

Prevalence of Depression, Anxiety, Stress and Suicide Ideation Among Undergraduate Medical Students in India: A Systematic Review and Meta-Analysis

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ABSTRACT

Background: Studies reported significant levels of psychological morbidity from across the globe among undergraduate medical students. Present meta-analysis aimed to provide a most up to date comprehensive insight into the prevalence of depression, stress, anxiety and suicidal ideation among undergraduate medical students in India.

Material and Methods: A systematic search was conducted in three databases PubMed, Scopus and Google Scholar from July 2023 to August 2023. Quality of included studies (43 studies, N=15557) was assessed using modified Newcastle-Ottawa scale and data was analyzed using MetaXL version 5.3. Pooled estimates with 95% confidence intervals were determined using the random-effects model.

Results: The pooled prevalence of depression, anxiety, stress and suicide ideation was 48% (95% CI: 41-55%) ($P=0.000$, $I^2=98\%$), 54% (95% CI 42-58%) ($P=0.00$, $I^2=98\%$), 50% (95% CI 45-63%) ($P=0.001$, $I^2=99\%$) and 21% (95% CI: 9-35%) ($P=0.000$, $I^2=98\%$) respectively. Subgroup analysis showed more females than males students were affected from depression, anxiety, stress and suicide ideation.

Conclusion: High prevalence of psychological disorders in medical students in India emphasize the need for the counselling services to control this morbidity and implement long term policies and programs at institutional level.

Keywords: India, Medical students, Mental health, Pooled prevalence, psychological disorders

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INTRODUCTION

Medical education is widely regarded as one of the most demanding and psychologically taxing professional courses. Medical training has high academic and emotional requirements as compared to other graduate training programmes.^{1,2} Generally, the total time required to acquire the necessary professional knowledge and skills is greater for medical students than those with other majors which negatively affects the mental health of medical students.^{3,4} The demanding academic workload, strict schedules, significant performance expectations, distance from loved ones, and transition to clinical environments, sleep deprivation, financial concerns, minimal relaxation, and recreation time cause more stress in medical students.⁵ Increased stress levels result in an increased psychological problems such as depression, anxiety, drug abuse, and suicide ideation.⁶⁻⁸

Studies from across the globe have shown that medical students experience significant levels of psychological morbidity ranging from stress, depression, anxiety and suicidal ideation to psychiatric disorders.⁹⁻¹¹ Existing research has emphasized the detrimental impacts of depression on young individuals, including impaired academic achievement, elevated substance abuse, and suicidal thoughts.¹²⁻¹⁶ Anxiety is another significant concern for medical students as studies reported that about one third (33.8%) of medical students were affected from this issue globally, with a higher prevalence observed among medical students from the Middle East and Asia.¹⁷ Medical doctors are one of the high-risk groups for suicide.^{18,19} It seems that this problem arises during medical school.^{20,21} The rates of suicidal ideation in medical students vary widely, ranging from 6.0% to 43.0%.^{20,22-24} Psychological morbidities in medical students are concerning as they can negatively impact their interpersonal relationships and future clinical practices like decrease in academic performance, professionalism, and empathy toward their patients; if left unnoticed and untreated.²⁵⁻²⁷

The medical education and healthcare work settings in India demonstrate some differences compared to those observed in Western or other Asian regions. Varying prevalence rates were reported in different epidemiological studies in India and there is a limited number of prevalence meta-analysis studies of mental health problems which makes generalization of prevalence rates difficult which are crucial for developing strategies to prevent, screen, treat, and support the mental well-being of medical students. In such a scenario, up-to-date pooled estimates are a need of the hour to estimate the burden of mental health disorders in medical students.¹²

Previous systematic review and meta-analysis conducted in 2015 on prevalence of depression, anxiety, and stress among medical students in India reviewed all the studies published from January 1970 to October 2015.²⁸ So, present meta-analysis aimed to up-

date the existing review and to provide most upto date comprehensive insight into the prevalence of depression, stress, anxiety and suicidal ideation among undergraduate medical students in India.

METHODOLOGY

The present systematic review and meta-analysis was conducted according to PRISMA checklist and Meta-analyses and Meta-analysis of Observational Studies in Epidemiology reporting guidelines.^{29,30} Before starting the literature search, we registered it in PROSPERO (CRD42023476411), an international database of prospectively registered systematic reviews. Two authors (VG, HK) conducted systematic searches in three databases PubMed, Scopus and Google Scholar from July 2023 to August 2023 and were blinded to each other's decisions. For searching articles on the prevalence of depression, anxiety, stress and suicide ideation among undergraduate medical students we used the following search terms: "Mental Health Problems" OR "Mental Health disorder" OR "Mental Health" OR "Anxiety" OR "Stress" OR "Depression" OR "Suicide Ideation" AND "MBBS students" OR "Undergraduate Medical Students" OR "Medical Students" AND India (Table S1). All the original quantitative articles published from August 2015 to June 2023 that reported prevalence of at least one of the depression, anxiety and/or stress were included for the review. There were very few quantitative studies that reported the prevalence of suicide ideation among students in India and no meta-analysis was published earlier on the prevalence of suicide ideation among undergraduate medical students in India. So, all the studies published from January 2000 to June 2023 that reported prevalence of suicide ideation among undergraduate medical students in India were reviewed. The reference sections of pertinent reviews identified through the database search were examined to locate relevant studies. All available articles published in English during the study period that examined the prevalence of stress, anxiety, depression, and suicidal ideation among undergraduate medical students in India were retrieved.

Inclusion criteria: Studies with cross sectional design, conducted among undergraduate medical students from India and reported at least one of the prevalence of stress, anxiety, depression and/ or suicide ideation were included in the review.

Exclusion criteria: We excluded publications reporting reviews, discussions, single-case studies, systematic review and meta-analysis and qualitative studies. Studies that not accessible online were not included. Also, studies looking at psychological morbidities only due to examination were excluded. Moreover, studies related to only interns, paramedical students and studies related to physical or mental illness in undergraduate medical students due to the COVID-19 pandemic were excluded.

Study selection: Rayyan (<https://rayyan.qcri.org>) software was used for the systematic review of the retrieved articles. Two investigators (HK, VG) independently screened title and abstract of the retrieved publications in-duplicate using Rayyan and decided whether they were appropriate for inclusion in the meta-analysis. Based on the above eligibility criteria, articles that considered to be relevant by two reviewers (VG, HK) were entered into full text screening process into in-duplicate Rayyan. Any disagreement was resolved by mutual discussion. PRISMA flow chart of study identification and selection processes is shown in Fig 1.

Data Extraction: After the study selection according to inclusion and exclusion criteria, two researchers who conducted screening procedures independently conducted descriptive data extraction from the final set of included studies. Data was extracted using predesigned spreadsheet in Microsoft Excel which included the year of publication, first author's name, study population region, study design, sampling technique, study period, age of participants, response rate, sample size, number of males and females, instrument used for assessing depression, anxiety, stress and suicide ideation, overall prevalence of at least one of the stress, anxiety, depression and suicide ideation and among male and female students.

Risk of Bias Assessment: Modified version of New Castle Ottawa Quality Assessment Scale adapted for cross sectional study was used for quality assessment.³¹ Following characteristics were assessed. Q1: Representativeness of sample (The inclusion of all subject or use of random sampling) Q2: Appropriate Sample size Q3: Non-Response rate equal to or greater than 80% Q4: Valid screening tools to evaluate depressive, stress, anxiety, suicide ideation symptoms and cutoff values Q5: Appropriate statistical analysis (appropriate and clearly described statistical test). Assessment was done at study level. For each characteristic minimum score 0 and maximum score 5 was given. Studies scoring ≥ 3 points and < 3 points were regarded as having a low risk of bias and a high risk of bias respectively. Two researchers independently assessed the risk of bias for each included study. Any discrepancies were resolved by discussion with a third researcher (HK, VG and AG).

Data Synthesis and Analysis: MetaXL version 5.3 was used for analysis of the data retrieved from the studies. The extracted data was utilized to determine the prevalence of depression, anxiety, stress and suicide ideation among medical students.

Pooled estimates with 95% confidence intervals were calculated using a random-effects model because of substantial variation across studies.³² Cochran's heterogeneity statistic (Q) was used to test if the effect sizes of different studies were similar or not. Q statistics with p -value < 0.10 was considered statistically significant heterogeneity. I^2 statistics were used to analyze the heterogeneity and $I^2 > 75\%$ was considered as high heterogeneity.³³ Subgroup

analyses stratified by gender and screening tool was done to study the source of heterogeneity among subgroup. Forest plots were used to determine the prevalence of pooled estimates. To determine possible publication bias, evidence of asymmetry and other small study effect funnel plots were used. Publication bias was assessed using the Doi plot and the LFK index to validate the asymmetries observed in the funnel plot. Value of LFK index over ± 1 is considered to be publication bias.³⁴ Sensitivity analysis was performed by excluding each study and rerunning the meta-analysis to test the robustness of the pooled prevalence of stress, anxiety, depression and suicide ideation.

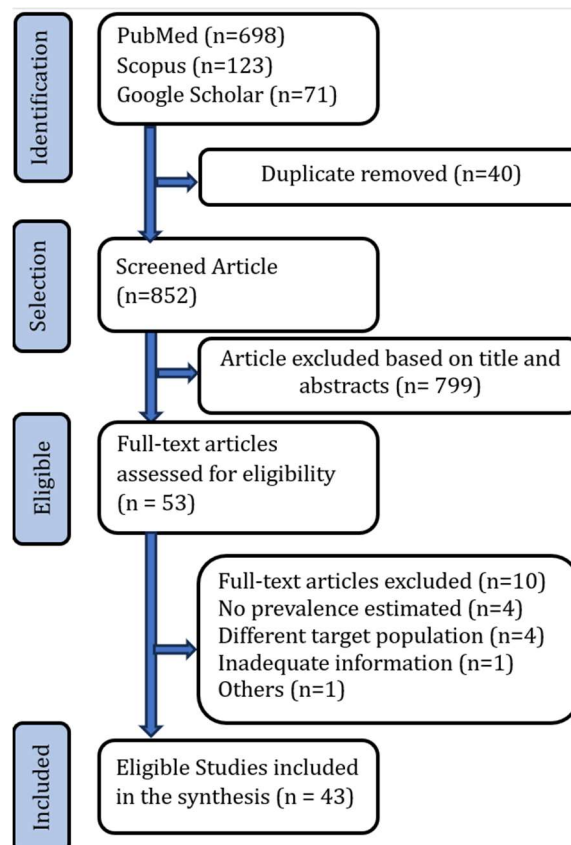


Figure 1: PRISMA flowchart for the identification and selection of observational studies in systematic review and meta-analysis of anxiety, depression, stress and suicide ideation

RESULTS

Our search with the pre-specified search strategies resulted in an overall of 892 articles. We removed 40 duplicated studies before further screening. After screening titles and abstract of remaining 852 studies, 799 were excluded being irrelevant to the main subject; and repetitive publications. After screening full text for remaining 53 articles for eligibility to be included in the current systematic review and meta-analysis study; 10 articles were excluded due to various reasons (4 no prevalence estimates, 4 different target population, 1 inadequate information, 1 others). Finally, 43 eligible studies were included for the present meta-analysis (Figure 1).

Table 1: Characteristics of Included Studies

Author (year of Publication) citation	Study design	Sampling Technique	Study period	Age (years)	Response rate	Sample size	Male	Screening Tool and Cutoff Values			
								Depression	Anxiety	Stress	Suicide Ideation
Mandyam (2023) ³⁵	Cross sectional	Complete enumeration	-	17-25	100	588	-	DASS 42>=10	DASS 42>=8	DASS 42>=15	-
Merchant (2023) ³⁶	Cross sectional	Consecutive Sampling	-	-	-	1300	-	DASS 21>=14	DASS 21>=10	DASS 21>=19	-
Shah (2023) ³⁷		Snowball Sampling	Jan-March, 2023	17-30	-	623	336	-	HAM-A>=18	-	-
Arun (2022) ³⁸	Cross sectional	Complete enumeration	Oct,2019	-	99	425	164	PHQ 9>=15	GAD 7>=10	-	SBQ-R>=7
Karthik (2022) ³⁹	Cross sectional	Stratified sampling	Nov,2019-Dec,2019	18-24	100	360	157	DASS 21>=10	DASS 21>=8	DASS 21>=15	-
Lepcha (2022) ⁴⁰	Cross sectional	Complete enumeration	Jan,2020-Jan,2021	-	-	382	144	HADS>=8	HADS >=5	-	-
Chakraborty (2021) ⁴¹	Cross sectional	-	Jul,2106- Oct, 2016	-	-	487	-	DASS 21>=10	DASS 21>=8	DASS 21>=15	-
Desai (2021) ⁴²	Cross sectional	Complete enumeration	Nov,2017	-	72	506	-	PHQ-9>=10	-	-	PHQ-9>=1
Jose (2021) ⁴³	Cross sectional	Non Probability Sampling	Nov,2020-Jan,2021	18-23	100	140	75	DASS 42>=10	DASS 42>=8	DASS 42>=15	-
Karmakar (2021) ⁴⁴	Cross sectional	Simple random sampling	Jan, 2017- Dec,2017	18-25	100	310	163	DASS 42>=10	DASS 42>=8	DASS 42>=15	-
Khan (2021) ⁴⁵	Cross sectional	-	Jan 2021-May,2021	18-25	100	264	131	-	-	PSS 10>=14	-
Kukreja (2021) ⁴⁶	Cross sectional	Complete enumeration	2019	21.28	100	301	148	BDI>=10	-	-	-
Pandey (2021) ⁴⁷	Cross sectional	Convenient sampling	Feb, 2018-Jan,2019	19-24	100	150	103	HAM-D>=7	-	SSDQ>=1 Domain	-
Solanki (2021) ⁴⁸	Cross sectional	Complete enumeration	June2019-Nov-2019	17-28	82.8	395	154	CES-D>=16	-	-	-
Haritay (2020) ⁴⁹	Cross sectional	Simple random & Systematic Random Sampling	2019	17-25	-	148	-	ADSS48>=3	ADSS 48>=3	ADSS 48>=3	-
Kamthan (2021) ⁵⁰	Cross sectional	Simple Rrandom Sampling	May,2017-Dec,2018	-	100	273	-	-	-	K 10>=20	-
Kumar (2020) ⁵¹	Cross sectional	-	-	21.33+1.98	96	200	-	DASS 21>=10	DASS 21>=8	DASS 21>=15	-
Luthra (2020) ⁵²	Cross sectional	Simple Random Sampling	Sep,2019	-	-	225	142	DASS 21>=10	DASS 21>=8	DASS 21>=15	-
Nesan (2020) ⁵³	Cross sectional	Complete enumeration	June-Aug,2017	17-20	100	415	179	-	-	-	BSSI>=9
Nezam (2020) ⁵⁴	Cross sectional	Complete enumeration	-	-	-	921	-	BDI>=10	-	-	-
Pattnaik (2020) ⁵⁵	Cross sectional	Complete enumeration	Nov,2019-Dec,2019	20.89+1.77	87.84	902	572	PHQ 9>=5	-	-	-
Singh (2020) ⁵⁶	Cross sectional	-	Feb, 2018-Jan,2019	20.8+1.9	-	150	103	HAM-D>=7	-	SSDQ>=1 Domain	-
Gupta (2018) ⁵⁷	Cross sectional	Complete enumeration	Dec, 2016- Feb,2017	19.8+1.85	-	417	117	BDI>=10	-	GHQ 12>=4	-
James (2018) ⁵⁸	Cross sectional	-	Nov, 2017-July,2018	18-20	-	137	52	-	BAI>=16	-	-
Nivetha (2018) ⁵⁹	Cross sectional	Simple Random Sampling	Jul-Sep, 2017	18-24	100	303	156	-	-	PSS 10>=14	-

Author (year of Publication) citation	Study design	Sampling Technique	Study period	Age (years)	Response rate	Sample size	Male	Screening Tool and Cutoff Values			
								Depression	Anxiety	Stress	Suicide Ideation
Rebello (2018) ⁶⁰	Cross sectional	Convenient sampling	Dec,2016	17-19	80.67	121	69	-	-	PSS 14>=28	-
Taneja (2018) ⁶¹	Cross sectional	Complete enumeration	Sep,2017	18-25	94	187	124	DASS 21>=10	DASS 21>=8	DASS 21>=15	-
Aggarwal (2017) ⁶²	Cross sectional	Convenient sampling	-	18-25	98	147	51	-	-	PSS 14>=28	-
Chellaiyan (2017) ⁶³	Cross sectional	Complete enumeration	April,2016-March,2017	>18	92.6	507	217	BDI>=10	GAD 7>=10	PSS 14>=7	-
Chenganakkattil (2017) ⁸	Cross sectional	Simple Random Sampling	-	-	100	150	-	SDS>=50	SAS>=45	PSS 10>=14	-
Hakim (2017) ⁶⁴	Cross sectional	Simple Random Sampling	Oct, 2016- April, 2017	-	100	426	249	PHQ 9>=5	GAD 7>=5	-	-
Kumar (2017) ⁶⁵	Cross sectional	Complete enumeration	Jan,12-June,2013	17-24	88.8	444	228	BDI>=10	-	PSS 14>=12	-
Samanta (2017) ⁶⁶	Cross sectional	Complete enumeration	March,2014-June,2015	20.64+1.19	76	225	137	-	-	PSS 10>=20	-
Chaudhary (2016) ⁶⁷	Cross sectional	Complete enumeration	Oct-Nov, 2014	17-32	90.4	452	243	-	-	PSS 10>=20	-
George (2016) ⁶⁸	Cross sectional	Simple Random Sampling	-	17-25	100	290	121	-	-	PSS 10>=26	-
Kumar (2016) ⁶⁹	Cross sectional	Convenient sampling	-	-	-	332	137	DASS 42>=10	DASS 42>=8	DASS 42>=15	-
Rawat (2016) ⁷⁰	Cross sectional	Simple Random Sampling	Sep- Nov,2015	-	100	300	187	PHQ 9>=5	-	-	-
Singh (2016) ⁷¹	Cross sectional	Complete enumeration	-	18-22	-	512	244	HAM-D>=7	HAM-A>=7	-	-
Yadav (2016) ⁷²	Cross sectional	Simple Random Sampling	Feb-May,2014	-	100	330	223	DASS 42>=14	DASS 42>=8	-	-
Naveen (2015) ⁷³	Cross sectional	Simple Random Sampling	Oct-Nov, 2014	18-22	100	152	50	DASS 42>=14	DASS 42>=8	DASS 42>=15	-
Suman (2015) ⁷⁴	Cross sectional	Simple Random Sampling	Jul-Aug,2015	18-25	100	120	60	DASS 42>=14	DASS 42>=8	DASS 42>=15	-
Goyal (2012) ⁷⁵	Cross sectional	Simple Random Sampling	-	17-30	100	265	138	-	-	-	TASR
Jain (2012) ⁷⁶	Cross sectional	Convenient sampling	-	-	87	-	-	-	-	-	Custom questionnaire

Cells containing “-“ indicate that the study author did not provide any relevant information for that column.

Abbreviations: HADS Hospital Anxiety and Depression Scale , PHQ-9 Patient Health Questionnaire, SDS Zung Self-Rating Depression Scale, BDI Beck Depression Inventory, DASS-21 Depression Anxiety Stress Scale 21 item, DASS-42 Depression Anxiety Stress Scale 42 item, ADSS Anxiety Depression Stress Scale, CES-D Centre for epidemiological studies depression scale, HAM-D Hamilton Depression Rating Scale, BAI Beck Anxiety Inventory , SAS Zung self-rating anxiety Scale, HAM-A Hamilton Anxiety Rating Scale, GAD-7 Generalized Anxiety Disorder 7 scale, SSDQ Students Stress Dimension Questionnaire, PSS Perceived Stress Scale, GHQ General Health Questionnaire, K 10 Kessler Psychological Distress Scale, SBQ-R Suicide Behaviors Questionnaire-Revised, BSSI Beck Scale for suicide Ideation, TASR Tool for Assessment of Suicide Risk

Table 2: Quality ratings of included studies using the modified Newcastle-Ottawa Scale

Sr No	Author (Year of Publication)	Representative	Sample Size	Non response	Valid Tool	Statistical Method	Score
1	Mandyam 2023 ³⁵	Y	Y	Y	Y	Y	5
2	Merchant 2023 ³⁶	Y	Y	Y	Y	Y	5
3	Shah 2023 ³⁷	Y	Y	Y	Y	Y	5
4	Arun 2022 ³⁸	N	N	Y	Y	Y	3
5	Karthik 2022 ³⁹	Y	Y	Y	Y	Y	5
6	Lepcha 2022 ⁴⁰	Y	Y	Y	Y	Y	5
7	Chakraborty 2021 ⁴¹	N	Y	N	Y	Y	3
8	Desai 2021 ⁴²	Y	Y	N	Y	Y	4
9	Jose 2021 ⁴³	N	Y	Y	Y	Y	4
10	Karmakar 2021 ⁴⁴	Y	Y	Y	Y	Y	5
11	Khan 2021 ⁴⁵	N	Y	Y	Y	Y	4
12	Kukreja 2021 ⁴⁶	Y	Y	N	Y	Y	4
13	Pandey 2021 ⁴⁷	N	Y	N	Y	Y	3
14	Solanki 2021 ⁴⁸	Y	Y	Y	Y	Y	5
15	Haritay 2020 ⁴⁹	Y	N	N	Y	Y	3
16	Kamthan 2020 ⁵⁰	Y	Y	Y	Y	Y	5
17	Kumar 2020 ⁵¹	N	N	Y	Y	Y	3
18	Luthra 2020 ⁵²	Y	N	N	Y	Y	3
19	Nesan 2020 ⁵³	Y	Y	N	Y	Y	4
20	Nezam 2020 ⁵⁴	Y	Y	Y	Y	Y	5
21	Pattnaik 2020 ⁵⁵	Y	Y	Y	Y	Y	5
22	Singh 2020 ⁵⁶	N	Y	N	Y	Y	3
23	Gupta 2018 ⁵⁷	Y	Y	N	Y	Y	4
24	James 2018 ⁵⁸	N	Y	N	Y	Y	3
25	Nivetha 2018 ⁵⁹	Y	Y	Y	Y	Y	5
26	Rebello 2018 ⁶⁰	N	Y	Y	Y	Y	4
27	Taneja 2018 ⁶¹	Y	Y	Y	Y	Y	5
28	Aggarwal 2017 ⁶²	N	Y	Y	Y	Y	4
29	Chellaiyan 2017 ⁶³	Y	Y	Y	Y	Y	5
30	Chenganakkattil 2017 ⁸	Y	N	N	Y	Y	3
31	Hakim 2017 ⁶⁴	Y	Y	Y	Y	Y	5
32	Kumar 2017 ⁶⁵	Y	Y	Y	Y	Y	5
33	Samanta 2017 ⁶⁶	Y	Y	N	Y	Y	4
34	Chaudhary 2016 ⁶⁷	Y	Y	Y	Y	Y	5
35	George 2016 ⁶⁸	Y	Y	Y	Y	Y	5
36	Kumar 2016 ⁶⁹	Y	Y	N	Y	Y	4
37	Rawat 2016 ⁷⁰	Y	Y	Y	Y	Y	5
38	Singh 2016 ⁷¹	Y	Y	N	Y	Y	4
39	Yadav 2016 ⁷²	Y	Y	Y	Y	Y	5
40	Naveen 2015 ⁷³	Y	Y	Y	Y	Y	5
41	Suman 2015 ⁷⁴	Y	Y	Y	Y	Y	5
42	Goyal 2012 ⁷⁵	Y	Y	Y	Y	Y	5
43	Jain 2012 ⁷⁶	N	N	Y	N	Y	2

Modified version of New Castle Ottawa Quality Assessment Scale adapted for cross sectional study³¹ was used to assess quality of the studies. This scale is based on the following criteria: Q1: Representativeness of sample (The inclusion of all subject or use of random sampling); Q2: Appropriate Sample size; Q3: Non-Response rate equal to or greater than 80%; Q4: Valid screening tools to evaluate depressive, stress, anxiety, suicide ideation symptoms and cutoff value; and Q5: Appropriate statistical analysis (appropriate and clearly described statistical test)

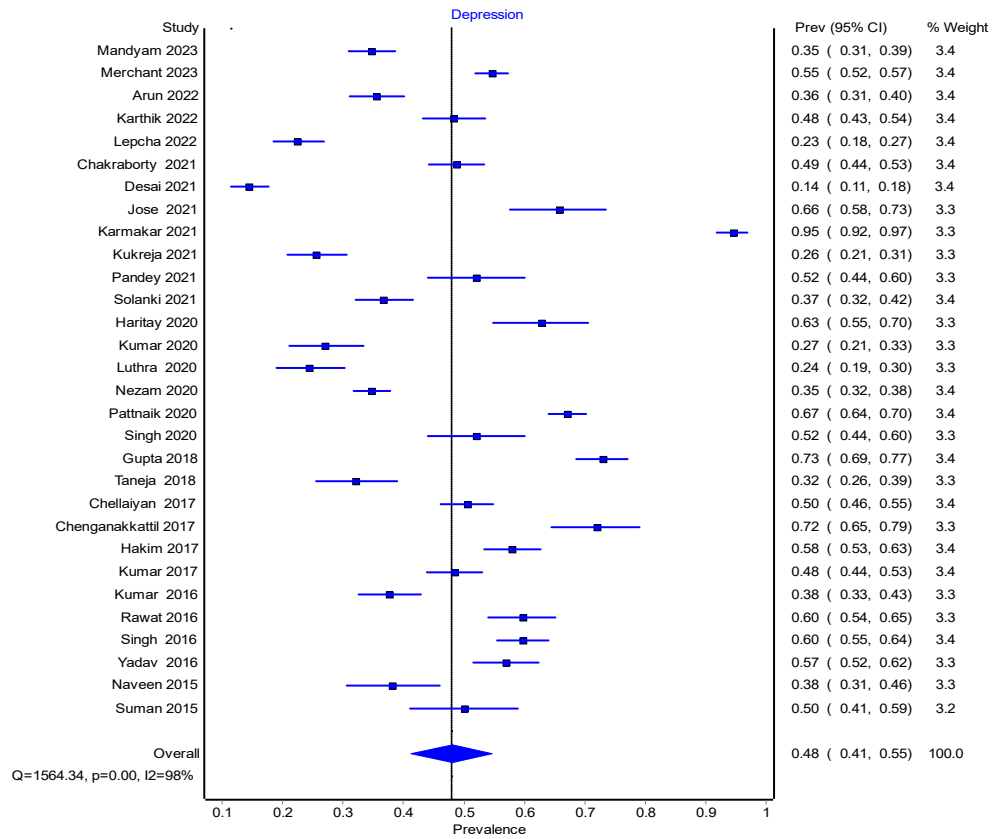


Figure 2: Forest plot of prevalence of Depression among undergraduate Indian medical students

CI Confidence Interval

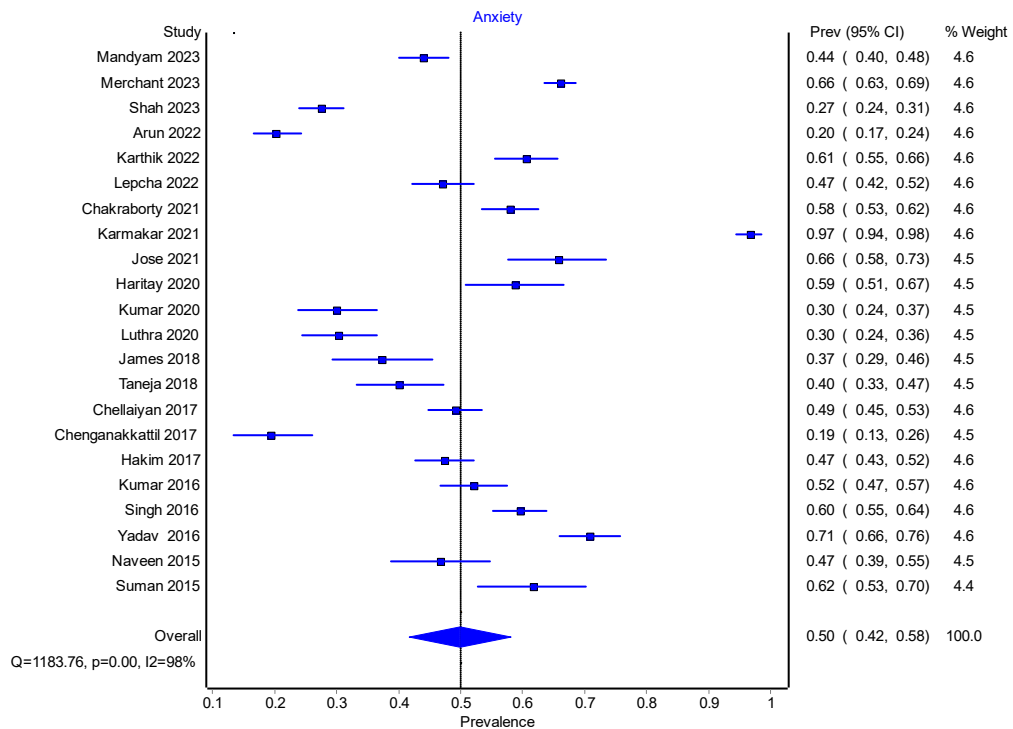


Figure 3: Forest plot for prevalence of Anxiety among undergraduate Indian medical students

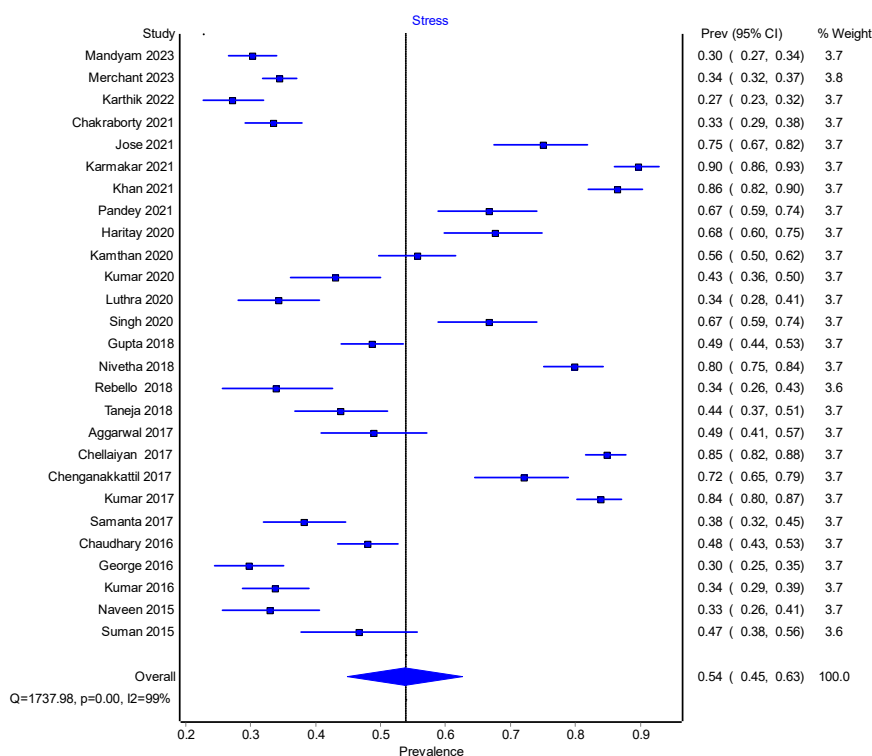


Figure 4: Forest plot for prevalence of Stress among undergraduate Indian medical students

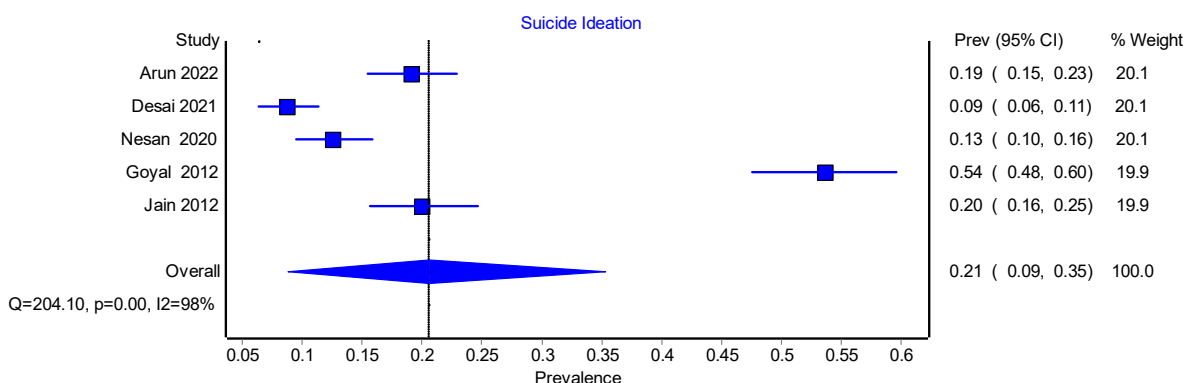


Figure 5. Forest plot for prevalence of Suicide Ideation among undergraduate Indian medical students

The characteristics of included studies are shown in Table 1; 30 studies reported prevalence rates of depression, 22 reported prevalence rates of anxiety, 27 studies reported prevalence of stress, and 5 reported prevalence of suicide ideation.

Quality of Included studies: Table 2 shows the Quality score of included studies. Out of all included studies, 42 were of high quality with score ≥ 3 except one study [76] which had score equal to 2.

Prevalence of Depression: The review of 30 studies (n= 11737) found that the prevalence of depression among medical students in India ranged from 14% to 95%, with a combined prevalence of 48% (95% CI: 41-55%). The significant heterogeneity between studies was present ($I^2= 98\%$, $p=0.00$) (Figure 2)

Prevalence of Anxiety: According to the analysis of 22 studies (n=8011) which reported anxiety, the prevalence of anxiety among medical students in India was found to range from 19% to 97%, with an overall combined rate of 50% (95% CI 42-58%). There was significant heterogeneity ($I^2=98\%$, $p=0.00$). (Figure 3)

Prevalence of Stress: The pooled prevalence of stress among the 27 included studies (n=8412) was 54% (95% CI 45-63%), with individual studies reporting prevalence rates ranging from 27% to 90%. There was significant heterogeneity ($I^2=99\%$, $p=0.00$). (Figure 4)

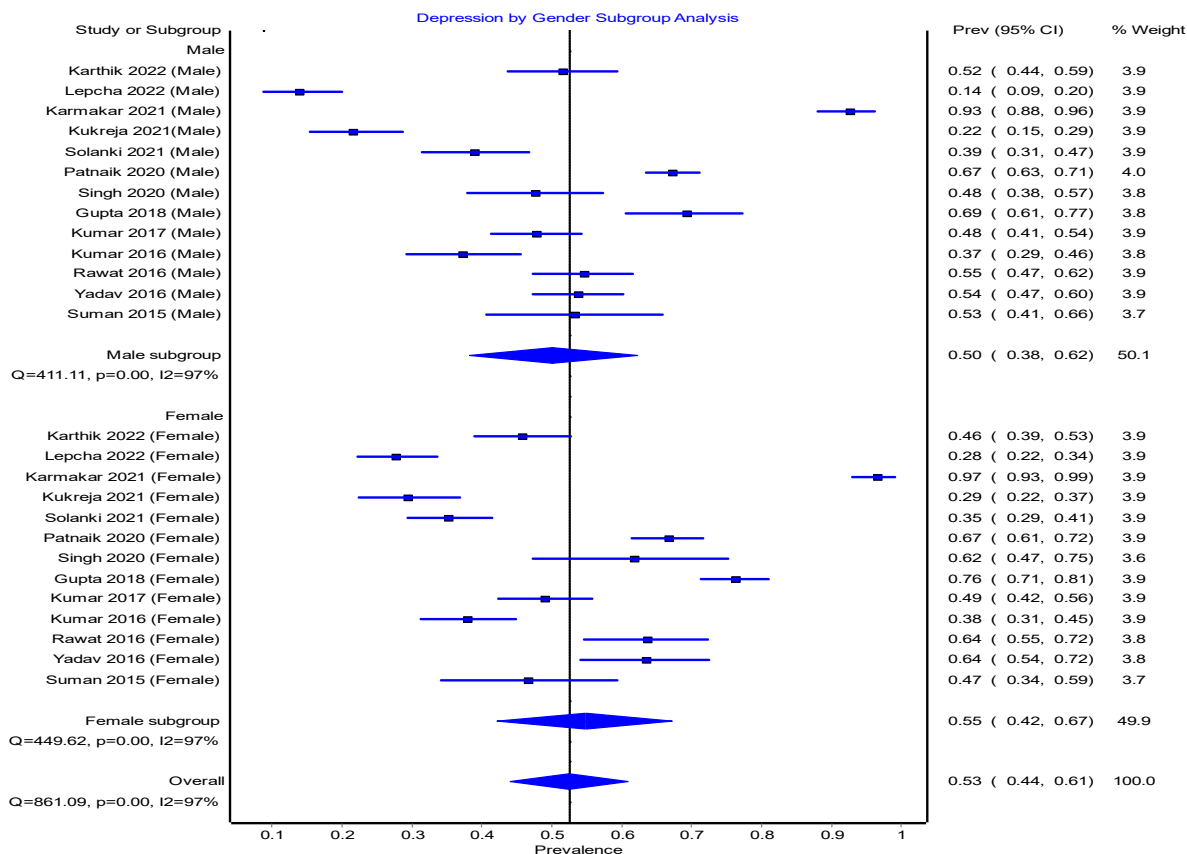


Figure 6: Subgroup analysis by Gender, Depression prevalence

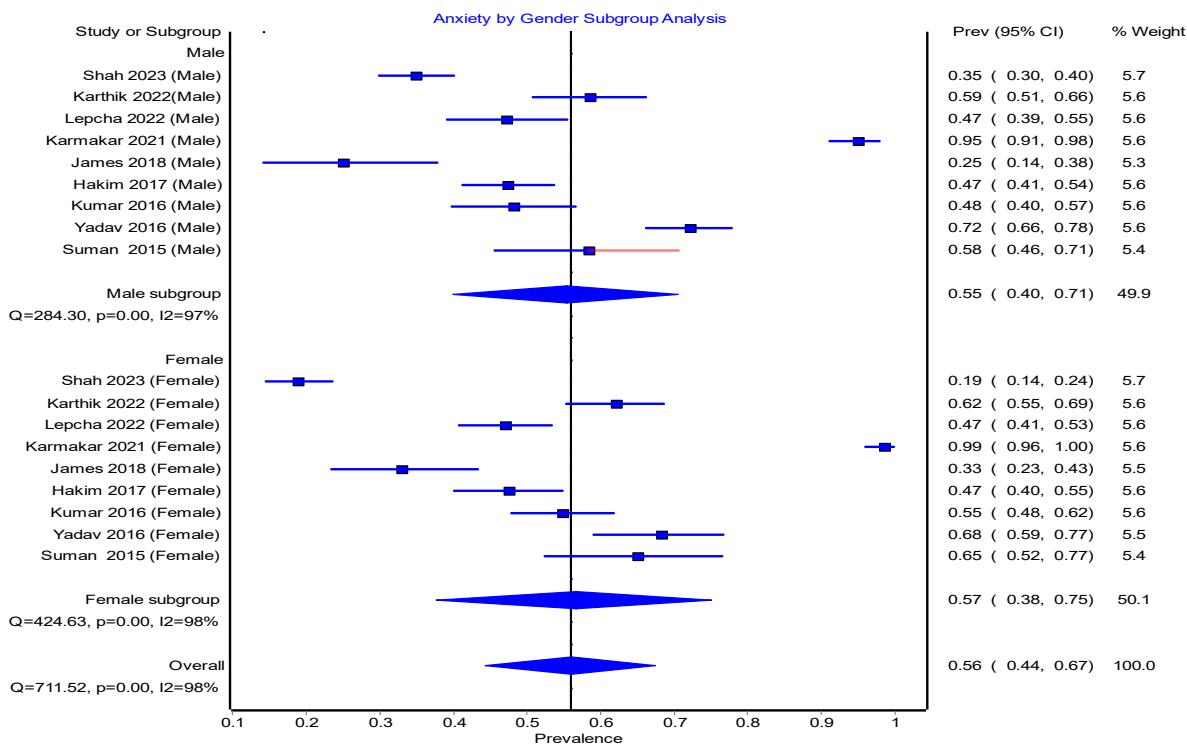


Figure 7: Subgroup analysis by Gender, Anxiety prevalence

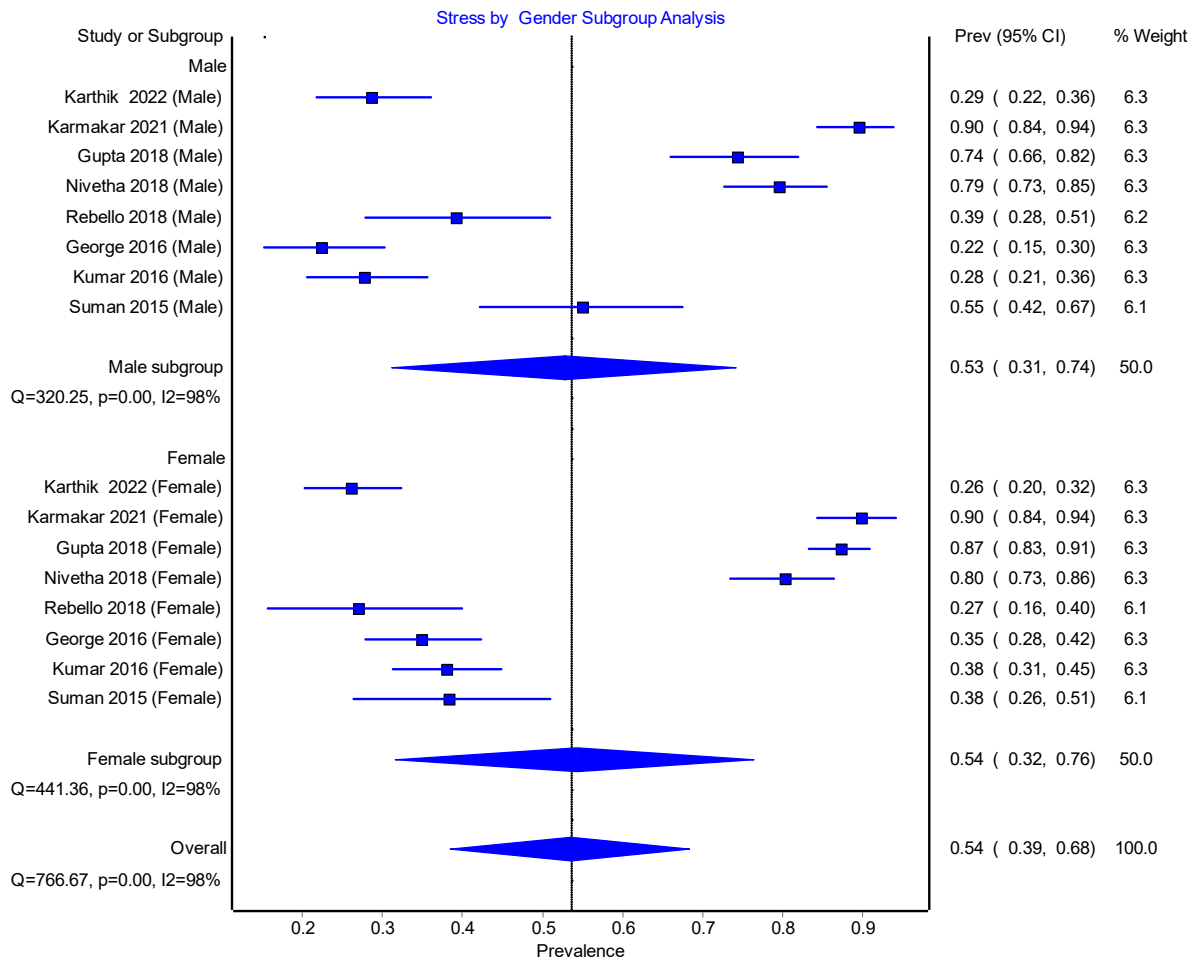


Figure 8: Subgroup analysis by Gender, Stress prevalence

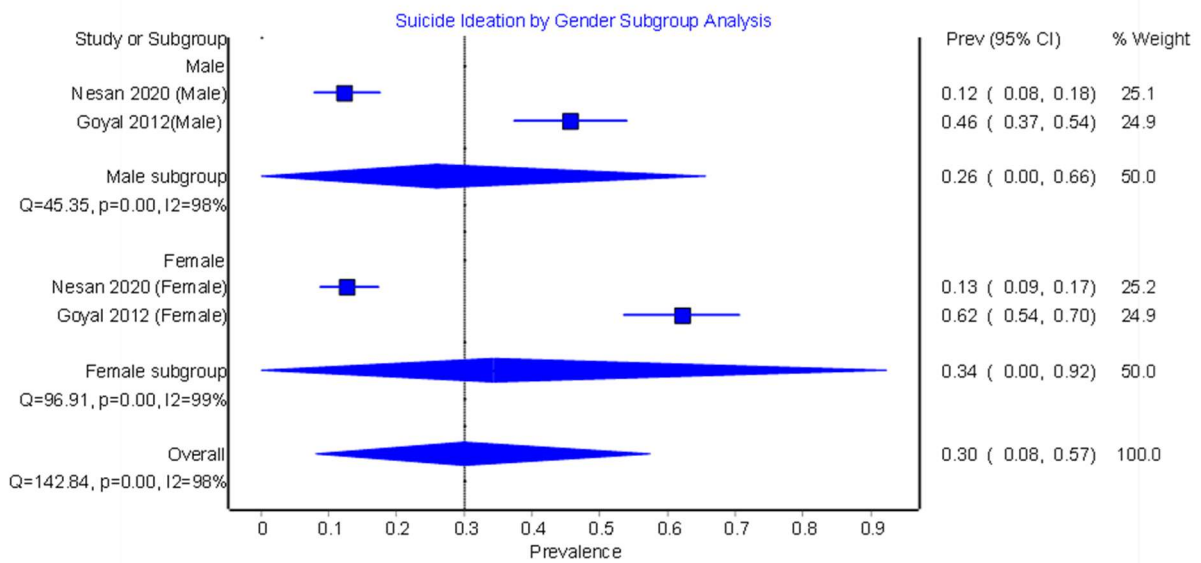


Figure 9: Subgroup analysis by Gender, Suicide prevalence

Prevalence of Suicide ideation: A total of 5 studies (n=1611) were identified which reported suicide ideation in medical students in India. The prevalence rate varied from 9% to 54%. The pooled prevalence of suicide ideation among medical students of 5 included studies was 21% (95% CI: 9-35%). There was significant heterogeneity ($I^2=98\%$, $p=0.00$). (Fig 5)

Publication Bias: Publication bias for depression, anxiety, stress and suicide ideation, the DOI plot shows no asymmetry confirming the absence of bias for depression (LFK=.22), for anxiety (LFK=.61) and suicide ideation (LFK=0.86) (Figure S3) respectively but shows minor asymmetry for stress (LFK=1.84). (Figure: S1-S4)

Sensitivity Analysis: Sensitivity analyses were conducted using the leave-one-out method. This involved sequentially removing one study at a time from the analysis and recalculating the pooled prevalence and I^2 of the remaining studies. This allowed for the identification of individual studies that significantly impacted the pooled prevalence or heterogeneity.

Depression: Seven studies [40,42,46,51,52,53,61] found to be the major determinants of the pooled prevalence of depression among undergraduate medical students and seven studies [39,41,47, 56,63,65,74] found to be the major source of heterogeneity. (Supplementary file: Table S2)

Anxiety: Sensitivity analysis showed that six studies [37,38,51,52,58,64] severely affected the pooled prevalence of anxiety among undergraduate medical students. Six studies [40,49,63,8,65,73] found to be the major source of heterogeneity. (Supplementary file: Table S3)

Stress: The sensitivity analysis revealed that nine studies [35,36,39,41,52,60,68,69,73] were the primary determinants of the pooled prevalence of stress among undergraduate medical students, and seven studies [50,51,57,61,62,67,74] substantially contributed to the observed heterogeneity. (Supplementary file: Table S4)

Suicide Ideation: Sensitivity analysis showed that one study [42] comparatively the prime determinant of the pooled prevalence of suicide ideation and two studies [38,76] found to be major source of heterogeneity among undergraduate medical students. (Supplementary file: Table S5)

Subgroup analysis by Gender

Subgroup analysis of the prevalence of depression, anxiety, stress and suicide ideation by gender is listed in Figure 6-9 respectively.

Depression: According to a synthesis of 13 studies that reported subgroup prevalence by gender, the pooled prevalence of depression was 50% (95% CI: 38-62%) for male medical students and 55% (95% CI: 42-67%) for female medical students. (Figure 6)

Anxiety: A total of 9 studies reported subgroup data by gender for the prevalence of Anxiety with pooled prevalence for male 55% (95% CI: 40-71%) and with pooled prevalence for female 57% (95% CI: 38-75%). (Figure 7)

Stress: The pooled prevalence of stress was 53% (95% CI: 31-74%) for male medical students and 54% (95% CI: 32-76%) for female medical students, as reported across 8 studies that provided subgroup data by gender. (Figure 8)

Suicide Ideation: Only two studies reported subgroup data by gender for the prevalence of suicide ideation with pooled prevalence for male 26% (95% CI: 0-66%) and with pooled prevalence for female 34% (95% CI: 0-92%). (Figure 9)

Subgroup analysis by Screening Tools

Subgroup analysis of the prevalence of depression, anxiety, stress and suicide ideation by screening tools is listed in Figure S5- S7 respectively. (Supplementary file)

Screening tools for assessment of depression: All included studies used validated screening tools. The most common instrument used to identify depression was Beck Depression Inventory (BDI) ≥ 10 and Depression Anxiety Stress Scale-21 (DASS-21) ≥ 10 based on 5 studies each and resulting in pooled prevalence of 46% and 35% respectively. Other commonly used criteria included Depression Anxiety Stress Scale-42 (DASS 42) ≥ 10 resulting in pooled prevalence of 61% based on 4 studies; Depression Anxiety Stress Scale-42 (DASS-42) ≥ 14 resulting in pooled prevalence of 49% based on 3 studies; Patient Health questionnaire-9 (PHQ-9) ≥ 5 resulting in pooled prevalence of 62% based on 3 studies and Hamilton Depression Rating Scale (HAM-D) ≥ 7 based on 3 studies resulting in pooled prevalence of 55%. The results did not indicate a significant decrease in heterogeneity for any of the subgroups except for screening tool Hamilton Depression Rating Scale (HAM-D) ≥ 7 . (Supplementary file: Figure S5)

Screening tools for assessment of anxiety: For anxiety symptom screening tools, all the studies used validated screening tools. 7 studies used the Depression Anxiety Stress Scale-42 (DASS-42) ≥ 8 resulting in pooled prevalence of 64%; Depression Anxiety Stress Scale-21 (DASS-21) ≥ 8 resulting in pooled prevalence of 43% based on 5 studies; General Anxiety Disorder-7 (GAD-7) ≥ 10 yielded a pooled prevalence of 34% based on 2 studies. The results did not indicate a significant decrease in heterogeneity for any of the subgroups (Supplementary file: Fig.S6)

Screening tools for assessment of Stress: All included studies used validated screening tools to evaluate stress. The most common instrument used to identify stress was Depression Anxiety Stress Scale-42 (DASS-42) ≥ 15 based on 6 studies each and resulting in pooled prevalence of 52%. Other commonly used criteria included Depression Anxiety Stress Scale-21 (DASS 21) ≥ 15 resulting in pooled

prevalence of 35% based on 5 studies; Perceived Stress Scale-10 (PSS-10) ≥ 14 resulting in pooled prevalence of 80% based on 3 studies; Perceived Stress Scale-10 (PSS-10) ≥ 20 resulting in pooled prevalence of 43% based on 2 studies; Perceived Stress Scale-14 (PSS-14) ≥ 28 resulting in pooled prevalence of 38% based on 2 studies; Students Stress Dimension Questionnaire (SSDQ) ≥ 1 Domain based on 2 studies resulting in pooled prevalence of 67%. No meaningful reduction in heterogeneity was observed across the examined subgroups except for screening tool Students Stress Dimension Questionnaire (SSDQ) ≥ 1 Domain. (Supplementary file: Figure S7)

Screening tools for assessment of suicide ideation: Each of five included studies used different screening tools to evaluate suicide ideation. Four studies [37,41,52,75] used validated screening tools while one study conducted by Jain et al [76] used unvalidated custom questionnaire to evaluate suicide ideation. Excluding the study by Jain et al. did not substantially impact the overall reported prevalence (20%, according to the leave-one-out analysis).

DISCUSSION

This systematic review and meta-analysis provide the comprehensive estimate of the prevalence of depression, anxiety, stress and suicide ideation among undergraduate medical students in India derived from pooling data from 43 observational studies with a total of 15,557 students.

Present review suggests that almost half (48%) of the undergraduate medical students in India were suffered from depression while individual studies reported prevalence varied from 14% to 95%. This meta-analysis also found that more females (55%) than males (50%) were affected from depression. These findings are similar to the findings of the systematic review conducted earlier in India that reported that half of the medical students in India were affected by depression and more females than males were affected.⁷⁷ This variation of the depression among males and females may reflect the trend in the general population which reported that depression is widely prevalent in women in all age groups especially in India.⁷⁸ All the studies included in present analysis to assess depression in undergraduate medical students used widely used validated tools. Most common tools used to assess depression were Beck Depression Scale (BDI); Depression Anxiety Stress Scale (DASS 21) and Depression Anxiety Stress Scale (DASS-42) with cutoff 10. Pooled prevalence of depression assessed by these tools was 46%, 35% and 61% respectively. The specific threshold selected to designate an individual as depressed can significantly impact the reported rates of depression. A common cutoff point utilized for both the Beck Depression Inventory and the Depression Anxiety Stress Scales is a score of 10 or higher. Raising the

cutoff value would likely lead to a lower reported prevalence of depressive symptoms. Overall, pooled prevalence found to be high among undergraduate medical students in India which is a cause of concern. Several reasons may account for this result. Given the direct impact of the medical profession on human life, the educational requirements for aspiring medical professionals are particularly rigorous and demanding in comparison to other academic disciplines.

In present meta-analysis, half (50%) of the medical students were found to be affected by anxiety while individual studies reported prevalence varied from 19% to 97%. Previous review reported a pooled prevalence of anxiety among medical students of 33.8% worldwide⁷⁹ and a systematic review included undergraduate medical students conducted in 2015 in India had reported the pooled prevalence for anxiety 34.5%.²⁸ Present meta-analysis suggests that incidence of anxiety has increased in recent years to a greater extent. Present review found that more females than males suffered from anxiety which is similar to the findings of another review which suggested that female medical students were more vulnerable to anxiety than male students.⁸⁰ Most common tool to evaluate anxiety was Depression Anxiety Stress Scale-42 (DASS-42) and Depression Anxiety Stress Scale-21 (DASS-21) with a cut off 8 resulting in pooled prevalence of 65% and 43% respectively. However, the difference in prevalence values of different screening tools may be due to substantial differences in sample size of subgroups. The results of our study indicate that anxiety disorders in medical students warrant serious consideration, prompt diagnosis, and supportive intervention by medical school faculty and administration.

Present meta-analysis reported more than half (54%) of the undergraduate medical students in India were affected by stress while individual studies reported prevalence varied from 27% to 90%. These findings are similar to the findings of existing review which reported that more than half of the medical students were affected from stress and more females than males found to be affected.²⁸ Similar results were reported from another systematic review that reported pooled prevalence of stress to be 49.9% among medical students in Brazil.⁸¹ Also, present review showed both the genders were almost equally affected by stress. The most common instrument used to identify stress was Depression Anxiety Stress Scale-42 (DASS-42) and Depression Anxiety Stress Scale-21 (DASS-21) with the cut off 15 resulting in pooled prevalence of 52% and 35% respectively.

Present review reported considerably higher prevalence of suicide ideation (21%) among medical students in India as compared to another systematic review that reported prevalence of suicide ideation amongst medical students 11% around the world and 13% in China.^{82,83} Higher prevalence of suicide ideation among undergraduate medical students in India is a serious cause of concern. Suicidal ideation

has been found to be closely associated with other mental health conditions, including depression and anxiety. The intense academic demands placed on medical students are believed to be a significant contributing factor to suicidal ideation among this population. Present analysis showed more females to be affected by suicide ideation than males. This result is similar to another meta-analysis which showed that more females than males had suicidal ideation.⁸⁴ The observed gender disparity in suicidal ideation may be attributed to societal expectations, wherein males are anticipated to be self-reliant and resolute, while females are expected to be dependent and indecisive, often expressing their distress through rumination. Suicidal ideation carries a high risk of transitioning into actual suicidal attempts and actions, potentially resulting in fatal and irreversible outcomes.⁸⁵ Therefore, providing increased access to mental health counselling and education on suicide prevention should be prioritized for medical students, in order to mitigate these adverse psychological outcomes.

In India, government has taken various steps in this direction time to time to help medical students by implementing various program. Student mentorship program has been introduced by National Medical Commission (NMC) in India to provide career-related information, General support, counselling on handling job stress and anxieties and sharing the successful experiences by mentors in managing mental health challenges. Moreover, recently national medical commission has formed a Task Force aimed at supporting students dealing with depression and suicidal tendencies. Though the implementation success of these programs across various institutes needs to be evaluated.

STRENGTHS

Our study exhibits no evidence of publication bias, as demonstrated by the funnel plots and Egger's regression analyses. Moreover, the outcomes were not notably affected by leave-one-out sensitivity analyses. All the studies included in the analysis to evaluate depression, anxiety and stress used validated screening tools except one study. Lastly, all the studies used appropriate statistical methods and most of the studies have a low risk of bias with high response rates. All the studies except one study showed high quality assessment score. This systematic review and meta-analysis could be an important warning and reminder regarding the current status of psychological morbidities among undergraduate medical students in India.

LIMITATIONS

The use of self-assessment instruments to screen for mental health issues in the included studies may have affected the precision of the results. The absence of further evaluation of the individuals identi-

fied as having positive mental health concerns could have influenced the reliability of the findings.

Potential associated factors to mental health problems were not studied which are important to know the most contributing factors to mental health problems in medical students.

CONCLUSION

Almost half of the medical undergraduate students in India were found to be suffered by depression, anxiety and stress and almost one fifth of the students found to be affected by suicide ideation. More females than males found to be affected by these mental problems. This high prevalence of psychological disorders in undergraduate medical students in India emphasize the need for the counselling services to be made available to the students in the medical college to control this morbidity. To target the source of the students' mental health issues, Institutes should implement long term policies and programs. Regular and Prompt mental health evaluations and support measures should be put in place to prevent these issues from escalating into more serious psychological conditions.

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