically using Forest plots [47]. Researchers used these confidence intervals to determine whether an impact is substantial; accordingly Drapery plots [48] and P-curve analysis were also reported [49].

Table 1 Detailed description of the clinical scales involved in the systematic review and meta-analysis of FEDs risk among medical students, psychometric properties, cut-off points and full citation

Abbreviation	Cut-off point	mean % of the general adult/college population meeting the cut-off	Reliability	Validity
EAT-26	≥ 20	13.7% Nurse applicants ($N=212$); 14.7% medical students ($N=95$); 20.9% control group ($N=139$) [122]	Cronbach's $\alpha=0.90$	EAT-26 correlates highly with the original EAT-40 scale ($r=0.98$)
EDE-Q	≥ 4	6.3% of a community sample of women aged 18–45 ($N=208$) met the study criteria for a clinically significant eating disorder [40, 123]	Cronbach's α for the global score=0.90 (ranged from 0.70 for weight concern to 0.80 for shape concern)	Women diagnosed with eating disorders scored significantly higher on the EDE-Q than the control women (sensitivity=0.83, specificity=0.96, positive predictive value=0.56) [40, 123]
SCOFF	≥ 2	12.5% of healthy women aged 18–39	kappa statistic=0.82	Sensitivity = 100%; specificity = 87.5%; and positive predictive value = 90.6%
EDI	≥ 50	18.3% of Italian female students aged 17.68±0.9 ($N=186$) [124]	Cronbach's α ranged from 0.82 to 0.90	Sensitivity = 52.9%, specificity = 85.2%, positive predictive value = 26.4%
ANIS	≥ 65	17.4% female medical students ($N=708$), 4.3% male medical students ($N=261$) [90]	Cronbach's α ranged from 0.80 to 0.90	In the three samples the ANIS total score correlated 0.41 to 0.51 with the 28-item General Health Questionnaire, and 0.15 to 0.26 with the percentage of ideal body weight [125]
DEBQ	-	-	Cronbach's α ranged from 0.80 to 0.95	All Pearson's correlation coefficients assessing interrelationships between scales (for restrained, emotional, and external eating) were significant, indicating that the scales have a high internal consistency and factorial validity [126]
ORTO-15	< 40	53.7% of high-school students aged 15–21 years old ($N=209$) [127]	Cronbach's $\alpha=0.83$	The ORTO-15 showed significant associations with eating psychopathology (EAT-26 and SR-YBC-EDS; range $r=0.64-0.29$; $P<0.05$) [127]
EDS-5	-	-	Cronbach's α ranged from 0.83 to 0.86	Sensitivity = 0.90 and specificity = 0.88

EAT-26: Eating Attitude Test-26 [128]; EDE-Q: Eating Disorder Examination – Questionnaire [129]; SCOFF: Sick, Control, One Stone, Fat, Food [39]; EDI: Eating Disorder Inventory [38, 41, 128]; ANIS: Anorexia Nervosa Inventory for Self-Rating [125, 130]; DEBQ: The Dutch Eating Behavior Questionnaire [126]; ORTO-15: ORTO-15 [131]; EDS-5: Eating Disorder Scale [132]

We assessed study heterogeneity using the I^2 statistic; a value of 75–100% was represented as a high heterogeneity [50]. The H was also reported as a mathematical transformation that describes the proportion of total variation in study estimates due to heterogeneity is I^2 [50]. This review also assessed the between-study heterogeneity using Cochran's Q statistics [51], tau2 (τ^2), and tau (τ) [50].

We performed a leave-one-out sensitivity analysis (Jackknife analysis) by eliminating one study at a time to verify that our results were not influenced by a single study [52]. When the probability of publication is influenced by its findings, this is known as a publication bias [53].

The inclusion of outliers may jeopardize the meta-analysis' validity and robustness. Outliers were therefore discovered and eliminated. If the study's confidence interval does not match the pooled effect's confidence interval, it is classified as an outlier [54].

To investigate publication bias, funnel plots were employed as a visual tool [55]. To conduct a rigorous analysis of publication bias, Kendall's rank-order correlations [56] and Egger's regression [55] were utilized. The trim and fill approach developed by Duval and Tweedie [57] to generate adjusted point estimates to correct for funnel plot asymmetry owing to probable publication bias was pre-planned to handle any bias.

In a meta-analysis, confounders analysis is the use of a method to find and account for systematic differences in the size of the effect or outcome that is being meta-analyzed [50, 58]. Meta-regression is one type of confounders analysis in which the observed effect sizes are regressed on one or more study characteristics [59]. There are other ways to conduct a confounders analysis; for example, one could simply subgroup studies according to categorical potential confounders [50].

All data analyses were performed using R software for Statistical Computing [60]. Package 'PRISMA2020' was used for making a selection flow diagram [61]. The packages 'meta' [62] and 'metafor' [63] were used to perform all meta-analytics. Quality assessment plots were produced using risk-of-bias visualization 'robvis' [64]. The traffic light plot, which tabulates the judgment for each study in each area of the NOS, was used to graphically show the findings of the quality evaluation [64]. For all investigations, a summary plot (weighted) was generated to show the proportion of information inside each judgment for each domain [64].

Results

Descriptive description of the studies included

From the inception of the databases through September 15, 2021, the search was conducted. A total of 1528 records were identified through electronic database searches and other sources. After removing duplicate records, there were 944 records left. Records marked as ineligible by automation tools and records removed for other reasons were 659. We screened 285 and excluded 164 based on criteria. We evaluated 121 prospective articles in their entirety. Ninety-seven papers were excluded, including narrative, systematic and comment essays, letters to the editor, position statements, irrelevant literature, duplicate papers, and incorrectly classified publications. A total of 28 studies were included in the systematic review and meta-analysis. The search procedure was depicted in Fig. 1 using the PRISMA2020 flowchart.

A total of 28 independent studies [24, 65–91] (28 cross-sectional studies, 35 subgroups, i.e., multiple tools, or multiple data points) comprising 21,383 participants from 20

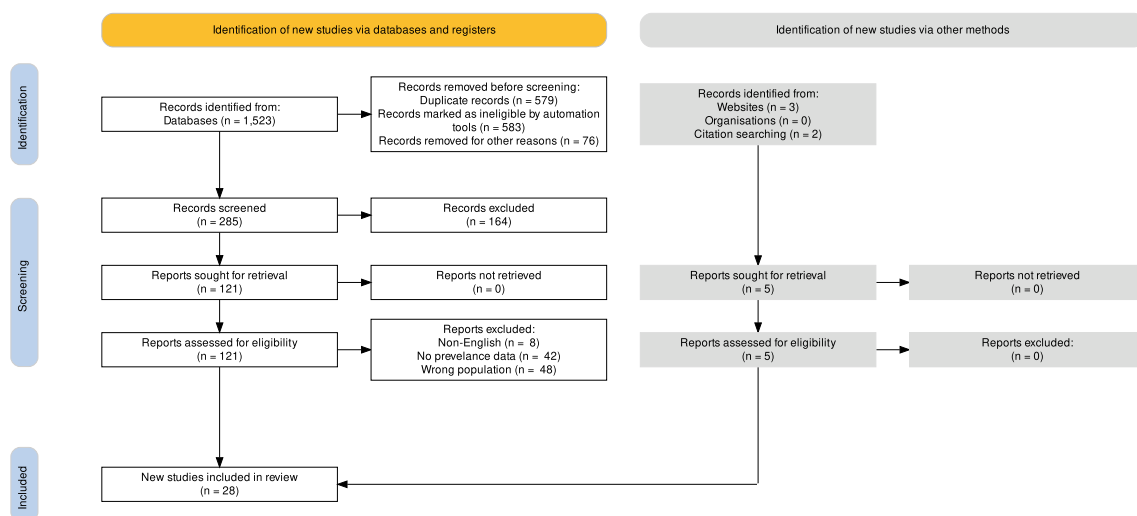


Fig. 1 PRISMA 2020 flow diagram for study selection

countries were included in the analyses. The countries were: Austria $N=2$; Egypt $N=1$; France $N=2$; Germany $N=2$; Hungary $N=4$; India $N=5$; Korea $N=1$; Lebanon $N=4$; Malaysia $N=1$; Mexico $N=1$; Morocco $N=1$; Norway $N=1$; Palestine $N=2$; Poland $N=1$; Romania $N=1$; Saudi Arabia $N=2$; Spain $N=1$; Thailand $N=1$; and United States $N=1$.

Five studies [68, 71, 72, 82, 90] utilized two screening tools to assess FEDs symptomatology. Furthermore, one study was cross-sectional at two time points [90]. The tools used were: Eating Attitudes Test-26 (EAT-26) $N=11$; Sick, Control, One Stone, Fat, Food (SCOFF) $N=7$; Eating Disorder Inventory-I/II (EDI) $N=6$; Anorexia Nervosa Inventory for Self-Rating (ANIS) $N=3$; Eating Disorder Examination- Questionnaire (EDEQ) $N=3$; Eating Disturbance Scale (EDS) $N=2$; ORTO-15 $N=2$; and Dutch Eating Behavior Questionnaire $N=1$.

The mean sample size was 611 (95% C.I. 445–776) participants. The median was 538 and the minimum and maximum were 90 and 2551, respectively. Participants were mainly females 65% (95% C.I. 59–70%), four studies focused only on female participants. The mean age was 21.8 years (95% C.I. 21.1–22.3 years), and the median was 22 years. The mean BMI was 22.1 kg/m² (95% C.I. 21.8–22.4 kg/m²), and the median was 22 kg/m². About 60% of the studies were published after 2018, with 40% being in the past two years. Only one study collected data from medical students during the COVID-19 pandemic.

The mean NOS quality score was 7.2 ± 0.75 and ranged from 5.0 to 8.0. Detailed examination of quality assessment for each study included in the meta-analysis is presented in Fig. 2. According to the summary results, 91% of the studies were of excellent quality, while the rest were of moderate quality. The majority of the risk bias was found in the selection dimension, especially in the sample size and representativeness, as shown in Fig. 3. Table 2 lists the summary characteristics of all considered studies.

FEDs risk in medical students: a meta-analysis

Global assessment of FEDs risk in medical students

Using all available studies, a random-effects meta-analysis evaluated the prevalence of FEDs symptoms in medical students ($K=35$, $N=21,383$), and generated a pooled prevalence rate of 17.35% (95% CI 14.15–21.10%), heterogeneity [$Q=1528$ (34), $P=0.001$], $\tau^2=0.51$ (95% CI 0.36–1.05), $\tau=0.71$ (95% CI 0.59–1.02), $I^2=97.8\%$; $H=6.70$ (95% CI 6.19–7.26). Using any FEDs measure in medical students, the raw prevalence estimates for FEDs problems varied from 5 to 74%. Figure 4 depicts the forest plot of the meta-analysis of FEDs risk in medical students using all assessment



Fig. 2 Traffic light plot of included studies

measures. Figure 5 presents the drapery plots of FEDs symptoms in medical students.

A (leave-one-out) sensitivity analysis found that no study had a greater than 1% impact on the global prevalence estimate of FEDs risk in medical students. Influence analysis was used to identify and eliminate outliers in our meta-analysis. Results of outliers' analysis revealed that nine studies contributed with thirteen data points were mathematical outliers [65, 66, 71, 72, 78, 81, 82, 87, 90]. After removing all outlier studies, meta-analytic results revealed random-effects model of the prevalence of FEDs in medical students of 16.58% (95% CI 15.25–17.99%), heterogeneity $Q=72.71$

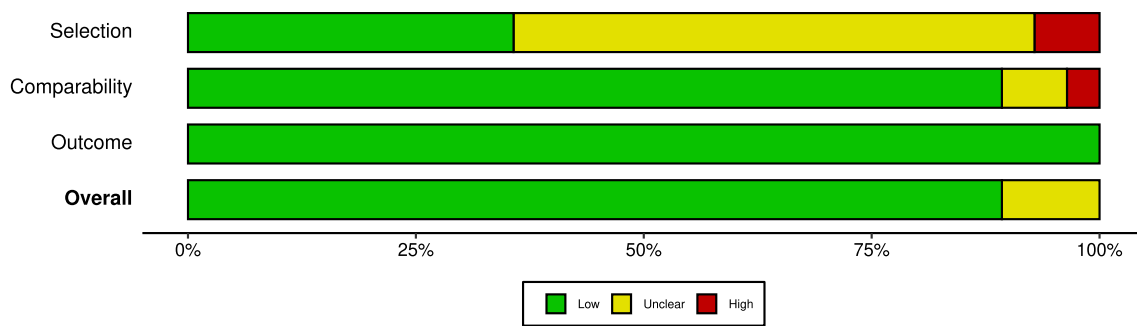


Fig. 3 Summary plot of the assessment of risk of bias

(21) $P < 0.0001$, $\tau^2 = 0.03$ (95% CI 0.01–0.11); $\tau = 0.18$ (95% CI 0.12–0.33), $I^2 = 71.1\%$ (95% CI 55.6–81.2%); $H = 1.86$ (95% CI 1.50–2.31).

Visual inspection to funnel plot in Fig. 6 showed no significant publication bias, Egger's regression ($P = 0.05$) and Begg's rank correlation test ($P = 0.21$) confirmed the absence of publication bias. Thus, the trim-and-fill technique was unnecessary to estimate and compensate for the quantity and findings of missing studies. Detailed influence analysis on the effect size and the heterogeneity markers is depicted in Fig. 7.

Meta-regression analysis revealed that neither age nor sex moderated the global prevalence rate of FEDs risk in medical students ($P = 0.65$ and $P = 0.085$, respectively). After controlling for age and sex, BMI was a strong statistical confounder in both univariate meta-regression analysis ($P = 0.001$); and multivariate meta-regression analysis ($P = 0.001$, Fig. 8). These findings are further detailed in Table 3.

FEDs risk in medical students by country

Nine countries had two or more studies, allowing to perform a subgroup meta-analysis. Results showed that overall pooled prevalence rate of FEDs symptoms in medical students varied significantly ($Q = 263$ (18), $P < 0.0001$), with the lowest being in Austria ($K = 2$, $N = 758$) and Hungary ($K = 2$, $N = 3014$), and the highest being in Lebanon ($K = 4$, $N = 1509$) [prevalence risk: 07.05% (95% CI 03.34–14.29%), 07.81% (95% CI 04.79–12.48%), and 33.43% (95% CI 12.00–64.90%), respectively]. Heterogeneity significantly improved for India (16.33% (95% CI 13.56–19.54%), $I^2 = 50.6\%$); Germany (12.36% (95% CI 08.44–17.74%), $I^2 = 46.2\%$); Saudi Arabia (12.11% (95% CI 09.42–15.43%), $I^2 = 59.8\%$); and France (17.97% (95% CI 15.97–20.17%), $I^2 = 31.2\%$). Detailed prevalence of FEDs risk in medical students by country is presented in Table 3.

FEDs risk in medical students by culture

Participants from non-Western cultures had a statistically higher prevalence of FEDs risk in medical students compared to participants from Western cultures [$Q = 6.41$ (1), $P = 0.01$]. Specifically, pooled prevalence rate of FEDs symptoms in participants from non-Western cultures ($K = 21$, $N = 10,304$) was 20.97% (95% CI 15.74–27.36%), $I^2 = 98\%$, $\tau^2 = 0.64$; and the overall pooled prevalence rate of FEDs symptoms in participants from Western cultures ($K = 14$, $N = 11,079$) was 12.98% (95% CI 10.18–16.42%), $I^2 = 96\%$, $\tau^2 = 0.25$. Detailed prevalence of FEDs risk in medical students by culture is presented in Table 3.

FEDs risk in medical students by measure

Six tools were used to measure the prevalence of FEDs symptoms in medical students. Detailed prevalence of FEDs risk in medical students by measure is presented in Table 3.

The most common research measure was the Eating Attitude Test-26 (EAT-26) with 32% of the studies using this measure ($K = 11$, $N = 6486$). Results from EAT-26 showed an overall prevalence rate of FEDs symptoms in medical students of 17.85% (95% CI 13.82–22.76%), $I^2 = 95.2\%$; $\tau^2 = 0.49$. The highest pooled prevalence rate of FEDs symptoms in participants [51.75% (95% CI 13.12–88.40%)] was obtained using the ORTO-15 measure ($K = 2$, $N = 1747$). The lowest pooled prevalence rate of FEDs symptoms in participants [08.97% (95% CI 04.97–15.63%)] was obtained using the Eating Disorder Inventory (EDI-I/II) ($K = 6$, $N = 4851$). Detailed descriptions of the measures used in various studies are included in the legend of Table 3.

Studies that used Eating Disorder Examination Questionnaire (EDE-Q) ($K = 3$, $N = 711$) appeared to be the best in terms of heterogeneity with $I^2 = 0\%$, suggesting that results obtained by EDE-Q are consistent in different sample groups.

Table 2 Selected descriptive results of the studies included in this systematic review and meta-analysis about FEDs risk in medical students

SN	Study	Country	Study characteristic	Sample characteristic	FEDs measure	FEDs symptoms	Quality score
1	Ali [65]	Egypt	Cross-sectional design, convenience sampling, sample size = 615	Sex (female %) = 67.2%, age = 21 years, BMI = 22 kg/m ²	EAT-26	UFED	8
2	Azzouzi [66]	Morocco	Cross-sectional design, convenience sampling, sample size = 710	Sex (female %) = 65.1%, age = 21.27 years, BMI = 22.9 kg/m ²	SCOFF	AN	7
3	Barayan [67]	Saudi Arabia	Cross-sectional design, convenience sampling, sample size = 319	Sex (female %) = 100%, age = 21.16 years, BMI = 22 kg/m ²	EDE-Q	UFED	5
4	Bizri [68]	Lebanon	Cross-sectional design, Convenience sampling, sample size = 124	Sex (female %) = 54%, age = 23 years, BMI = 22 kg/m ²	SCOFF, EAT-26	UFED	7
5	Brumboiu [24]	Romania	Cross-sectional design, convenience sampling, sample size = 222	Sex (female %) = 82%, age = 21.5 years, BMI = 21.3 kg/m ²	SCOFF	AN	7
6	Chan [69]	Malaysia	Cross-sectional design, Convenience sampling, Sample size = 1017	Sex (female %) = 51%, age = 20.73 years, BMI = 22 kg/m ²	EAT-26	UFED	8
7	Chaudhari [70]	India	Cross-sectional design, convenience sampling, sample size = 193	Sex (female %) = 60.6%, Age = 23.4 years, BMI = 24.5 kg/m ²	EDE-Q	UFED	7
8	Damiri [71]	Palestine	Cross-sectional design, convenience sampling, sample size = 1047	Sex (female %) = 61.3%, age = 20.21 years, BMI = 23.27 kg/m ²	SCOFF, EAT-26	UFED	8
9	Farchakh, 2019 [72]	Lebanon	Cross-sectional design, Convenience sampling, Sample Size = 627	Sex (female %) = 50.4%, Age = 21.81 years, BMI = 23.38 kg/m ²	ORTO-15, EAT-26	ON	8
10	Herzog [73]	United States	Cross-sectional design, convenience sampling, sample size = 121	Sex (female %) = 100%, age = 25.1 years, BMI = 22 kg/m ²	EDQ	UFED	5
11	Iyer [74]	India	Cross-sectional design, convenience sampling, sample size = 332	Sex (female %) = 56.33%, age = 22.3 years, BMI = 22 kg/m ²	EAT-26	UFED	7
12	Joja [75]	Germany	Cross-sectional design, convenience sampling, sample size = 110	Sex (female %) = 100%, age = 20.3 years, BMI = 21.5 kg/m ²	EDI	AN	8
13	Lee [76]	Korea	Cross-sectional design, convenience sampling, sample size = 199	Sex (female %) = 52.26%, age = 29.21 years, BMI = 21.95 kg/m ²	DEBQ	UFED	7
14	Pitanupong, 2017 [77]	Thailand	Cross-sectional design, Convenience sampling, Sample Size = 885	Sex (female %) = 56%, age = 20.8 years, BMI = 21.2 kg/m ²	EAT-26	UFED	7
15	Plichta [78]	Poland	Cross-sectional design, convenience sampling, sample size = 1120	Sex (Female %) = 70.4%, Age = 21.4 years, BMI = 22 kg/m ²	ORTO-15	ON	7

Table 2 (continued)

SN	Study	Country	Study characteristic	Sample characteristic	FEDs measure	FEDs symptoms	Quality score
16	Polanco [79]	Mexico	Cross-sectional design, Convenience sampling, Sample Size = 90	Sex (female %) = 66.4%, age = 20 years, BMI = 22 kg/m ²	EAT-26	UFED	6
17	Ramaiah [80]	India	Cross-sectional design, convenience sampling, sample size = 172	Sex (female %) = 65%, age = 21 years, BMI = 21.58 kg/m ²	EAT-26	UFED	7
18	Rasman [81]	Malaysia	Cross-sectional design, convenience sampling, sample size = 279	Sex (female %) = 75.3%, age = 21.86 years, BMI = 22.47 kg/m ²	SCOFF	AN	8
19	Rathner [82]	Austria	Cross-sectional design, convenience sampling, sample size = 379	Sex (female %) = 40.89%, age = 22 years, BMI = 21 kg/m ²	EDI, ANIS	AN	7
20	Rostad [83]	Norway	Cross-sectional design, convenience sampling, sample size = 1044	Sex (female %) = 70.9%, age = years, BMI = 22.8 kg/m ²	EDS-4	UFED	8
21	Sepulveda [84]	Spain	Cross-sectional design, convenience sampling, sample size = 2551	Sex (female %) = 67.9%, age = 21 years, BMI = 22 kg/m ²	EDI	UFED	8
22	Sharma [85]	India	Cross-sectional design, convenience sampling, sample size = 370	Sex (female %) = 42.4%, age = 20.3 years, BMI = 22 kg/m ²	EAT-26	UFED	8
23	Spillebout [86]	France	Cross-sectional design, convenience sampling, sample size = 731	Sex (female %) = 69.9%, age = 20 years, BMI = 22.1 kg/m ²	SCOFF	AN	7
24	Taha [87]	Saudi Arabia	Cross-sectional design, convenience sampling, sample size = 1200	Sex (female %) = 65%, age = 21 years, BMI = 22 kg/m ²	EAT-26	UFED	7
25	Tavolacci [88]	France	Cross-sectional design, convenience sampling, sample size = 1225	Sex (female %) = 61%, age = 21.6 years, BMI = 22 kg/m ²	SCOFF	AN	7
26	Thangaraju [89]	India	Cross-sectional design, convenience sampling, sample size = 199	Sex (female %) = 100%, age = 20.4 years, BMI = 23.78 kg/m ²	EDE-Q	UFED	7
27	Tury [90]	Hungary	Cross-sectional design, random sampling, sample size = 538 and 969	Sex (female %) = 53.9%, age = 21.43 years, BMI = 21.42 kg/m ²	EDI, ANIS	AN	7
28	Weigel [91]	Germany	Cross-sectional design, convenience sampling, sample size = 304	Sex (female %) = 58.2%, age = 22.6 years, BMI = 20.06 kg/m ²	EDI	AN	7

FEDs feeding and eating disorders, *AN* Anorexia nervosa, *ON* Orthorexia, or orthorexia nervosa, *UFED* Unspecified feeding or eating disorder. Quality score was computed based on Newcastle–Ottawa quality assessment scale total score for cross-sectional studies

ANIS = Anorexia Nervosa Inventory for Self-Rating; DEBQ = Dutch Eating Behavior Questionnaire; EAT-26 = Eating Attitudes Test-26; EDE-Q = Eating Disorder Examination- Questionnaire; EDI = Eating Disorder Inventory-I/II; EDS = Eating Disturbance Scale; ORTO-15 = ORTO-15; SCOFF = Sick, Control, One Stone, Fat, Food

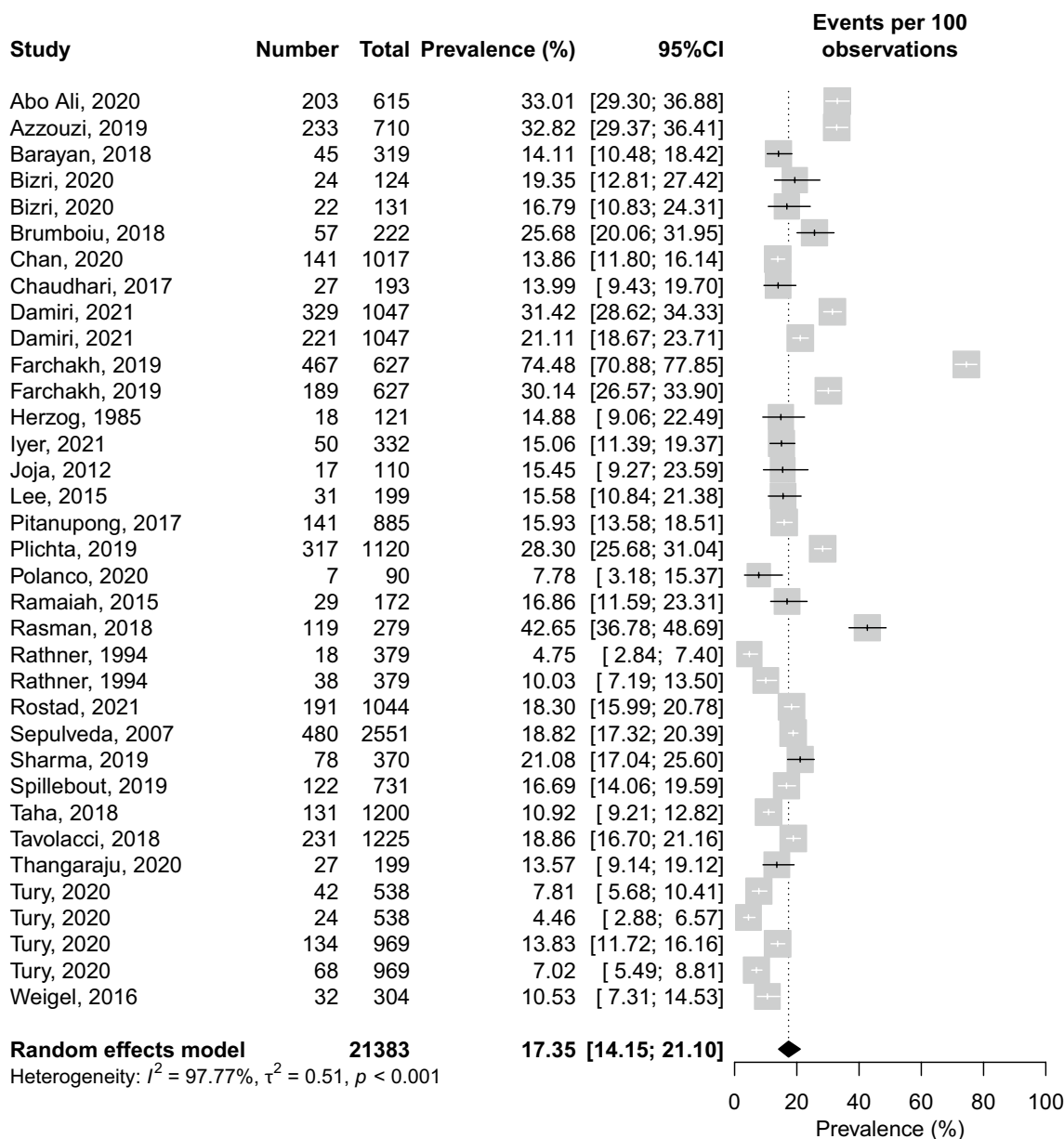


Fig. 4 Meta-analysis of FEDs symptoms in medical students

Discussion

A total of 21,383 medical students executed from 35 research data belong to 20 countries were included in this systematic review and meta-analysis. This review demonstrated that 17.35% of medical students screened positive for FEDs symptoms. Meta-regression analysis showed that FEDs symptoms were not associated with age nor sex. However, increased BMI was a strong statistical predictor of FEDs symptoms. A statistically significant difference was obtained between non-Western vs Western cultured students ($P=0.001$), explaining differences between countries. The

highest prevalence of FEDs symptoms was obtained by ORTO-15 suggesting that orthorexia nervosa (ON) symptoms, which is a FEDs characterized by an unhealthy obsession with healthy eating being the major concern.

In accordance with our first hypothesis, this meta-analysis found an overall prevalence of FEDs symptoms in medical students of 17.35%, hence showing an increase as compared to previous research. Indeed, an earlier meta-analysis using the same methods in 2018 reported an overall prevalence rate of FEDs symptoms in medical students to be 10.40% [21]. Moreover, medical students displayed higher prevalence rates of FEDs symptoms as compared to community

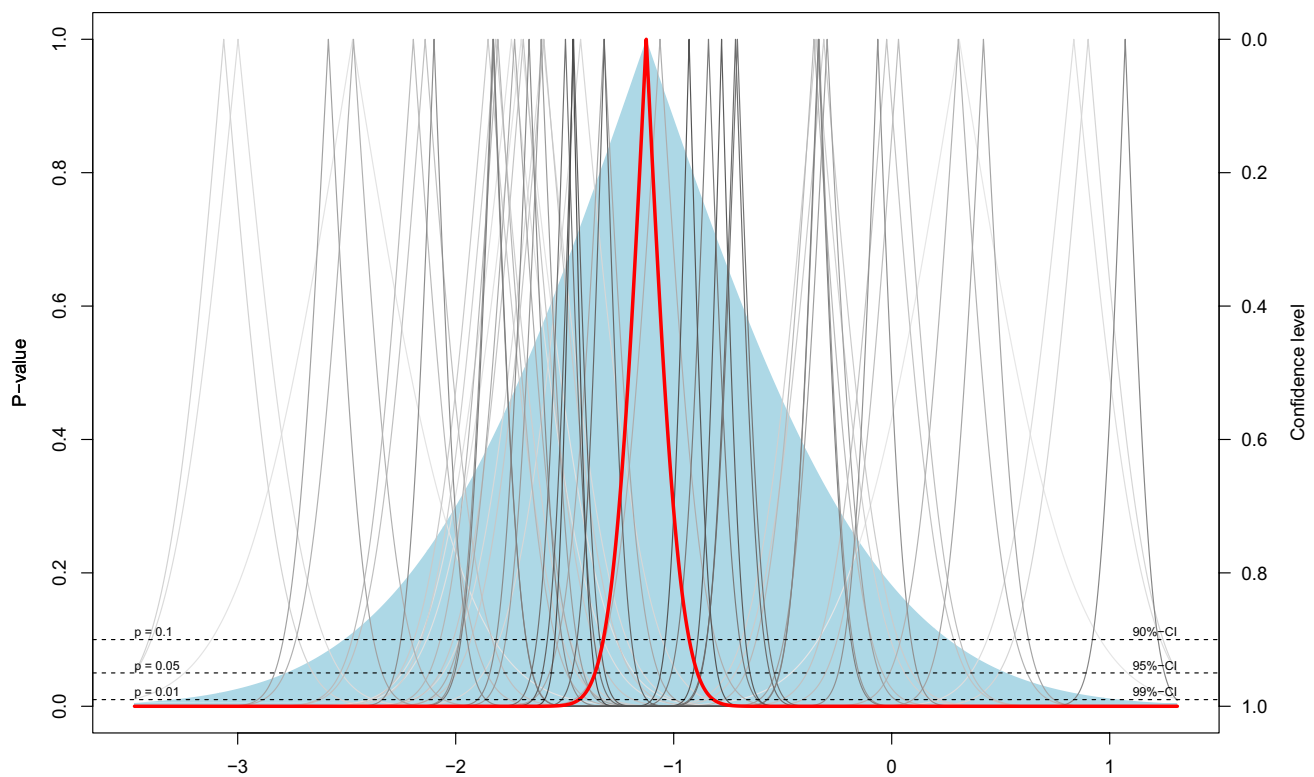


Fig. 5 Drapery plots of FEDs symptoms in medical students

samples across the globe [e.g., Canada ($N=31,130$, 50.9% female, risk of lifetime history of an eating disorder of 4.54%) [92], Spain ($N=4334$, 55.9% females, prevalence of population at risk for eating disorders of 2.2% for men and 15.3% for women) [93], Australia ($N=3034$, 67% female, prevalence of eating disorder behaviors of 6.4%) [94], London ($N=1,698$, 56.6% female, prevalence of reported disordered eating of 10%) [95], US ($N=100,000$, 50% female, annual prevalence of eating disorders occurring at age 21 years for males 7.4% and females 10.3%) [96], and six European countries (Belgium, France, Germany, Italy, the Netherlands and Spain) ($N=4139$, 51.6% female, lifetime estimated prevalence of eating disorders 0.48–2.15%) [97]]. Over the past years, the student population is increasingly facing high amounts of stress leading to more prevalent mental health challenges. The WHO World Mental Health International College Student project found ‘rising’ and ‘widely distributed’ rates of mental disorders among students in 19 colleges across 8 countries [98]. Medical students have been found to be exposed to more stressors and to experience more mental health issues as compared to students from other fields [99–101], and to age-matched general population [102]. This might explain the significant increase in the FEDs symptoms observed in medical students between 2018 and 2021. However, the extent to which the medical students’ population might be at a specific high risk for

FEDs compared to other populations remains unknown [90]. Future studies comparing FEDs symptoms of medical students with that of non-medical students and of the general population might shed light on the role of medical education-related factors (e.g., the choice of a medical career) on the prevalence of FEDs risk.

We expected to find higher FEDs symptoms among female students than males. However, our review showed that both male students are at a comparable risk of FEDs symptoms compared to females. FEDs has long been thought to be a disease that mainly affects early teenage girls; nevertheless, the frequency of FEDs in men is on the rise, requiring care providers’ attention to battle these complicated biopsychological diseases [103]. The stigma associated with male FEDs is a significant concern. The misconception that FEDs primarily affects women has resulted in feelings of guilt and isolation in men who are affected, delaying their seeking of assistance and therapy. As a result, initiatives should be developed to make care more accessible to both men and women.

Furthermore, according to our secondary hypothesis, we expected to find a higher prevalence risk of FEDs in medical students with western background. However, our findings provided evidence against this hypothesis. In addition, the increase in prevalence of FEDs symptoms was mainly observed in participants from non-Western

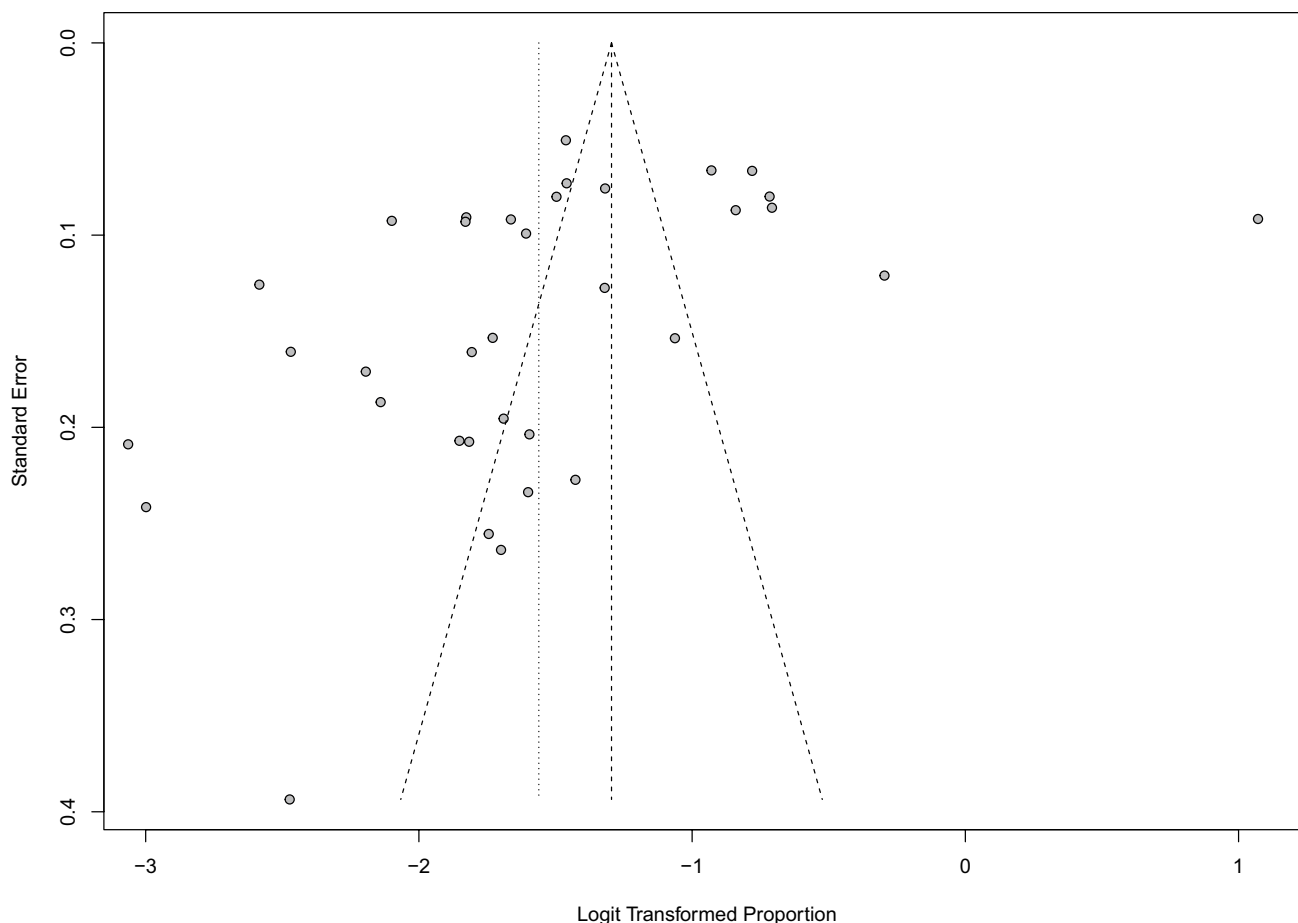


Fig. 6 Funnel plot of FEDs symptoms in medical students

countries. This might be explained by the fact that FEDs is a global problem, and as the world's population and westernization expand, so do reports of FEDs in non-Western cultures. Consistent with this finding, Weigel et al. found that medical students from the newly formed German states reported higher levels of drive for thinness and body dissatisfaction as compared to a historical sample of East German medical students, suggesting “an acculturation to Western beauty ideals” [91]. In the same line, a meta-analysis of 94 studies using the EDI by Podar and Allik found more pronounced symptoms of eating disorders in non-Western than Western participants [104]. There has been a rise in body dissatisfaction within the population, particularly in university students in non-Western civilizations [105]. Fiji has contributed to a better knowledge of eating disorders in non-Western cultures throughout the world [106, 107]. The conventional definition of beauty in Fiji was a female figure that was heavier, rounder, and softer. Back to late 1990s, eating disorders rise steeply after the introduction of media and Western television [106]. Body dissatisfaction, dieting, the desire to lose weight, the slim ideal, and disordered eating practices were all on the rise

as risk factors. Fijian society's definition of female beauty was also redefined as a more ‘Westernized’ ‘thin ideal’ [108].

Our findings supported the hypothesis that elevated BMI is associated with greater FEDs symptoms in medical students. Indeed, there is some evidence that suggests that increased weight is associated with different types of FEDs symptoms [109] and is one of the risk factors for their development and maintenance [110–112]. For instance, a recent online survey of a large cohort of 13,341 individuals seeking medical weight correction assistance found that obesity was associated with a higher eating disorders risk [113]. Yilmaz et al. [121] found that premorbid metabolic factors in addition to weight could be relevant factors to the etiology of FED. However, it is worth noting that existing literature regarding the relationship between eating disorders and BMI was mainly limited to adolescents or students, and has shown mixed results [114–119]. For example, Sanlier et al. surveyed university students in Turkey and found that there was not a significant difference in EAT-40 scores (Eating attitudes and eating disorders test) according to gender and BMI classification [120]. Contrarily, a low premorbid

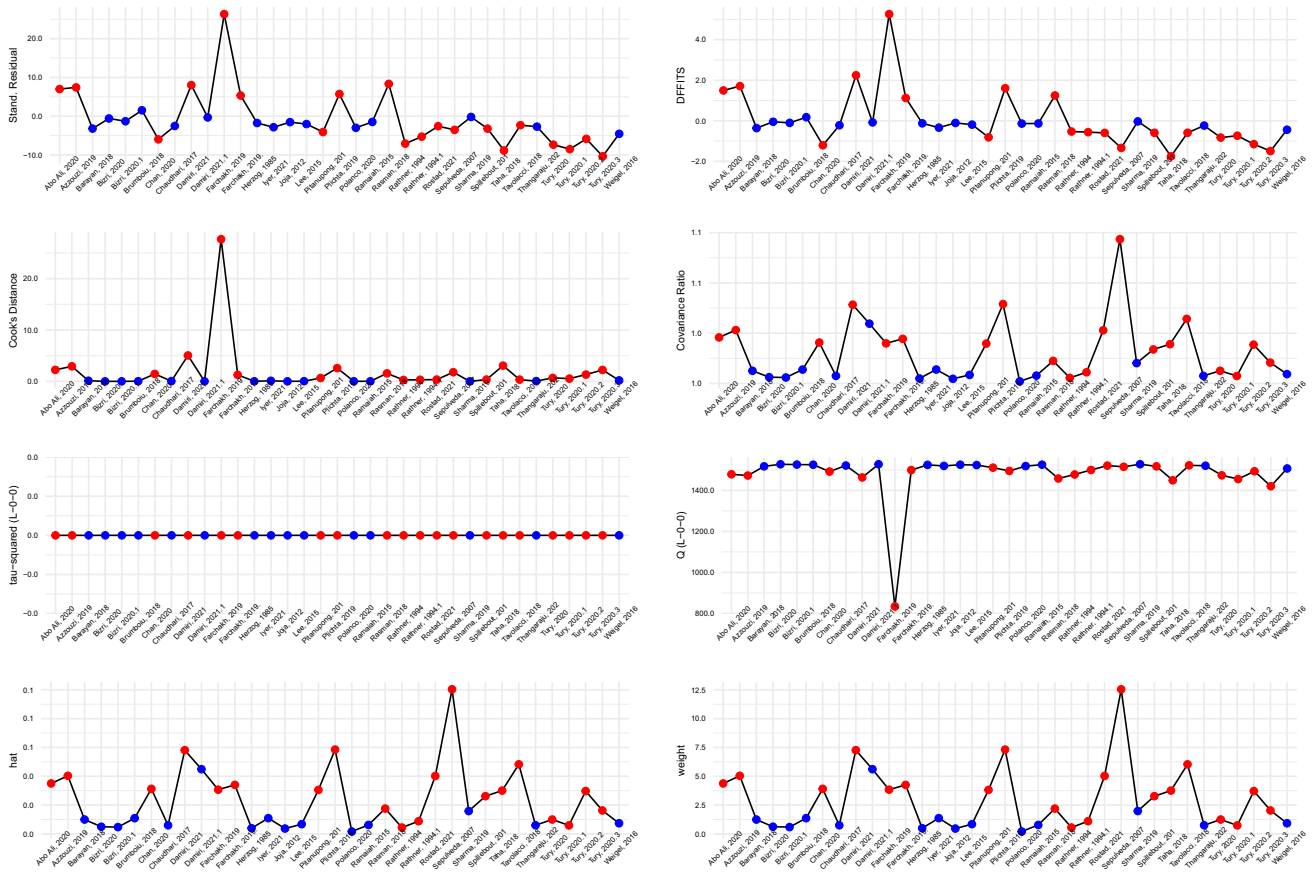


Fig. 7 Influence analysis of FEDs symptoms in medical students

weight was considered as a key biological risk factor or early manifestation of an emerging disease process in anorexia nervosa [121]. These inconsistent findings call for further epidemiological studies on the link between BMI and FEDs risk.

The current review is the largest and most updated systematic review and meta-analysis on the topic, which represents its major strength. To manage bias, detect outliers, and assess heterogeneity, robust statistical tests were utilized. The generalizability of the present review's results is also expected to be good because the pooled sample size was extremely big and the participants were recruited from a variety of nations. The second strength of this review is based on using the best available standards that enable objective evaluation of the quality of published evidence using a comprehensive and detailed assessment of the risk of bias of a large number of studies. Finally, this meta-analysis resolved uncertainty when studies disagree regarding FEDs in medical students.

Despite these strengths, certain limitations need to be discussed. The major limitation of this review are the focus on English language papers only. However, to the author's knowledge, non-English papers were very few in peer review

journals. Another limitation was the presence of increased heterogeneity. In addition, there is a lack of direct comparison between medical students and other populations (e.g., non-medical students, the general population). Moreover, we have suggested an increase of the prevalence of FEDs risk among medical students based on a prior meta-analysis published in 2018 by Jahrami et al. using the same methods; however, comparing our current findings with this previous work may be affected by the type of FEDs included in the meta-analyses. Finally, all studies included in this meta-analysis presented self-reported data, and none of them included individuals with clinically diagnosed FEDs.

Conclusion

The prevalence of FEDs symptoms in medical students was estimated to be increasing in the past few years, reaching a pooled prevalence rate of 17.35%. The findings of future prospective studies are urgently required to better understand the interactions between the risk factors and to use the information to construct prevention and treatment programs, in

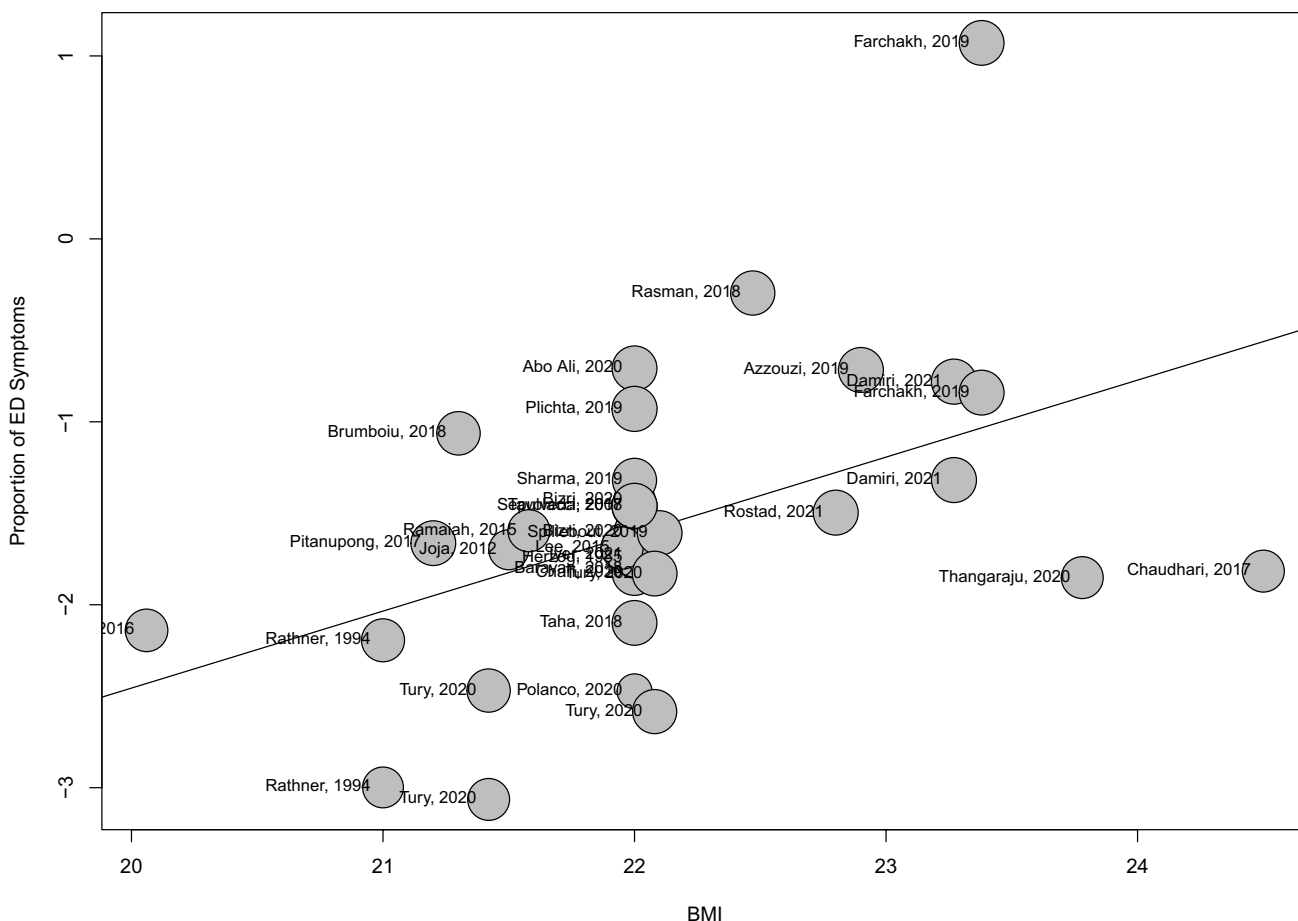


Fig. 8 Meta-regression between BMI and FEDs symptoms in medical students.

order to provide better outcomes for students at risk to or suffering from FEDs.

What is already known on this subject?

- Previous literature has pointed that medical students displayed higher prevalence rates of eating disorders risk as compared to the general population; which calls for further studies on this topic.
- Female medical students were reported to be at more risk for eating disorders than male medical students. Other risk factors for FEDs have also been reported among this population, including elevated BMI and western origin.

What does this study add?

- This review showed that the overall prevalence rate of FEDs symptoms in medical students (17.35%) was higher than those reported in prior research.
- Male and female students were affected similarly by risk of FEDs symptoms, which implies that efforts should be made to provide stigma-free care access for FEDs problems to male students.
- Medical students from non-Western cultures reported higher prevalence of FEDs compared to students from Western cultures, highlighting that prominent attention should be given to FEDs problems in medical schools in non-Western countries.

Table 3 Meta-analysis of the prevalence of FEDs risk in medical students

Analysis	Descriptive			Random-effects meta-analysis			Heterogeneity			Potential con-founders			Publication bias	
	K	N	Pooled results (95% CI)	Forest plot	I ²	H	τ ²	Q (within)	Q (between)	Age	Sex	BMI	egger's test	
Prevalence of FEDs risk in medical students (all countries, all measures, all cultures)	35	21,383	17.35% (95% C.I. 14.15–21.10%)	Figure 2	97.8%	6.70	0.51	1528	NA	NS	NS	0.001	NS	
Prevalence of FEDs risk in medical students (by country)														
India	5	1266	16.33% (95% C.I. 13.56–19.54%)	NA	50.6%	0.18	0.03	8.10	263	NS	NS	0.001	NS	
Lebanon	4	1509	33.43% (95% C.I. 12.00–64.90%)	NA	99.0%	1.32	1.74	310.69		NS	NS	0.001	NS	
Hungary	4	3014	07.81% (95% C.I. 04.79–12.48%)	NA	93.3%	0.51	0.26	44.52		NS	NS	0.001	NS	
Saudi Arabia	2	1519	12.11% (95% C.I. 09.42–15.43%)	NA	59.8%	0.16	0.03	2.49		NS	NS	0.001	NS	
Malaysia	2	1296	25.67% (95% C.I. 07.15–60.74%)	NA	99.0%	1.08	1.16	102.35		NS	NS	0.001	NS	
Palestine	2	2094	25.96% (95% C.I. 17.14–37.26%)	NA	96.5%	0.37	0.14	28.47		NS	NS	0.001	NS	
Germany	2	414	12.36% (95% C.I. 08.44–17.74%)	NA	46.2%	0.21	0.04	1.86		NS	NS	0.001	NS	
Austria	2	758	07.05% (95% C.I. 03.34–14.29%)	NA	86.5%	0.53	0.28	7.39		NS	NS	0.001	NS	
France	2	1956	17.97% (95% C.I. 15.97–20.17%)	NA	31.2%	0.06	0.0034	1.45		NS	NS	0.001	NS	
Prevalence of FEDs risk in medical students (by culture)														
Non-Western	21	10,304	20.97% (95% C.I. 15.74–27.36%)	NA	98.0%	0.80	0.64	1010.58	6.41	NS	NS	0.001	NS	
Western	14	11,079	12.98% (95% C.I. 10.18–16.42%)	NA	96.0%	0.50	0.25	325.03		NS	NS	0.001	NS	
Prevalence of FEDs risk in medical students (by FEDs measure)														
EAT-26	11	6486	17.85% (95% C.I. 13.82–22.76%)	NA	95.2%	0.49	0.24	209.09	31.23	NS	NS	0.001	NS	
SCOFF	7	4338	26.06% (95% C.I. 19.93–33.30%)	NA	95.6%	0.45	0.21	137.72		NS	NS	0.001	NS	
EDI	6	4851	08.97% (95% C.I. 04.97–15.63%)	NA	96.6%	0.77	0.59	147.01		NS	NS	0.001	NS	
EDE-Q	3	711	13.93% (95% C.I. 11.57–16.67%)	NA	0.0%	0	0	0.03		NS	NS	0.001	NS	
ANIS	3	1886	10.45% (95% C.I. 07.23–14.87%)	NA	84.6%	0.33	0.11	13.02		NS	NS	0.001	NS	
ORTO-15	2	1747	51.75% (95% C.I. 13.12–88.40%)	NA	99.7%	1.41	1.99	312.90		NS	NS	0.001	NS	

Anorexia Nervosa Inventory for Self-Rating (ANIS) 31-item self-rating scale consisting of 6 interpretable factors; (1) Figure Consciousness; (2) Feelings of Insufficiency; (3) Anancasm; (4) Adverse Effect of Meals; (5) Sexual Anxieties; and (6) Bulimia [130]. Eating Attitudes Test-26 (EAT-26) is 26 self-report questions assessing general eating behavior and five additional questions assessing risky behaviors. Using with adolescents (13+) and adults. The scale has three subscales: (1) Dieting, (2) Bulimia and Food Preoccupation, (3) Oral Control [128]. Eating Disorder Examination- Questionnaire (EDE-Q) is a 28-item self-reported questionnaire to assess the range and severity of features associated with a diagnosis of eating disorder using 4 subscales (Restraint, Eating Concern, Shape Concern, and Weight Concern) and a global score [129]. Eating Disorder Inventory-III (EDI) comprises 64 self-report questionnaires, divided into eight subscales: (1) Drive for thinness, (2) Bulimia, (3) Body dissatisfaction, (4) Ineffectiveness, (5) Perfectionism; (6) Interpersonal distrust; (7) Interceptive awareness, (8) Maturity fears [133]. ORTO-15: The ORTO-15 is a self-report measure ostensibly designed to assess Orthorexia Nervosa (ON) is a proposed diagnostic category that captures a pathological need to eat healthfully [134]. Sick, Control, One Stone, Fat, Food (SCOFF): the questionnaire is simple and easy to administer by non-specialists, a five-question screening measure to assess the possible presence of an eating disorder [39].

FEDs feeding and eating disorders

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

Human and animal rights This article does not contain any studies with human participants or animals performed by any of the authors. Data were obtained from published studies available in the public domain.

Informed consent For this type of study (systematic review and meta-analysis) formal consent is not required.

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