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Prevalence of Depression, Depressive Symptoms, and Suicidal Ideation Among Medical Students
A Systematic Review and Meta-Analysis

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IMPORTANCE Medical students are at high risk for depression and suicidal ideation. However, the prevalence estimates of these disorders vary between studies.

OBJECTIVE To estimate the prevalence of depression, depressive symptoms, and suicidal ideation in medical students.

DATA SOURCES AND STUDY SELECTION Systematic search of EMBASE, ERIC, MEDLINE, psycARTICLES, and psycINFO without language restriction for studies on the prevalence of depression, depressive symptoms, or suicidal ideation in medical students published before September 17, 2016. Studies that were published in the peer-reviewed literature and used validated assessment methods were included.

DATA EXTRACTION AND SYNTHESIS Information on study characteristics; prevalence of depression or depressive symptoms and suicidal ideation; and whether students who screened positive for depression sought treatment was extracted independently by 3 investigators. Estimates were pooled using random-effects meta-analysis. Differences by study-level characteristics were estimated using stratified meta-analysis and meta-regression.

MAIN OUTCOMES AND MEASURES Point or period prevalence of depression, depressive symptoms, or suicidal ideation as assessed by validated questionnaire or structured interview.

RESULTS Depression or depressive symptom prevalence data were extracted from 167 cross-sectional studies (n = 116 628) and 16 longitudinal studies (n = 5728) from 43 countries. All but 1 study used self-report instruments. The overall pooled crude prevalence of depression or depressive symptoms was 27.2% (37 933/122 356 individuals; 95% CI, 24.7% to 29.9%, I^2 = 98.9%). Summary prevalence estimates ranged across assessment modalities from 9.3% to 55.9%. Depressive symptom prevalence remained relatively constant over the period studied (baseline survey year range of 1982-2015; slope, 0.2% increase per year [95% CI, −0.2% to 0.7%]). In the 9 longitudinal studies that assessed depressive symptoms before and during medical school (n = 2432), the median absolute increase in symptoms was 13.5% (range, 0.6% to 35.3%). Prevalence estimates did not significantly differ between studies of only preclinical students and studies of only clinical students (23.7% [95% CI, 19.5% to 28.5%] vs 22.4% [95% CI, 17.6% to 28.2%]; P = .72). The percentage of medical students screening positive for depression who sought psychiatric treatment was 15.7% (110/954 individuals; 95% CI, 10.2% to 23.4%, I^2 = 70.1%). Suicidal ideation prevalence data were extracted from 24 cross-sectional studies (n = 21 002) from 15 countries. All but 1 study used self-report instruments. The overall pooled crude prevalence of suicidal ideation was 11.1% (2043/21 002 individuals; 95% CI, 9.0% to 13.7%, I^2 = 95.8%). Summary prevalence estimates ranged across assessment modalities from 7.4% to 24.2%.

CONCLUSIONS AND RELEVANCE In this systematic review, the summary estimate of the prevalence of depression or depressive symptoms among medical students was 27.2% and that of suicidal ideation was 11.1%. Further research is needed to identify strategies for preventing and treating these disorders in this population.

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Studies have suggested that medical students experience high rates of depression and suicidal ideation.[1] However, estimates of the prevalence of depression or depressive symptoms among students vary across studies from 1.4% to 73.5%,[2,3] and those of suicidal ideation vary from 4.9% to 35.6%.[4,5] Studies also report conflicting findings about whether student depression and suicidality vary by undergraduate year, sex, or other characteristics.[6-11]

Reliable estimates of depression and suicidal ideation prevalence during medical training are important for informing efforts to prevent, treat, and identify causes of emotional distress among medical students,[12] especially in light of recent work revealing a high prevalence of depression in resident physicians.[13] We conducted a systematic review and meta-analysis of published studies of depression, depressive symptoms, and suicidal ideation in undergraduate medical trainees.

Key Points

Question Are medical students at high risk for depression and suicidal ideation?

Findings In this meta-analysis, the overall prevalence of depression or depressive symptoms among medical students was 27.2%, and the overall prevalence of suicidal ideation was 11.1%. Among medical students who screened positive for depression, 15.7% sought psychiatric treatment.

Meaning The overall prevalence of depressive symptoms among medical students in this study was higher than that reported in the general population, which underscores the need for effective preventive efforts and increased access to care for medical students.

Methods

Search Strategy and Study Eligibility

Two authors (M.A.R. and D.A.M.) independently identified cross-sectional and longitudinal studies published prior to September 17, 2016, that reported on the prevalence of depression, depressive symptoms, or suicidal ideation in medical students by systematically searching EMBASE, ERIC, MEDLINE, psycARTICLES, and psycINFO. In addition, the authors screened the reference lists of identified articles and corresponded with study investigators using the approaches implied by the Preferred Reporting Items for Systematic Reviews and Meta-analyses and Meta-analysis of Observational Studies in Epidemiology reporting guidelines.[14,15]

For the database searches, terms related to medical students and study design were combined with those related to depression and suicide without language restriction (complete details of the search strategy appear in eMethods 1 in the Supplement). Included studies (1) reported data on medical students, (2) were published in peer-reviewed journals, and (3) used a validated method to assess for depression, depressive symptoms, or suicidal ideation.[16] A third author (L.S.R.) resolved discrepancies by discussion and adjudication.

Data Extraction and Quality Assessment

Three authors (L.S.R., M.T., and J.B.S.) independently extracted the following data from each article using a standardized form: study design; geographic location; years of survey; year in school; sample size; average age of participants; number and percentage of male participants; diagnostic or screening method used; outcome definition (ie, specific diagnostic criteria or screening instrument cutoff); and reported prevalence estimates of depression, depressive symptoms, or suicidal ideation. Whether students who screened positive for depression sought psychiatric or other mental health treatment also was extracted. When there were studies involving the same population of students, only the most comprehensive or recent publication was included.

The same 3 authors independently assessed the risk of bias of these nonrandomized studies using a modified version of the Newcastle-Ottawa scale, which assesses sample representativeness and size, comparability between respondents and nonrespondents, ascertainment of depressive or suicidal symptoms, and thoroughness of descriptive statistics reporting (complete details regarding scoring appear in eMethods 2 in the Supplement).[17] Studies were judged to be at low risk of bias (≥3 points) or high risk of bias (<3 points). A fourth author (D.A.M.) resolved discrepancies through discussion and adjudication.

Data Synthesis and Analysis

Prevalence estimates of depression or depressive symptoms and suicidal ideation were calculated by pooling the study-specific estimates using random-effects meta-analyses that accounted for between-study heterogeneity.[18] The same approach was used to estimate the summary percentage of students screening positive for depression who sought treatment. When studies reported point prevalence estimates made at different periods within the year, the overall period prevalence was used. Standard χ^2 tests and the I^2 statistic (ie, the percentage of variability in prevalence estimates due to heterogeneity rather than sampling error, or chance, with values ≥75% indicating considerable heterogeneity) were used to assess between-study heterogeneity.[19,20]

Sensitivity analyses were performed by serially excluding each study to determine the influence of individual studies on the overall prevalence estimates. Results from studies grouped according to prespecified study-level characteristics were compared using stratified meta-analysis (for diagnostic criteria or screening instrument cutoff, study design, undergraduate level, continent or region, country, and Newcastle-Ottawa Scale components) or random-effects meta-regression (for year of baseline survey, age, and sex).[21,22] To isolate associations within the medical school experience from associations with assessment tools, an analysis restricted to longitudinal studies reporting both pre- and intramedical school depressive symptom prevalence estimates was performed.

Bias secondary to small study effects was investigated using funnel plots and the Egger test.[23,24] All analyses were performed using R version 3.2.3 (R Foundation for Statistical Computing).[25] Statistical tests were 2-sided and used a significance threshold of $P < .05$.

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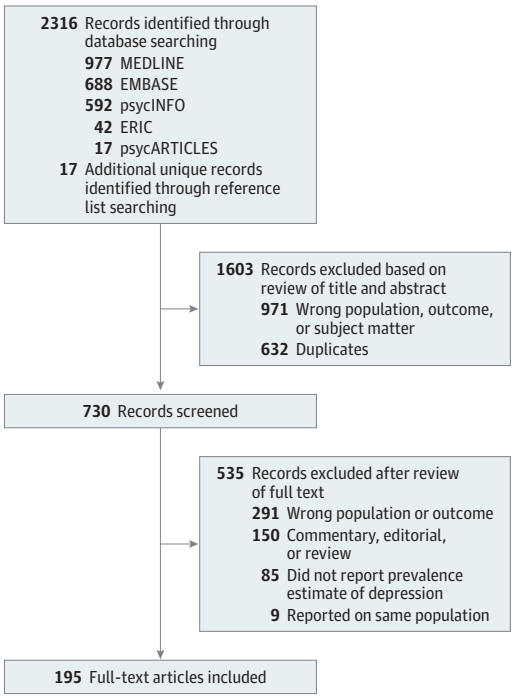
Figure 1. Study Identification and Selection



Results

Study Characteristics

One hundred ninety-five studies[2-11,26-210] involving a total of 129 123 individuals in 47 countries were included in the analysis (**Figure 1**). The median number of participants per study was 336 (range, 44-10 140). One hundred sixty-seven cross-sectional studies[2-4,6-9,11,26-184] (n = 116 628) and 16 longitudinal studies[10,196-210] (n = 5728) in 43 countries reported on depression or depressive symptom prevalence (**Table 1**). Twenty-four cross-sectional studies (n = 21 002) in 15 countries reported on the prevalence of suicidal ideation (**Table 2**).[4,5,34,62,65,73,74,79,112,160,165,167,174,185-195]

Medical student training level, continent or region, country, diagnostic criteria or screening instrument cutoff, and total Newcastle-Ottawa scores for the studies appear in eTable 1 in the Supplement. Newcastle-Ottawa score components for all 195 individual studies appear in eTable 2 in the Supplement.

Prevalence of Depression or Depressive Symptoms Among Medical Students

Meta-analytic pooling of the prevalence estimates of depression or depressive symptoms reported by 183 studies yielded a crude summary prevalence of 27.2% (37 933/122 356 individuals; 95% CI, 24.7%-29.9%), with significant evidence of between-study heterogeneity (Q = 16721.1, τ^2 = 0.78, I^2 = 98.9%, P < .001) (**Figures 2**, **3**, **4**, **5**, and **6**). The prevalence estimates reported by the individual studies ranged from 1.4% to 73.5%. Sensitivity analysis, in which the meta-analysis was serially repeated after exclusion of each study, demonstrated that no individual study affected the overall prevalence estimate by more than 0.3% (eTable 3 in the Supplement).

To further characterize the range of depression or depressive symptom prevalence estimates identified by these methodologically diverse studies, meta-analyses stratified by screening instrument and cutoff score were conducted (**Figure 7**). Summary prevalence estimates ranged from 9.3% (157/1234 individuals [95% CI, 5.3%-15.7%]; Q = 19.7, τ^2 = 0.24, I^2 = 84.8%) for the Hospital Anxiety and Depression Scale with a cutoff score of 11 or greater to 55.9% (540/1039 individuals [95% CI, 45.1%-66.2%]; Q = 32.9, τ^2 = 0.18, I^2 = 90.9%) for the Aga Khan University Anxiety and Depression Scale with a cutoff score of 19 or greater. The median summary prevalence was 32.4% (5042/19 160 individuals [95% CI, 25.8%-39.7%]; Q = 1665.3, τ^2 = 0.62, I^2 = 98.6%) for the Beck Depression Inventory (BDI) with a cutoff score of 10 or greater.

Among medical students who screened positive for depression, 15.7% (110/954 individuals [95% CI, 10.2%-23.4%]; Q = 20.1, τ^2 = 0.26, I^2 = 70.1%) reportedly sought psychiatric or other mental health treatment as assessed by a subset of 7 studies reporting this information (eFigure 1 in the Supplement).

Prevalence of Depression or Depressive Symptoms by Study-Level Characteristics

No statistically significant differences in prevalence estimates were noted between cross-sectional studies (36 632/116 628 [27.3%; 95% CI, 24.7%-30.1%]) and longitudinal studies (1301/5728 [26.7%; 95% CI, 19.1%-36.1%]) (test for subgroup differences, Q = 0.02, P = .90) or studies performed in the United States (14 356/36 249 [26.7%; 95% CI, 22.5%-31.3%]) compared with those performed outside the United States (23 577/86 107 [27.4%; 95% CI, 24.5%-30.6%]) (Q = 0.08, P = .78). Studies were further stratified by continent or region in **Figure 8**. Prevalence estimates from studies limited to preclinical students (4866/25 462 [23.7%; 95% CI, 19.5%-28.5%]) did not significantly differ from estimates from studies limited to clinical students (2917/13 172 [22.4%; 95% CI, 17.6%-28.2%]) (Q = 0.13, P = .72).

Prevalence estimates did not significantly vary with baseline survey year (survey year range, 1982-2015; slope = 0.2% 1-year increase [95% CI, −0.2% to 0.7%]; Q = 1.17, P = .28). There were no significant associations between prevalence and mean or median age (slope = 0.2% per 1-year increase [95% CI, −1.4% to 1.8%]; Q = 0.07, P = .79) or sex (slope = −1.1% per percentage increase in male study participants [95% CI, −15.9% to 13.7%]; Q = 0.02, P = .88).

When evaluated by Newcastle-Ottawa criteria, higher prevalence estimates were found among studies with more representative participant populations (24 366/68 693; 36.3% [95% CI, 29.9%-43.3%]) compared with those with less representative participant populations (13 567/53 663; 25.4% [95% CI, 22.8%-28.2%]) (Q = 9.6, P = .002; **Figure 9**). There were no statistically significant differences in prevalence estimates when studies were stratified by sample size, respondent and nonrespondent comparability, validity of ascertainment of depression or depressive symptoms (details regarding

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Table 1. Selected Characteristics of the 183 Studies of Depression or Depressive Symptoms[a]

Source	Country	Survey Years	Year of Training	No. of Students	Age, y	Men, No. (%)	Instrument and Cutoff Score
Bore et al,[52] 2016	Australia	2013	1-5	127	Mean (SD): 23 (5.6)	32 (25.6)	DASS-21 ≥10
De Sousa Lima et al,[67] 2010	Brazil	2001	1-4	80	Range: 18-30	45 (56.3)	BDI ≥10
de Melo Cavestro and Rocha,[65] 2006	Brazil	2003	1-6	213	Mean (SD): 23.1 (2.3)	109 (51.2)	MINI ≥ *DSM IV* criteria
Amaral et al,[39] 2008	Brazil	2006	1-6	287	Mean: 21.3	131 (45.7)	BDI ≥10
Costa et al,[61] 2012	Brazil	2008	5, 6	84	NR	NR	BDI ≥10
Serra et al,[147] 2015	Brazil	2012	1-6	657	Mean: 22.7	255 (38.8)	BDI ≥10
Castaldelli-Maia et al,[55] 2012	Brazil	2001-2006	1-6	465	NR	NR	BDI ≥15
Alexandrino-Silva et al,[34] 2009	Brazil	2006-2007	1-6	336	Mean (SD): 22.4 (2.5)	105 (31)	BDI ≥21
Paro et al,[130] 2010	Brazil	2006-2007	1-6	352	Mean (SD): 22.3 (2.4)	134 (38.4)	BDI >9
Bassols et al,[49] 2014	Brazil	2010-2011	1, 6	232	Mean (SD): 23.1 (3.2)	117 (50.4)	BDI ≥11
Del-Ben et al,[200] 2013	Brazil	NR	1	85	Mean (SD): 19.1 (1.6)	58 (68.2)	BDI ≥10
Leão et al,[66] 2011	Brazil	NR	6	111	Mean (SD): 24.6 (1.4)	87 (56)	BDI ≥12
Hirata et al,[87] 2007	Brazil	NR	1-2	161	Mean (SD): 22.1 (2.1)	77 (47.8)	BDI >10
Baldassin et al,[47] 2008	Brazil	NR	1-6	481	Mean (SD): 21.9 (2.4)	195 (40.5)	BDI ≥10
Matheson et al,[117] 2016	Canada	2013	1-4	232	NR	NR	K-10 ≥20
Helmers et al,[84] 1997	Canada	1994-1995	1-4	356	Mean (SD): 23.5 (2.6)	185 (52)	DSP >50
Berner et al,[51] 2014	Chile	2012	1-5	384	Mean (SD): 20.8 (1.8)	224 (58.3)	GHQ-12 ≥5
Tang,[163] 2005	China	2003	2	121	NR	0	Zung-SDS ≥50
Shen et al,[151] 2009	China	2006	1	313	Mean (SD): 23.8 (1.8)	NR	Zung-SDS ≥53
Wan et al,[4] 2012	China	2010	1-5	4063	Mean (SD): 20.5 (1.1)	1895 (46.6)	Zung-SDS ≥50
Sobowale et al,[160] 2014	China	2012	2-3	348	NR	NR	PHQ-9 ≥10
Shi et al,[154] 2015	China	2014	1-5	1738	Mean (SD): 21.4 (1.6)	586 (33.7)	CES-D ≥16
Shi et al,[153] 2016	China	2014	1-7	2925	Mean (SD): 21.7 (2)	1028 (35.2)	CES-D ≥16
Pan et al,[129] 2016	China	2013-2014	1-5	8819	Mean (SD): 20.7 (1.6)	3415 (37.9)	BDI ≥14
Liao et al,[110] 2010	China	NR	1	487	Mean (SD): 18.5 (0.8)	181 (37.4)	Zung-SDS ≥50
Sun et al,[162] 2011	China	NR	1-2	10140	Mean (SD): 19.6 (1.3)	4680 (46.2)	BDI ≥10
Yang et al,[6] 2014	China	NR	1-5	1137	Range: 17-24	624 (54.9)	SCL-90 >2
Pinzón-Amado et al,[137] 2013	Colombia	2006	1-6	973	Mean (SD): 20.3 (2.3)	414 (43)	CES-D ≥16
Amir and Gillany,[40] 2010	Egypt	2010	1-6	311	Mean (SD): 20.7 (2.4)	164 (52.7)	HADS-D ≥8
Ibrahim and Abdelreheem,[89] 2015	Egypt	2013	1	164	NR	82 (50)	BDI ≥17
Abdel Wahed and Hassan,[27] 2016	Egypt	2015	1-4	442	Mean (SD): 20.2 (1.9)	172 (38.9)	DASS-21 ≥10
Eller et al,[184] 2006	Estonia	2003	1-6	413	Mean (SD): 21.3 (2.5)	95 (23)	EST-Q ≥12
Vaysse et al,[171] 2014	France	2012-2013	2	197	Mean (SD): 19.7 (0.9)	79 (39.9)	HADS-D ≥8
Prinz et al,[2] 2012	Germany	2008	4, 5	73	NR	54 (74)	HADS-D ≥11
Voltmer et al,[172] 2012	Germany	2010-2011	1, 2, 5	153	Mean (SD): 25.6 (3.1)	44 (28.7)	HADS-D ≥11
Kötter et al,[107] 2014	Germany	2011-2012	1	350	Mean (SD): 20.9 (3.2)	118 (33.7)	HADS-D ≥8
Wege et al,[174] 2016	Germany	2012-2013	1	590	Mean (SD): 21.1 (3.9)	177 (29.9)	PHQ-9 >10
Jurkat et al,[100] 2011	Germany	NR	1, 4	651	NR	252 (38.7)	BDI ≥11
Kohls et al,[105] 2012	Germany	NR	NR	419	NR	122 (29.1)	ADS-K >17
Nasioudis et al,[126] 2015	Greece	2013	1-3	146	Mean (SD): 19.8 (1)	91 (62.3)	Zung-SDS >45
Chan,[57] 1992	Hong Kong	NR	1	95	Mean (range): 19.6 (18-29)	64 (67.4)	BDI ≥19
Chan,[56] 1991	Hong Kong	NR	1-4	335	Mean (SD): 20.1 (1.6)	239 (71.3)	BDI ≥10
Kumar et al,[26] 2012	India	2008	1-4	400	NR	217 (54.3)	BDI ≥10
Gupta and Basak,[82] 2013	India	2008	1-5	150	Range: 18-26	104 (69.3)	BDI ≥10
David and Hamid Hashmi,[64] 2013	India	2012	1	128	Mean (range): 17.9 (17-21)	46 (35.9)	BDI ≥17
Vankar et al,[170] 2014	India	2012	1-4	331	Mean (SD): 19.8 (1.4)	178 (53.8)	PHQ-9 ≥10
Iqbal et al,[95] 2015	India	2012	1-5	353	Mean (SD): 20.8 (1.5)	145 (41.1)	DASS-42 ≥10

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Table 1. Selected Characteristics of the 183 Studies of Depression or Depressive Symptoms[a] (continued)

Source	Country	Survey Years	Year of Training	No. of Students	Age, y	Men, No. (%)	Instrument and Cutoff Score
Ali and Vankar,[37] 1994	India	NR	1-3	215	Mean (range): 19.6 (17-25)	132 (61.4)	Zung-SDS ≥50
Supe,[3] 1998	India	NR	1-3	238	NR	128 (53.8)	Zung-SDS ≥40
Sidana et al,[156] 2012	India	NR	1-5	237	NR	126 (53.2)	PHQ-9 ≥10
Bayati et al,[9] 2009	Iran	2008	NR	172	NR	NR	GHQ-28 ≥23
Akbari et al,[31] 2014	Iran	2011	NR	138	NR	NR	GHQ-28 >6
Farahangiz et al,[76] 2016	Iran	2014	1-4	208	Mean (SD): 20.7 (1.1)	82 (39.4)	GHQ-28 ≥23
Vahdat Shariatpanaahi et al,[150] 2007	Iran	2004-2005	NR	192	Mean (SD): 24.5 (1.6)	0	BDI ≥10
Aghakhani et al,[29] 2011	Iran	NR	NR	628	Mean (SD): 22 (0.3)	334 (53.2)	BDI ≥10
Ashor,[43] 2012	Iraq	2010-2011	1-6	269	NR	147 (54.6)	Zung-SDS ≥50
Lupo and Strous,[111] 2011	Israel	NR	1-6	119	Mean (SD): 25.1 (2.8)	NR	BDI-II ≥10
Peleg-Sagy and Shahar,[131] 2012	Israel	NR	1-7	60	Mean (SD): 27 (2.9)	0	CES-D ≥16
Peleg-Sagy and Shahar,[205] 2013	Israel	NR	1, 4, 7	192	Mean (SD): 26.6 (2.6)	0	CES-D ≥16
Yoon et al,[179] 2014	Korea	NR	2, 3, 5	174	Mean (SD): 23.3 (2.8)	96 (55.2)	PHQ-9 ≥10
Naja et al,[125] 2016	Lebanon	2014	2-5	340	NR	145 (42.6)	PHQ-9 ≥10
Mehanna and Richa,[119] 2006	Lebanon	2003-2004	1-6	356	NR	NR	BDI ≥8
Bunevicius et al,[53] 2008	Lithuania	2005	NR	338	Mean (SD): 21 (1)	73 (21.6)	HADS-D ≥8
Mancevska et al,[114] 2008	Macedonia	2007-2008	1-2	354	NR	120 (33.9)	BDI ≥17
Sherina et al,[152] 2004	Malaysia	2002	1-5	396	Mean (range): 21.6 (18-29)	152 (38.4)	GHQ-12 ≥4
Tan et al,[167] 2015	Malaysia	2013	1-5	537	NR	188 (35)	PHQ-9 ≥10
Yusoff et al,[46] 2011	Malaysia	2008	5	92	NR	25 (27.2)	BDI ≥9
Yusoff,[181] 2013	Malaysia	2009-2010	1	194	NR	66 (34)	DASS-21 ≥14
Yusoff et al,[210] 2013	Malaysia	2010-2011	1	170	NR	57 (32.8)	DASS-21 ≥10
Saravanan and Wilks,[145] 2014	Malaysia	NR	1-5	358	NR	177 (49.4)	DASS-21 ≥10
Manaf et al,[113] 2016	Malaysia	NR	2-5	206	Mean (SD): 19.5 (2.6)	0	PHQ-9 ≥5
Guerrero López et al,[7] 2013	Mexico	2007	1	455	Mean (SD): 18.3 (1.2)	139 (30.5)	CES-D ≥16
Romo-Nava et al,[142] 2016	Mexico	2011	1-5	1068	NR	421 (39.4)	PHQ-9 ≥10
Melo-Carrillo et al,[120] 2012	Mexico	2006-2007	1-4	302	NR	NR	BDI ≥10
Nava et al,[127] 2013	Mexico	2010-2011	1, 5	1871	NR	707 (37.9)	PHQ-9 ≥10
El-Gilany et al,[75] 2008	Multiple	2007	1-6	588	Mean: 20.8	588 (100)	HADS-D ≥12
Seweryn et al,[148] 2015	Multiple	2015	1-6	1262	Median: 22	345 (27.3)	BDI ≥10
Sreeramareddy et al,[161] 2007	Nepal	2005-2006	NR	407	Mean (SD): 20.7 (1.8)	227 (55.8)	GHQ-12 ≥4
Basnet et al,[48] 2012	Nepal	2008-2009	1, 3	94	Mean (SD): 21.2 (1.7)	57 (60.6)	Zung-SDS ≥50
Borst et al,[197] 2015	Netherlands	2010-2011	1-6	951	Mean (SD): 23 (2.6)	279 (29)	BSI-DEP >0.41
Carter et al,[54] 2014	New Zealand	2010	4-6	198	Mean (SD): 23.5 (2.1)	75 (38.1)	DASS-21 ≥14
Samaranayake and Fernando,[144] 2011	New Zealand	2008-2009	3	255	Median (range): 20 (18-36)	123 (48.2)	PHQ-9 ≥10
Oku et al,[128] 2015	Nigeria	2010	1, 2, 4, 5	451	Mean (SD): 23.4 (4.4)	288 (63.8)	GHQ-12 ≥4
Aniebue and Onyema,[42] 2008	Nigeria	2008-2009	NR	262	Mean (SD): 23.7 (2.7)	133 (50.8)	Zung-SDS ≥50
Rab et al,[138] 2008	Pakistan	2002	1-5	87	Mean (SD): 20.7 (1.9)	0	HADS-D ≥8
Jadoon et al,[97] 2010	Pakistan	2008	1-5	482	Mean (SD): 20.7 (1.8)	257 (53.3)	AKUADS ≥19
Marwat,[116] 2013	Pakistan	2011	3	166	NR	73 (28.7)	Zung-SDS ≥50
Imran et al,[92] 2016	Pakistan	2013	NR	527	Mean (SD): 20.2 (2.3)	282 (53.5)	GHQ-12 >15
Khan et al,[103] 2015	Pakistan	2014	3	110	Mean: 21	55 (50)	HADS-D ≥8
Ali et al,[36] 2015	Pakistan	2014	1-2	182	NR	114 (62.6)	AKUADS >19
Rizvi et al,[140] 2015	Pakistan	2014	1-5	66	Mean (SD): 22.2 (1.3)	28 (40)	DASS-42 ≥10
Alvi et al,[38] 2010	Pakistan	2007-2008	2-5	279	Mean (SD): 21.4 (1.4)	77 (27.6)	BDI-II ≥14
Waqas et al,[173] 2015	Pakistan	2014-2015	1-5	409	Mean (SD): 19.9 (1.3)	123 (30)	HADS-D ≥8
Inam et al,[93] 2003	Pakistan	NR	1-4	189	NR	60 (31.7)	AKUADS ≥19

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Table 1. Selected Characteristics of the 183 Studies of Depression or Depressive Symptoms[a] (continued)

Source	Country	Survey Years	Year of Training	No. of Students	Age, y	Men, No. (%)	Instrument and Cutoff Score
Khan et al,[11] 2006	Pakistan	NR	1-5	142	Mean (SD): 21.3 (1.9)	59 (41.5)	AKUADS ≥19
Perveen et al,[133] 2016	Pakistan	NR	1,5	1000	NR	431 (43.1)	QIDS ≥9
Mojs et al,[122] 2015	Pakistan	NR	NR	477	NR	NR	KADS ≥6
Phillips et al,[134] 2006	Panama	2005	1-6	122	NR	63 (51.6)	Zung-SDS ≥50
Pereyra-Elías et al,[132] 2010	Peru	2010	1-4	590	Mean (SD): 19 (2.5)	184 (28.9)	Zung SF ≥22
Valle et al,[169] 2013	Peru	2010	1-6	615	Mean (SD): 22 (4.5)	357 (58)	Zung-SDS ≥50
Walkiewicz et al,[209] 2012	Poland	1999-2005	2	178	NR	NR (69)	MMPI-D >70
Adamiak et al,[28] 2004	Poland	NR	2, 4	263	Mean: 22.3	NR	BDI ≥12
Inam,[94] 2007	Saudi Arabia	2002	1-3	226	NR	149 (65.9)	AKUADS ≥19
Aziz et al,[45] 2011	Saudi Arabia	2010	1-5	295	Mean (SD): 21.6 (1.7)	0	BDI-II ≥20
AlFaris et al,[35] 2014	Saudi Arabia	2011	1-2	543	NR	340 (62.6)	BDI-II ≥14
Ibrahim et al,[91] 2013	Saudi Arabia	2012	2-6	558	Mean (SD): 21.7 (1.8)	300 (50.3)	HADS-D ≥11
Ibrahim et al,[90] 2013	Saudi Arabia	2010-2011	2-6	450	Mean (SD): 21.1 (1.4)	0	HADS-D ≥11
Kulsoom and Afsar,[108] 2015	Saudi Arabia	2012-2013	1-5	442	NR	274 (62)	DASS-21 ≥14
Al-Faris et al,[8] 2012	Saudi Arabia	NR	1-5	797	Mean (SD): 21.6 (1.6)	590 (74)	BDI ≥10
Saeed et al,[143] 2016	Saudi Arabia	NR	NR	80	Mean (SD): 25.9 (1.5)	55 (68.8)	K-10 ≥20
Ristić-Ignjatović et al,[139] 2013	Serbia	2002-2012	4	615	Mean (SD): 23.6 (1.5)	239 (36.8)	BDI ≥10
Miletic et al,[121] 2015	Serbia	2012-2013	1, 3, 6	1294	Mean (SD): 21.9 (2.8)	500 (38.6)	PHQ-9 ≥10
Pillay et al,[136] 2016	South Africa	NR	1-5	230	Mean: 21	66 (28.7)	Zung-SDS >30
Jeong et al,[99] 2010	South Korea	2008	1-2	89	NR	0	CES-D ≥16
Kim and Roh,[104] 2014	South Korea	2011	1-2	122	NR	92 (75.4)	BDI ≥10
Choi et al,[60] 2015	South Korea	2013	1-4	534	NR	308 (57.7)	BDI-II ≥17
Roh et al,[141] 2009	South Korea	2006-2007	1-4	7357	NR	NR	BDI ≥16
Dahlin et al,[63] 2011	Sweden	2006	NR	408	Median (range): 24 (22-27)	157 (36.5)	MDI >27
Dahlin et al,[62] 2005	Sweden	2001-2002	1, 3, 6	309	Mean (range): 26.1 (18-44)	126 (39.8)	*DSM-IV* criteria A and C
Kongsomboon,[106] 2010	Thailand	2008	1-6	593	Mean (range): 20.7 (15-27)	243 (41)	HRSRS ≥25
Angkurawaranon et al,[41] 2016	Thailand	2013	2-6	1014	Mean (SD): 20.8 (1.5)	476 (46.9)	PHQ-9 ≥9
N Wongpakaran and T Wongpakaran,[177] 2010	Thailand	NR	1-5	368	Mean (SD): 20.8 (1)	155 (42)	TDI >35
Youssef,[180] 2016	Trinidad and Tobago	NR	1-3	381	Mean (SD): 22.4 (3)	126 (0.3)	PHQ-9 ≥10
Güleç et al,[81] 2005	Turkey	1993	1-6	668	Mean (SD): 21.1 (2)	658 (96.2)	BDI ≥17
Akvardar et al,[32] 2003	Turkey	2002	1, 6	447	Mean (SD): 21 (1.2)	272 (39.1)	HADS-D ≥7
Marakoğlu et al,[115] 2006	Turkey	2006	1-2	331	Mean (SD): 19.5 (1.4)	186 (56.2)	BDI ≥10
Mayda et al,[118] 2010	Turkey	2009	1-5	202	Mean (SD): 20.5 (2.2)	85 (40.1)	BDI ≥17
Yilmaz et al,[178] 2014	Turkey	2010	1-6	995	Mean (SD): 21.1 (1.9)	517 (52)	BDI ≥10
Aktekin et al,[196] 2001	Turkey	1996-2002	1-2	119	NR	NR	GHQ-12 ≥4
Karaoğlu and Şeker,[101] 2011	Turkey	2008-2009	1-3	485	Mean (SD): 19.5 (1.5)	272 (56.1)	HADS-D ≥8
Baykan et al,[50] 2012	Turkey	NR	6	193	Mean (SD): 24.5 (1.5)	107 (55.4)	DASS-42 ≥10
Akvardar et al,[33] 2004	Turkey	NR	1, 6	166	NR	NR	HADS-D ≥7
Kaya et al,[102] 2007	Turkey	NR	NR	352	NR	226 (64.2)	BDI ≥17
Ahmed et al,[30] 2009	UAE	2008	1-5	165	NR	0	BDI ≥10
James et al,[98] 2013	UK	2007	1	324	NR	194 (60)	GHQ-12 ≥4
Honney et al,[88] 2010	UK	2008	NR	553	Mean (SD): 21.6 (3)	220 (39.8)	PHQ-9 ≥10
Ashton and Kamali,[44] 1995	UK	1993-1994	2	186	Mean (SD): 20.4 (1.8)	77 (40.7)	HADS-D ≥8
Newbury-Birch et al,[204] 2001	UK	1995, 1998	5	114	NR	38 (33.3)	HADS-D ≥8
Quince et al,[206] 2012	UK	2007-2010	1-6	2155	NR	122 (43.2)	HADS-D ≥8
Guthrie et al,[201] 1998	UK	NR	1	172	NR	88 (51.2)	GHQ-12 ≥4
Pickard et al,[135] 2000	UK	NR	2	136	NR	46 (33.8)	HADS-D ≥8

(continued)

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Table 1. Selected Characteristics of the 183 Studies of Depression or Depressive Symptoms[a] (continued)

Source	Country	Survey Years	Year of Training	No. of Students	Age, y	Men, No. (%)	Instrument and Cutoff Score
Herzog et al,[86] 1987	US	1985	1-2	200	Mean (range): 23.1 (19-31)	NR	BDI ≥10
Hendryx et al,[85] 1991	US	1988	1	110	Mean (SD): 24.1 (3.1)	70 (63.6)	BDI ≥10
Givens and Tjia,[78] 2002	US	1994	1-2	194	NR	83 (43)	BDI-SF ≥8
Thomas et al,[164] 2007	US	2004	1-4	535	NR	248 (45.4)	PRIME-MD
Dyrbye et al,[72] 2006	US	2004	NR	545	NR	245 (45)	PRIME-MD
Shah et al,[149] 2009	US	2005	1-4	2683	Mean (SD): 26 (3.2)	1076 (40)	CES-D ≥19
Dyrbye et al,[71] 2007	US	2006	1-4	1691	NR	777 (46)	PRIME-MD
Smith et al,[159] 2011	US	2008	1-5	480	Mean (range): 26.3 (18-51)	480 (100)	CES-D ≥16
Smith et al,[158] 2010	US	2008	1-5	844	Mean (SD): 25.7 (4.1)	844 (100)	CES-D ≥16
Shindel et al,[155] 2011	US	2008	1-5	1241	Mean (SD): 25.4 (3.4)	0	CES-D ≥16
Schwenk et al,[146] 2010	US	2009	1-4	504	NR	210 (41.6)	PHQ-9 ≥10
Wimsatt et al,[175] 2015	US	2009	1-4	505	NR	210 (41.6)	PHQ-9 ≥10
Dyrbye et al,[69] 2010	US	2009	1-4	2661	NR	1352 (51.4)	PRIME-MD
Chang et al,[59] 2012	US	2010	1-3	364	NR	160 (44)	PRIME-MD
Jackson et al,[96] 2016	US	2012	1-4	4354	Median (range): 25 (22-32)	1957 (45.3)	PRIME-MD
Dyrbye et al,[68] 2015	US	2012	2-4	870	NR	442 (50.9)	PRIME-MD
Thompson et al,[166] 2016	US	2013	1-4	153	NR	75 (46.6)	PHQ-9 ≥10
Gold et al,[80] 2015	US	2013	1-5	183	NR	79 (43.2)	PRIME-MD
Lapinski et al,[109] 2016	US	2014	1-4	1294	NR	681 (52.6)	PHQ-9 ≥5
Zoccolillo et al,[183] 1986	US	1982-1984	1-2	304	NR	NR	BDI ≥10
Vitaliano et al,[208] 1988	US	1984-1985	1	312	Mean (SD): 25.6 (3.5)	196 (63)	BDI ≥5
Rosal et al,[207] 1997	US	1987-1993	2	171	NR	140 (51)	CES-D ≥80th percentile
Camp et al,[198] 1994	US	1991-1993	1	232	NR	153 (65.9)	Zung-SDS ≥50
Mosley et al,[123] 1994	US	1992-1993	3	69	Mean (range): 26 (24-37)	47 (68)	CES-D ≥16
Levine et al,[202] 2006	US	2000-2003	2	330	NR	NR	BDI ≥8
Tjia et al,[168] 2005	US	2001-2002	1-4	322	Mean (SD): 25.3 (2.6)	175 (54.4)	BDI-SF ≥8
Thompson et al,[165] 2010	US	2002-2003	3	44	NR	NR	CES-D ≥16
Goebert et al,[79] 2009	US	2003-2004	1-4	1184	NR	NR	CES-D ≥16
Dyrbye et al,[70] 2011	US	2006, 2007, 2009	4	1428	NR	NR	PRIME-MD
Haglund et al,[10] 2009	US	2006-2007	3	101	Mean (SD): 25.4 (2.2)	47 (47)	BDI-II ≥14
Dyrbye et al,[73] 2008	US	2006-2007	1-4	2228	NR	1159 (51.6)	PRIME-MD
Ghodasara et al,[77] 2011	US	2008-2009	1-3	301	NR	154 (51)	BDI-II ≥14
Hardeman et al,[83] 2015	US	2010-2011	1	3149	NR	1592 (49.4)	PROMIS-T >60
Ludwig et al,[203] 2015	US	2010-2014	3	336	NR	NR	CES-D >16
Dyrbye et al,[74] 2014	US	2011-2012	1-4	4402	Median: 25	1972 (45.1)	PRIME-MD
Wolf and Rosenstock,[176] 2016	US	2012-2013	1-4	130	NR	NR	PRIME-MD
Mousa et al,[124] 2016	US	2013-2014	1-4	336	NR	NR	PRIME-MD
Clark and Zeldow,[199] 1988	US	NR	2	110	Mean (SD): 23.6 (2.9)	80 (73)	BDI ≥8
MacLean et al,[112] 2016	US	NR	1-4	385	NR	NR	PRIME-MD
Chandavarkar et al,[58] 2007	US	NR	1-4	427	NR	145 (34)	BDI-II ≥21
Zeldow et al,[182] 1987	US	NR	NR	99	Mean: 25.4	67 (67.7)	BDI-II ≥14
Smith et al,[157] 2007	US	NR	NR	438	Mean (SD): 24.8 (2.8)	318 (72.6)	BDI ≥10

Abbreviations: ADS-K, General Depression Scale Short Form (in German); AKUADS, Aga Khan University Anxiety and Depression Scale; BDI, Beck Depression Inventory; BDI-SF, BDI Short Form; BSI-DEP, Brief Symptom Inventory Depression; CES-D, Center for Epidemiological Studies Depression Scale; DASS, Depression Anxiety Stress Scale; *DSM-IV*, *Diagnostic and Statistical Manual of Mental Disorders*, *Fourth Edition*; DSP, Derogatis Stress Profile; EST-Q, Emotional State Questionnaire; GHQ, General Health Questionnaire; HADS-D, Hospital Anxiety and Depression Scale; HRSRS, Health-Related Self-Reported Scale; K-10, Kessler Psychological Distress Scale; KADS, Kutcher Adolescent Depression Scale; MDI, Major Depression Inventory; MINI, Mini International Neuropsychiatric Interview; MMPI-D, Minnesota Multiphasic Personality Inventory-Depression Scale; NR, not reported; PHQ-9, 9-item Patient Health Questionnaire; PRIME-MD, Primary Care Evaluation of Mental Disorders; PROMIS-T, Patient-Reported Outcomes Measurement Information System; QIDS, Quick Inventory of Depressive Symptomatology; SCL-90, 90-item Symptom Checklist; TDI, Thai Depression Inventory; UAE, United Arab Emirates; UK, United Kingdom; US, United States; Zung-SDS, Zung Self-Rating Depression Scale; Zung-SF, Zung-SDS Short Form.

[a] Studies are ordered alphabetically by country and then by year of survey.

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Table 2. Selected Characteristics of the 24 Studies of Suicidal Ideation[a]

Source	Country	Survey Years	Year of Training	No. of Students	Age, y	Men, No. (%)	Instrument and Cutoff Score or Description[b]
de Melo Cavestro and Rocha,[65] 2006	Brazil	2003	1-6	213	Mean (SD): 23.1 (2.3)	109 (51.2)	MINI
Alexandrino-Silva et al,[34] 2009	Brazil	2006-2007	1-6	336	Mean (SD): 22.4 (2.5)	105 (31)	BSI >0
Chen et al,[188] 2004	China	2002	2-3	892	Mean (SD): 17.5 (0.4)	0	Suicidal ideation over past 12 mo
Wan et al,[4] 2012	China	2010	1-5	4063	Mean (SD): 20.5 (1.1)	1895 (46.6)	Suicidal ideation over past 12 mo
Sobowale et al,[160] 2014	China	2012	2-3	348	NR	NR	Suicidal ideation over past 2 wk (PHQ-9)
Ahmed et al,[185] 2016	Egypt	2016	NR	612	Mean (SD): 21.2 (1.6)	190 (31)	BSI >24
Okasha et al,[192] 1981	Egypt	1978-1979	5	516	NR	NR	Suicidal ideation over past 12 mo
Alem et al,[186] 2005	Ethiopia	2001	NR	273	NR	227 (83.2)	Suicidal ideation over past 1 mo
Wege et al,[174] 2016	Germany	2012-2013	1	590	Mean (SD): 21.1 (3.9)	177 (29.9)	Suicidal ideation over past 2 wk (PHQ-9)
Tin et al,[167] 2015	Malaysia	2013	1-5	517	NR	188 (35)	SBQ-R ≥7
Eskin et al,[189] 2011	Multiple	NR	1-6	646	Mean: 21.4	353 (54.6)	Suicidal ideation over past 12 mo
Menezes et al,[191] 2012	Nepal	2010	2-3	206	Mean (SD): 21 (1.7)	112 (54.4)	Suicidal ideation over past 12 mo (GHQ-28)
Tyssen et al,[194] 2001	Norway	1993-1994	6	522	Mean (SD): 28 (2.8)	224 (43)	Suicidal ideation over past 12 mo (Paykel Inventory)
Osama et al,[5] 2014	Pakistan	2013	1-5	331	Mean (SD): 20.7 (1.7)	135 (41.2)	Suicidal ideation over past 12 mo (GHQ-28)
Khokher and Khan,[190] 2005	Pakistan	NR	1-5	217	Mean: 22.6	96 (44.2)	Suicidal ideation over past 12 mo (GHQ-28)
Wallin and Runeson,[195] 2003	Sweden	1998	1, 5	305	Mean: 27.4	127 (41.6)	Suicidal ideation over past 12 mo
Dahlin et al,[62] 2005	Sweden	2001-2002	1, 3, 6	296	Mean (range): 26.1 (18-44)	126 (39.8)	Suicidal ideation over past 12 mo (Meehan Inventory)
Amiri et al,[187] 2013	United Arab Emirates	NR	1-6	115	Mean (SD): 20.7 (2.1)	47 (40.9)	Suicidal ideation over past 12 mo
Thompson et al,[165] 2010	US	2002-2003	3	43	NR	NR	Suicidal ideation over past 2 wk (PRIME-MD)
Goebert et al,[79] 2009	US	2003-2004	1-4	1215	NR	NR	Suicidal ideation over past 2 wk (PRIME-MD)
Dyrbye et al,[73] 2008	US	2006-2007	1-4	2230	NR	1159 (51.6)	Suicidal ideation over past 12 mo (Meehan Inventory)
Dyrbye et al,[74] 2014	US	2011-2012	1-4	4032	Median: 25	1972 (45.1)	Suicidal ideation over past 12 mo (Meehan Inventory)
MacLean et al,[112] 2016	US	NR	1-4	385	NR	NR	Suicidal ideation over past 12 mo (Meehan Inventory)
Tran et al,[193] 2015	Vietnam	2009	1, 3, 5	2099	Mean (range): 21.5 (18-30)	1052 (50.1)	Suicidal ideation over past 12 mo

Abbreviations: BSI, Beck Scale for Suicidal Ideation; GHQ, General Health Questionnaire; MINI, Mini International Neuropsychiatric Interview; NR, not reported; PHQ-9, 9-item Patient Health Questionnaire; PRIME-MD, Primary Care Evaluation of Mental Disorders; SBQ-R, Revised Suicidal Behaviors Questionnaire; US, United States.

[a] Studies are ordered alphabetically by country and then by year of survey.

[b] Studies for which a specific instrument is not specified used variably worded short form screening instruments.

determination of screening instrument validity appear in eMethods 2 in the Supplement), thoroughness of descriptive statistics reporting, or total Newcastle-Ottawa score ($P > .05$ for all comparisons).

Heterogeneity Within Depression Screening Instruments

To identify potential sources of heterogeneity independent of assessment modality, heterogeneity was examined within subgroups of studies using common instruments when at least 6 studies were available (complete results appear in eTable 4 in the Supplement). No significant differences between cross-sectional and longitudinal studies were observed within any instruments when at least 3 studies were in each comparator subgroup.

Heterogeneity was partially accounted for by country with US studies yielding lower depression or depressive symptom prevalence estimates than non-US studies among the 24 studies using the BDI and a cutoff score of 10 or greater (13.0% vs 37.5%, respectively; $Q = 12.7$, $P < .001$) and the 13 studies using the Center for Epidemiological Studies Depression Scale (CES-D) and a cutoff score of 16 or greater (34.4% vs 50.3%; $Q = 3.8$, $P = .05$). However, this difference was not seen among other instruments.

Level of training did not significantly contribute to between-study heterogeneity among any of the examined instruments. Year of baseline survey significantly contributed to observed statistical heterogeneity among 3 instruments,

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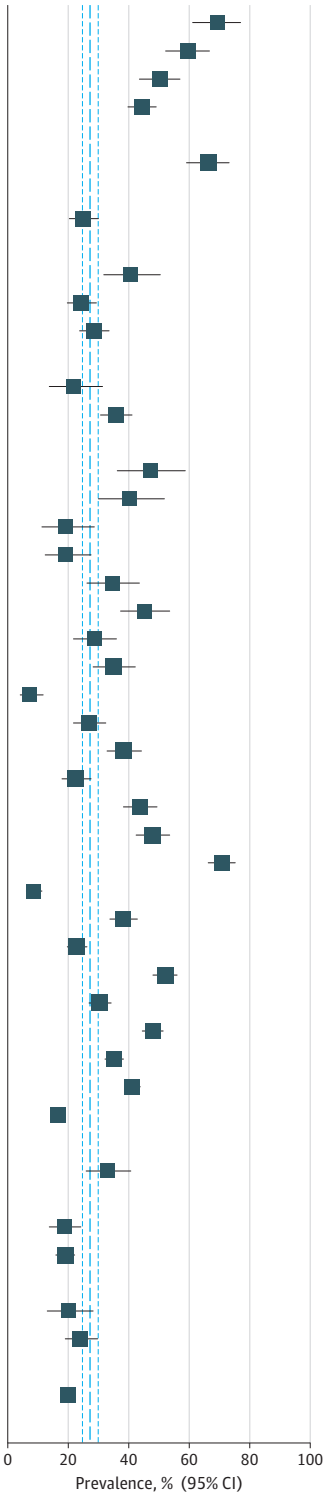
Figure 2. Meta-analysis by Scores on the Aga Khan University Anxiety and Depression Scale and the Beck Depression Inventory

Source	No. Depressed	Total No.	Prevalence, % (95% CI)	Weight, %
Aga Khan University Anxiety and Depression Scale Score ≥19				
Khan et al,[11] 2006	99	142	69.7 (61.5-77.1)	0.5
Inam et al,[93] 2003	113	189	59.8 (52.4-66.8)	0.6
Inam,[94] 2007	114	226	50.4 (43.7-57.1)	0.6
Jadoon et al,[97] 2010	214	482	44.4 (39.9-49.0)	0.6
Aga Khan University Anxiety and Depression Scale Score >19				
Ali et al,[36] 2015	121	182	66.5 (59.1-73.3)	0.6
Beck Depression Inventory Score ≥5				
Vitaliano et al,[208] 1988	78	312	25.0 (20.3-30.2)	0.6
Beck Depression Inventory Score ≥8				
Clark and Zeldow,[199] 1988	45	110	40.9 (31.6-50.7)	0.5
Levine et al,[202] 2006	80	330	24.2 (19.7-29.2)	0.6
Mehanna and Richa,[119] 2006	101	356	28.4 (23.7-33.4)	0.6
Beck Depression Inventory Score ≥9				
Yusoff et al,[46] 2011	20	92	21.7 (13.8-31.6)	0.5
Paro et al,[130] 2010	126	352	35.8 (30.8-41.0)	0.6
Beck Depression Inventory Score ≥10				
De Sousa Lima et al,[67] 2010	38	80	47.5 (36.2-59.0)	0.5
Costa et al,[61] 2012	34	84	40.5 (29.9-51.7)	0.5
Del-Ben et al,[200] 2013	16	85	18.8 (11.2-28.8)	0.5
Hendryx et al,[85] 1991	21	110	19.1 (12.2-27.7)	0.5
Kim and Roh,[104] 2014	42	122	34.4 (26.1-43.6)	0.5
Gupta and Basak,[82] 2013	68	150	45.3 (37.2-53.7)	0.5
Ahmed et al,[30] 2009	47	165	28.5 (21.7-36.0)	0.5
Vahdat Shariatpanaahi et al,[150] 2007	67	192	34.9 (28.2-42.1)	0.6
Herzog et al,[86] 1987	14	200	7.0 (3.9-11.5)	0.5
Amaral et al,[39] 2008	77	287	26.8 (21.8-32.4)	0.6
Melo-Carrillo et al,[120] 2012	116	302	38.4 (32.9-44.2)	0.6
Zoccolillo et al,[183] 1986	68	304	22.4 (17.8-27.5)	0.6
Marakoğlu et al,[115] 2006	145	331	43.8 (38.4-49.3)	0.6
Chan,[56] 1991	161	335	48.1 (42.6-53.6)	0.6
Kumar et al,[26] 2012	285	400	71.2 (66.5-75.6)	0.6
Smith et al,[157] 2007	37	438	8.4 (6.0-11.5)	0.5
Baldassin et al,[47] 2008	184	481	38.3 (33.9-42.8)	0.6
Ristić-Ignjatović et al,[139] 2013	140	615	22.8 (19.5-26.3)	0.6
Aghakhani et al,[29] 2011	328	628	52.2 (48.2-56.2)	0.6
Serra et al,[147] 2015	200	657	30.4 (26.9-34.1)	0.6
Al-Faris et al,[8] 2012	384	797	48.2 (44.7-51.7)	0.6
Yilmaz et al,[178] 2014	350	995	35.2 (32.2-38.2)	0.6
Seweryn et al,[148] 2015	521	1262	41.3 (38.6-44.1)	0.6
Sun et al,[162] 2011	1699	10 140	16.8 (16.0-17.5)	0.6
Beck Depression Inventory Score >10				
Hirata et al,[87] 2007	53	161	32.9 (25.7-40.8)	0.5
Beck Depression Inventory Score ≥11				
Bassols et al,[49] 2014	43	232	18.5 (13.8-24.1)	0.5
Jurkat et al,[100] 2011	123	651	18.9 (16.0-22.1)	0.6
Beck Depression Inventory Score ≥12				
Leão et al,[66] 2011	22	111	19.8 (12.9-28.5)	0.5
Adamiak et al,[28] 2004	63	263	24.0 (18.9-29.6)	0.6
Beck Depression Inventory Score ≥14				
Pan et al,[129] 2016	1751	8819	19.9 (19.0-20.7)	0.6



The vertical dashed lines indicate the pooled summary estimate (95% CI) for all studies in Figures 2-6: 27.2% (37 933/122 356 individuals); 95% CI, 24.7%-29.9%; I^2 = 98.9%, τ^2 = 0.78, P < .001. The area of each square is proportional to the inverse variance of the estimate. Horizontal lines indicate 95% confidence intervals of the estimate. The studies in Figures 2-6 are ordered alphabetically by screening instrument and then sorted by increasing sample size within each instrument.

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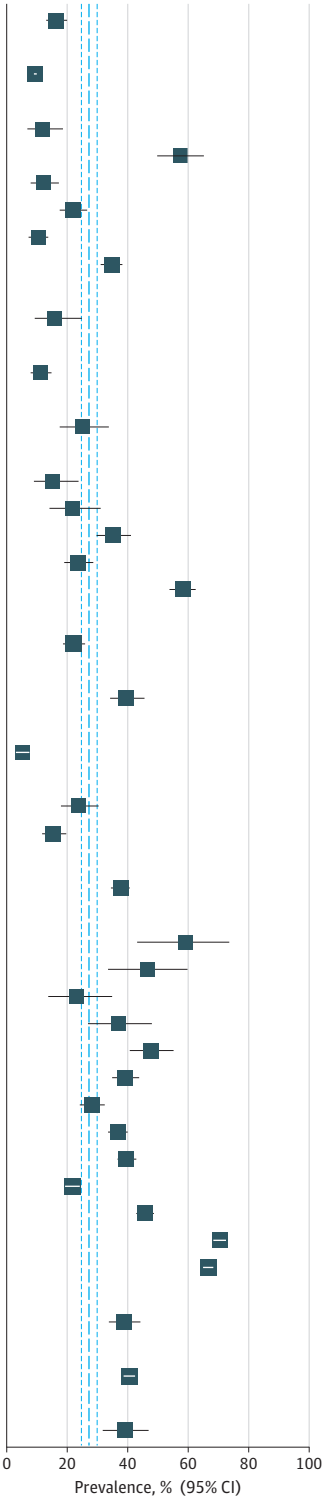
Figure 3. Meta-analysis by Scores on the First, Second, and Short Form Versions of the Beck Depression Inventory, Brief Symptom Inventory Depression Scale, and the Center for Epidemiological Studies Depression Scale

Source	No. Depressed	Total No.	Prevalence, % (95% CI)	Weight, %
Beck Depression Inventory Score ≥15				
Castaldelli-Maia et al,[55] 2012	76	465	16.3 (13.1-20.0)	0.6
Beck Depression Inventory Score ≥16				
Roh et al,[141] 2009	689	7357	9.4 (8.7-10.1)	0.6
Beck Depression Inventory Score ≥17				
David and Hamid Hashmi,[64] 2013	15	128	11.7 (6.7-18.6)	0.5
Ibrahim and Abdelreheem,[89] 2015	95	164	57.9 (50.0-65.6)	0.5
Mayda et al,[118] 2010	24	202	11.9 (7.8-17.2)	0.5
Kaya et al,[102] 2007	77	352	21.9 (17.7-26.6)	0.6
Mancevska et al,[114] 2008	36	354	10.2 (7.2-13.8)	0.5
Güleç et al,[81] 2005	232	668	34.7 (31.1-38.5)	0.6
Beck Depression Inventory Score ≥19				
Chan,[57] 1992	15	95	15.8 (9.1-24.7)	0.5
Beck Depression Inventory Score ≥21				
Alexandrino-Silva et al,[34] 2009	37	336	11.0 (7.9-14.9)	0.5
Beck Depression Inventory II Score ≥10				
Lupo and Strous,[111] 2011	30	119	25.2 (17.7-34.0)	0.5
Beck Depression Inventory II Score ≥14				
Zeldow et al,[182] 1987	15	99	15.2 (8.7-23.8)	0.5
Haglund et al,[10] 2009	22	101	21.8 (14.2-31.1)	0.5
Alvi et al,[38] 2010	98	279	35.1 (29.5-41.0)	0.6
Ghodasara et al,[77] 2011	71	301	23.6 (18.9-28.8)	0.6
AlFaris et al,[35] 2014	317	543	58.4 (54.1-62.6)	0.6
Beck Depression Inventory II Score ≥17				
Choi et al,[60] 2015	118	534	22.1 (18.6-25.9)	0.6
Beck Depression Inventory II Score ≥20				
Aziz et al,[45] 2011	117	295	39.7 (34.0-45.5)	0.6
Beck Depression Inventory II Score ≥21				
Chandavarkar et al,[58] 2007	21	427	4.9 (3.1-7.4)	0.5
Beck Depression Inventory Short Form Score ≥8				
Givens and Tjia,[78] 2002	46	194	23.7 (17.9-30.3)	0.5
Tjia et al,[168] 2005	49	322	15.2 (11.5-19.6)	0.6
Brief Symptom Inventory Depression Scale Score >0.41				
Borst et al,[197] 2015	359	951	37.7 (34.7-40.9)	0.6
Center for Epidemiological Studies Depression Scale Score ≥16				
Thompson et al,[165] 2010	26	44	59.1 (43.2-73.7)	0.5
Peleg-Sagy and Shahar,[131] 2012	28	60	46.7 (33.7-60.0)	0.5
Mosley et al,[123] 1994	16	69	23.2 (13.9-34.9)	0.5
Jeong et al,[99] 2010	33	89	37.1 (27.1-48.0)	0.5
Peleg-Sagy and Shahar,[205] 2013	92	192	47.9 (40.7-55.2)	0.6
Guerrero López et al,[7] 2013	179	455	39.3 (34.8-44.0)	0.6
Smith et al,[159] 2011	135	480	28.1 (24.1-32.4)	0.6
Smith et al,[158] 2010	310	844	36.7 (33.5-40.1)	0.6
Pinzón-Amado et al,[137] 2013	385	973	39.6 (36.5-42.7)	0.6
Goebert et al,[79] 2009	257	1184	21.7 (19.4-24.2)	0.6
Shindel et al,[155] 2011	569	1241	45.9 (43.1-48.7)	0.6
Shi et al,[154] 2015	1230	1738	70.8 (68.6-72.9)	0.6
Shi et al,[153] 2016	1954	2925	66.8 (65.1-68.5)	0.6
Center for Epidemiological Studies Depression Scale Score >16				
Ludwig et al,[203] 2015	131	336	39.0 (33.7-44.4)	0.6
Center for Epidemiological Studies Depression Scale Score ≥19				
Shah et al,[149] 2009	1093	2683	40.7 (38.9-42.6)	0.6
Center for Epidemiological Studies Depression Scale Score ≥80th percentile				
Rosal et al,[207] 1997	67	171	39.2 (31.8-46.9)	0.6



The vertical dashed lines indicate the pooled summary estimate (95% CI) for all studies in Figures 2-6: 27.2% (37 933/122 356 individuals); 95% CI, 24.7%-29.9%; I^2 = 98.9%, τ^2 = 0.78, P < .001. The area of each square is proportional to the inverse variance of the estimate. Horizontal lines indicate 95% confidence intervals of the estimate. The studies in Figures 2-6 are ordered alphabetically by screening instrument and then sorted by increasing sample size within each instrument.

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Figure 4. Meta-analysis by Scores on the Depression Anxiety Stress Scale, *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*, Criteria A and C, Derogatis Stress Profile, Emotional State Questionnaire, General Depression Scale Short Form, General Health Questionnaire, and the Hospital Anxiety and Depression Scale

Source	No. Depressed	Total No.	Prevalence, % (95% CI)	Weight, %
21-Item Depression Anxiety Stress Scale Score ≥10				
Bore et al,[52] 2016	40	127	31.5 (23.5-40.3)	0.5
Yusoff et al,[210] 2013	70	170	41.2 (33.7-49.0)	0.6
Saravanan and Wilks,[145] 2014	125	358	34.9 (30.0-40.1)	0.6
Abdel Wahed and Hassan,[27] 2016	266	442	60.2 (55.4-64.8)	0.6
21-Item Depression Anxiety Stress Scale Score ≥14				
Yusoff,[181] 2013	58	194	29.9 (23.5-36.9)	0.6
Carter et al,[54] 2014	24	198	12.1 (7.9-17.5)	0.5
Kulsoom and Afsar,[108] 2015	190	442	43.0 (38.3-47.7)	0.6
42-Item Depression Anxiety Stress Scale Score ≥10				
Rizvi et al,[140] 2015	27	66	40.9 (29.0-53.7)	0.5
Baykan et al,[50] 2012	57	193	29.5 (23.2-36.5)	0.5
Iqbal et al,[95] 2015	181	353	51.3 (45.9-56.6)	0.6
***Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*, Criteria A and C**				
Dahlin et al,[62] 2005	40	309	12.9 (9.4-17.2)	0.5
Derogatis Stress Profile Score >50				
Helmers et al,[84] 1997	217	356	61.0 (55.7-66.1)	0.6
Emotional State Questionnaire Score ≥12				
Eller et al,[184] 2006	126	413	30.5 (26.1-35.2)	0.6
General Depression Scale Short Form Score >17				
Kohls et al,[105] 2012	107	419	25.5 (21.4-30.0)	0.6
12-Item General Health Questionnaire Score ≥4				
Aktekin et al,[196] 2001	57	119	47.9 (38.7-57.2)	0.5
Guthrie et al,[201] 1998	63	172	36.6 (29.4-44.3)	0.5
James et al,[98] 2013	103	324	31.8 (26.8-37.2)	0.6
Sherina et al,[152] 2004	166	396	41.9 (37.0-47.0)	0.6
Sreeramareddy et al,[161] 2007	85	407	20.9 (17.0-25.2)	0.6
Oku et al,[128] 2015	177	451	39.2 (34.7-43.9)	0.6
12-Item General Health Questionnaire Score ≥5				
Berner et al,[51] 2014	88	384	22.9 (18.8-27.5)	0.6
12-Item General Health Questionnaire Score >15				
Imran et al,[92] 2016	276	527	52.4 (48.0-56.7)	0.6
28-Item General Health Questionnaire Score >6				
Akbari et al,[31] 2014	20	138	14.5 (9.1-21.5)	0.5
28-Item General Health Questionnaire Score ≥23				
Bayati et al,[9] 2009	93	172	54.1 (46.3-61.7)	0.6
Farahangiz et al,[76] 2016	105	208	50.5 (43.5-57.5)	0.6
Hospital Anxiety and Depression Scale Score ≥7				
Akvardar et al,[33] 2004	56	166	33.7 (26.6-41.5)	0.5
Akvardar et al,[32] 2003	154	447	34.5 (30.1-39.1)	0.6
Hospital Anxiety and Depression Scale Score ≥8				
Rab et al,[138] 2008	17	87	19.5 (11.8-29.4)	0.5
Khan et al,[103] 2015	18	110	16.4 (10.0-24.6)	0.5
Newbury-Birch et al,[204] 2001	5	114	4.4 (1.4-9.9)	0.4
Pickard et al,[135] 2000	13	136	9.6 (5.2-15.8)	0.5
Ashton and Kamali,[44] 1995	73	186	39.2 (32.2-46.7)	0.6
Vaysse et al,[171] 2014	7	197	3.6 (1.4-7.2)	0.5
Amir and Gillany,[40] 2010	88	311	28.3 (23.4-33.7)	0.6
Bunevicius et al,[53] 2008	48	338	14.2 (10.7-18.4)	0.6
Kötter et al,[107] 2014	12	350	3.4 (1.8-5.9)	0.5
Waqas et al,[173] 2015	118	409	28.9 (24.5-33.5)	0.6
Karaoğlu and Şeker,[101] 2011	136	485	28.0 (24.1-32.3)	0.6
Quince et al,[206] 2012	142	2155	6.6 (5.6-7.7)	0.6

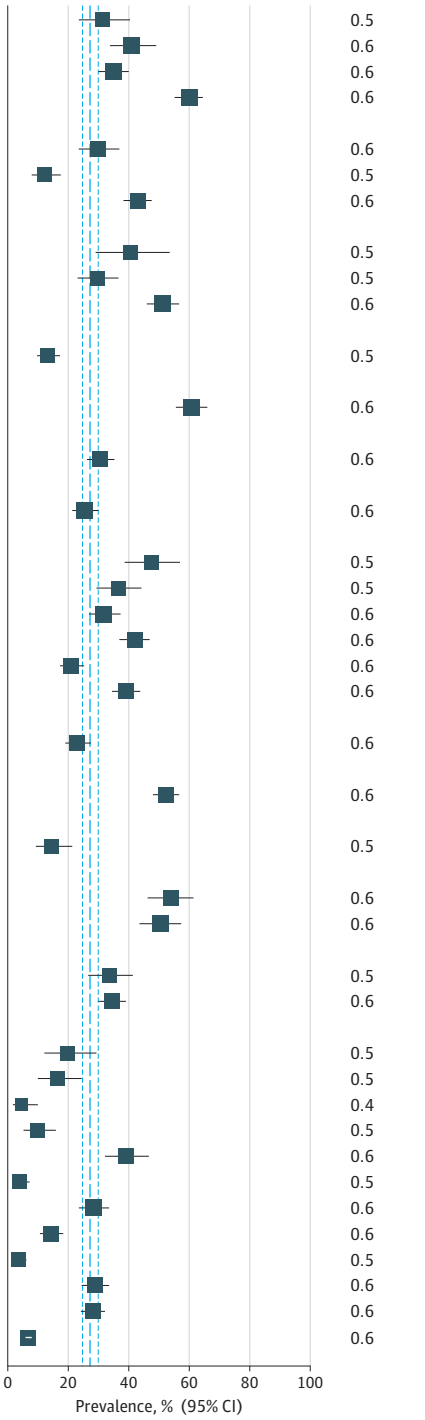

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Figure 5. Meta-analysis by Scores on Several Scales

Source	No. Depressed	Total No.	Prevalence, % (95% CI)	Weight, %
Hospital Anxiety and Depression Scale Score ≥11				
Prinz et al,[2] 2012	1	73	1.4 (0.0-7.4)	0.2
Voltmer et al,[172] 2012	4	153	2.6 (0.7-6.6)	0.4
Ibrahim et al,[90] 2013	66	450	14.7 (11.5-18.3)	0.6
Ibrahim et al,[91] 2013	86	558	15.4 (12.5-18.7)	0.6
Hospital Anxiety and Depression Scale Score ≥12				
El-Gilany et al,[75] 2008	127	588	21.6 (18.3-25.1)	0.6
Health-Related Self-Reported Scale Score ≥25				
Kongsomboon,[106] 2010	42	593	7.1 (5.2-9.5)	0.5
Kessler Psychological Distress Scale Score ≥20				
Saeed et al,[143] 2016	56	80	70.0 (58.7-79.7)	0.5
Matheson et al,[117] 2016	92	232	39.7 (33.3-46.3)	0.6
Kutcher Adolescent Depression Scale Score ≥6				
Mojs et al,[122] 2015	30	477	6.3 (4.3-8.9)	0.5
Major Depression Inventory Score >27				
Dahlin et al,[63] 2011	37	408	9.1 (6.5-12.3)	0.5
Mini International Neuropsychiatric Interview ≥ *DSM-IV* criteria				
de Melo Cavestro and Rocha,[65] 2006	19	213	8.9 (5.5-13.6)	0.5
Minnesota Multiphasic Personality Inventory-Depression Scale Score >70				
Walkiewicz et al,[209] 2012	32	178	18.0 (12.6-24.4)	0.5
9-Item Patient Health Questionnaire Score ≥5				
Manaf et al,[113] 2016	135	206	65.5 (58.6-72.0)	0.6
Lapinski et al,[109] 2016	537	1294	41.5 (38.8-44.2)	0.6
9-Item Patient Health Questionnaire Score ≥9				
Angkurawaranon et al,[41] 2016	100	1014	9.9 (8.1-11.9)	0.6
9-Item Patient Health Questionnaire Score ≥10				
Thompson et al,[166] 2016	26	153	17.0 (11.4-23.9)	0.5
Yoon et al,[179] 2014	24	174	13.8 (9.0-19.8)	0.5
Sidana et al,[156] 2012	51	237	21.5 (16.5-27.3)	0.5
Samaranayake and Fernando,[144] 2011	43	255	16.9 (12.5-22.0)	0.5
Vankar et al,[170] 2014	88	331	26.6 (21.9-31.7)	0.6
Naja et al,[125] 2016	117	340	34.4 (29.4-39.7)	0.6
Sobowale et al,[160] 2014	47	348	13.5 (10.1-17.6)	0.6
Youssef,[180] 2016	145	381	38.1 (33.2-43.1)	0.6
Schwenk et al,[146] 2010	72	504	14.3 (11.3-17.6)	0.6
Wimsatt et al,[175] 2015	72	505	14.3 (11.3-17.6)	0.6
Tan et al,[167] 2015	38	537	7.1 (5.1-9.6)	0.5
Honney et al,[88] 2010	270	553	48.8 (44.6-53.1)	0.6
Romo-Nava et al,[142] 2016	173	1068	16.2 (14.0-18.5)	0.6
Miletic et al,[121] 2015	285	1294	22.0 (19.8-24.4)	0.6
Nava et al,[127] 2013	79	1871	4.2 (3.4-5.2)	0.6
9-Item Patient Health Questionnaire Score >10				
Wege et al,[174] 2016	61	590	10.3 (8.0-13.1)	0.6
Primary Care Evaluation of Mental Disorders				
Wolf and Rosenstock,[176] 2016	12	130	9.2 (4.9-15.6)	0.5
Gold et al,[80] 2015	7	183	3.8 (1.6-7.7)	0.5
Mousa et al,[124] 2016	55	336	16.4 (12.6-20.8)	0.6
Chang et al,[59] 2012	217	364	59.6 (54.4-64.7)	0.6
MacLean et al,[112] 2016	33	385	8.6 (6.0-11.8)	0.5
Thomas et al,[164] 2007	294	535	55.0 (50.6-59.2)	0.6
Dyrbye et al,[72] 2006	296	545	54.3 (50.0-58.6)	0.6
Dyrbye et al,[68] 2015	330	870	37.9 (34.7-41.2)	0.6
Dyrbye et al,[70] 2011	541	1428	37.9 (35.4-40.5)	0.6
Dyrbye et al,[71] 2007	820	1691	48.5 (46.1-50.9)	0.6
Dyrbye et al,[73] 2008	1037	2228	46.5 (44.5-48.6)	0.6
Dyrbye et al,[69] 2010	1398	2661	52.5 (50.6-54.4)	0.6
Jackson et al,[96] 2016	2528	4354	58.1 (56.6-59.5)	0.6
Dyrbye et al,[74] 2014	2552	4402	58.0 (56.5-59.4)	0.6

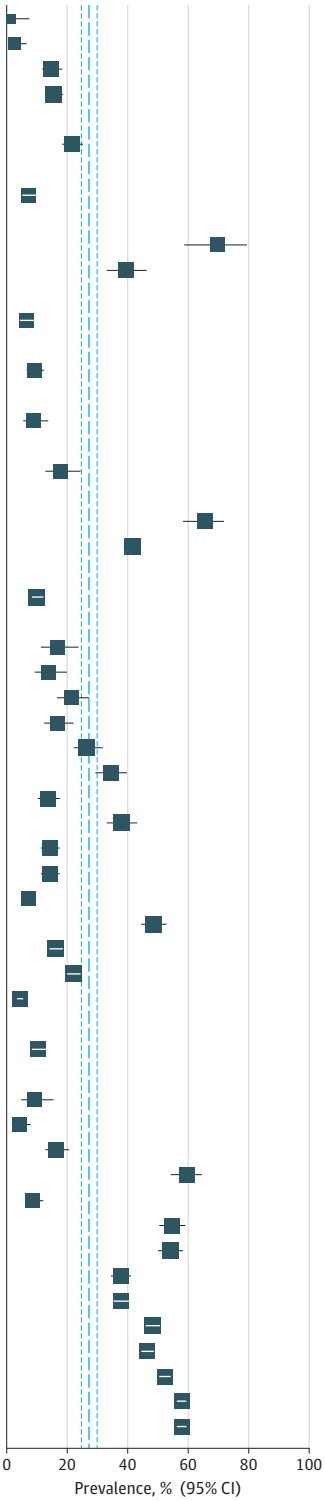

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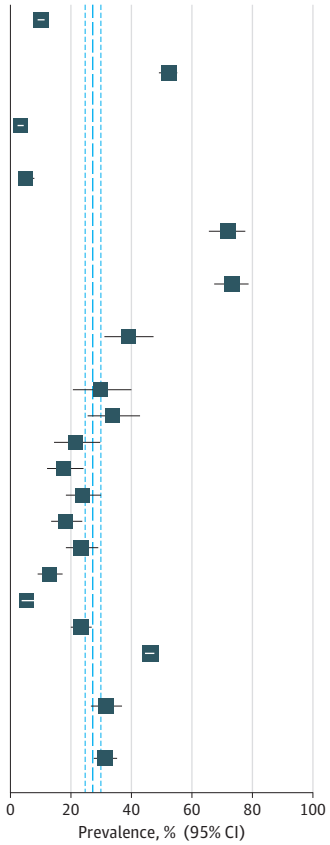
Figure 6. Meta-analysis by Scores on the Patient-Reported Outcomes Measurement Information System, Quick Inventory of Depressive Symptomatology, 90-Item Symptom Checklist, Thai Depression Inventory, and the Zung Self-Rating Depression Scale

Source	No. Depressed	Total No.	Prevalence, % (95% CI)	Weight, %
Patient-Reported Outcomes Measurement Information System Score >60				
Hardeman et al,[83] 2015	316	3149	10.0 (9.0-11.1)	0.6
Quick Inventory of Depressive Symptomatology Score ≥9				
Perveen et al,[133] 2016	524	1000	52.4 (49.3-55.5)	0.6
90-Item Symptom Checklist Score >2				
Yang et al,[6] 2014	36	1137	3.2 (2.2-4.4)	0.5
Thai Depression Inventory Score >35				
N Wongpakaran and T Wongpakaran,[177] 2010	19	368	5.2 (3.1-7.9)	0.5
Zung Self-Rating Depression Scale Score >30				
Pillay et al,[136] 2016	166	230	72.2 (65.9-77.9)	0.6
Zung Self-Rating Depression Scale Score ≥40				
Supe,[3] 1998	175	238	73.5 (67.4-79.0)	0.6
Zung Self-Rating Depression Scale Score >45				
Nasioudis et al,[126] 2015	57	146	39.0 (31.1-47.5)	0.5
Zung Self-Rating Depression Scale Score ≥50				
Basnet et al,[48] 2012	28	94	29.8 (20.8-40.1)	0.5
Tang,[163] 2005	41	121	33.9 (25.5-43.0)	0.5
Phillips et al,[134] 2006	26	122	21.3 (14.4-29.6)	0.5
Marwat,[116] 2013	29	166	17.5 (12.0-24.1)	0.5
Ali and Vankar,[37] 1994	51	215	23.7 (18.2-30.0)	0.5
Camp et al,[198] 1994	42	232	18.1 (13.4-23.7)	0.5
Aniebue and Onyema,[42] 2008	61	262	23.3 (18.3-28.9)	0.6
Ashor,[43] 2012	34	269	12.6 (8.9-17.2)	0.5
Liao et al,[110] 2010	26	487	5.3 (3.5-7.7)	0.5
Valle et al,[169] 2013	143	615	23.3 (20.0-26.8)	0.6
Wan et al,[4] 2012	1881	4063	46.3 (44.8-47.8)	0.6
Zung Self-Rating Depression Scale Score ≥53				
Shen et al,[151] 2009	99	313	31.6 (26.5-37.1)	0.6
Zung Self-Rating Depression Scale Short Form Score ≥22				
Pereyra-Elías et al,[132] 2010	184	590	31.2 (27.5-35.1)	0.6



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although the results were inconsistent (ie, 2 analyses suggested that depression was increasing with time, whereas a third suggested it was decreasing). Age and sex were not significantly associated with depression prevalence among any instruments.

Analysis of Longitudinal Studies

The temporal relationship between exposure to medical school and depressive symptoms was assessed in an analysis of 9 longitudinal studies that measured depressive symptoms before and during medical school (**Table 3**). Because studies used different assessment instruments, the relative change in depressive symptoms was calculated for each study individually (ie, follow-up prevalence divided by baseline prevalence) and then the relative changes derived from the individual studies were examined. Overall, the median absolute increase in depressive symptoms was 13.5% (range, 0.6%-35.3%) following the onset of medical training.

Prevalence of Suicidal Ideation Among Medical Students

In an analysis of 24 studies, the crude summary prevalence of suicidal ideation, variably reported as having occurred over the past 2 weeks to the past 12 months, was 11.1% (2043/21 002 individuals; 95% CI, 9.0%-13.7%), with significant evidence of between-study heterogeneity (Q = 547.1, τ^2 = 0.32, I^2 = 95.8%, P < .001) (**Figure 10**). The prevalence estimates reported by the individual studies ranged from 4.9% to 35.6%. Sensitivity analysis showed that no individual study affected the overall pooled estimate by more than 1.9% (eTable 5 in the Supplement).

To further characterize the range of the suicidal ideation prevalence estimates identified, stratified meta-analyses were performed by screening instrument and cutoff score. Summary prevalence estimates ranged from 7.4% (69/938 individuals [95% CI, 5.9%-9.2%]; Q = 0.01, τ^2 = 0, I^2 = 0%) over the past 2 weeks for studies using the 9-item Patient Health Questionnaire (PHQ-9) to 24.2% (208/754 individuals

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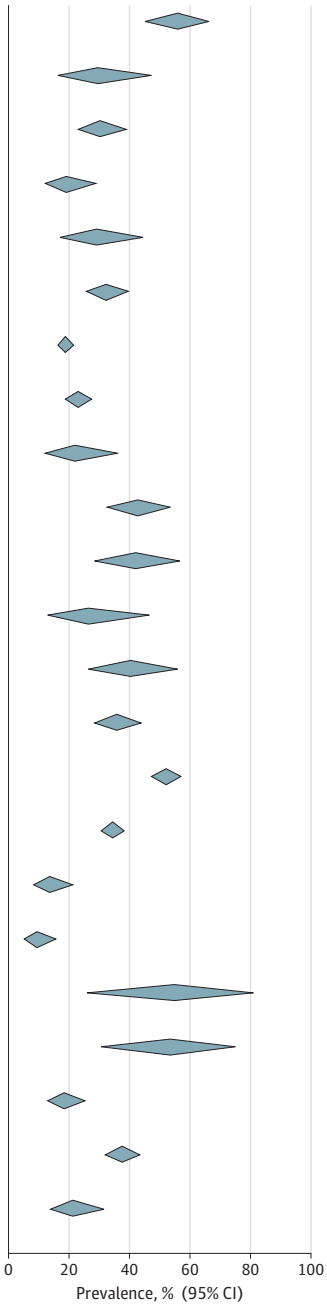
Figure 7. Meta-analyses of the Prevalence of Depression or Depressive Symptoms Among Medical Students Stratified by Screening Instrument and Cutoff Score

Screening Method and Cutoff Score	No. of Studies	Study Sample: No. Depressed	Study Sample: Total No.	Prevalence, % (95% CI)
Aga Khan University Anxiety and Depression Scale Score ≥19 I^2 = 98.9%, τ^2 = 0.78, P < .001	4	540	1039	55.9 (45.1-66.2)
Beck Depression Inventory II Score ≥14 I^2 = 97.2%, τ^2 = 0.73, P < .001	5	523	1323	29.5 (16.3-47.4)
Beck Depression Inventory Score ≥8 I^2 = 81.9%, τ^2 = 0.09, P = .004	3	226	796	30.2 (22.8-38.7)
Beck Depression Inventory Short Form Score ≥8 I^2 = 82.6%, τ^2 = 0.12, P = .02	2	95	516	19.0 (12.1-28.7)
Beck Depression Inventory Score ≥9 I^2 = 84.3%, τ^2 = 0.20, P = .01	2	146	444	29.0 (17.2-44.6)
Beck Depression Inventory Score ≥10 I^2 = 98.6%, τ^2 = 0.62, P < .001	24	5042	19160	32.4 (25.8-39.7)
Beck Depression Inventory Score ≥11 I^2 = 0%, τ^2 = 0, P = .91	2	166	883	18.8 (16.4-21.5)
Beck Depression Inventory Score ≥12 I^2 = 0%, τ^2 = 0, P = .39	2	85	374	22.8 (18.8-27.3)
Beck Depression Inventory Score ≥17 I^2 = 97.1%, τ^2 = 0.75, P < .001	6	479	1868	21.7 (12.0-36.0)
Center for Epidemiological Studies Depression Scale Score ≥16 I^2 = 99.0%, τ^2 = 0.61, P < .001	13	5214	10294	42.8 (32.7-53.6)
21-Item Depression Anxiety Stress Scale Score ≥10 I^2 = 95.3%, τ^2 = 0.35, P < .001	4	501	1097	41.9 (28.5-56.6)
21-Item Depression Anxiety Stress Scale Score ≥14 I^2 = 96.3%, τ^2 = 0.58, P < .001	3	272	834	26.5 (13.0-46.6)
42-Item Depression Anxiety Stress Scale Score ≥10 I^2 = 91.5%, τ^2 = 0.28, P < .001	3	265	612	40.4 (26.5-56.0)
12-Item General Health Questionnaire Score ≥4 I^2 = 91.1%, τ^2 = 0.15, P < .001	6	651	1869	35.7 (28.5-43.6)
28-Item General Health Questionnaire Score ≥23 I^2 = 0%, τ^2 = 0, P = .49	2	198	380	52.1 (47.1-57.1)
Hospital Anxiety and Depression Scale Score ≥7 I^2 = 0%, τ^2 = 0, P = .87	2	210	613	34.3 (30.6-38.1)
Hospital Anxiety and Depression Scale Score ≥8 I^2 = 97.2%, τ^2 = 0.85, P < .001	12	677	4878	13.6 (8.4-21.3)
Hospital Anxiety and Depression Scale Score ≥11 I^2 = 84.8%, τ^2 = 0.24, P < .001	4	157	1234	9.3 (5.3-15.7)
Kessler Psychological Distress Scale Score ≥20 I^2 = 95.2%, τ^2 = 0.76, P < .001	2	148	312	54.9 (26.0-80.8)
9-Item Patient Health Questionnaire Score ≥5 I^2 = 97.5%, τ^2 = 0.47, P < .001	2	672	1500	53.5 (30.5-75.1)
9-Item Patient Health Questionnaire Score ≥10 I^2 = 98.0%, τ^2 = 0.67, P < .001	15	1530	8551	18.3 (12.8-25.4)
Primary Care Evaluation of Mental Disorders I^2 = 98.4%, τ^2 = 0.19, P < .001	14	10120	20112	37.5 (32.0-43.3)
Zung Self-Rating Depression Scale Score ≥50 I^2 = 98.0%, τ^2 = 0.76, P < .001	11	2362	6646	21.3 (13.8-31.5)



Pooled summary estimates are ordered alphabetically by screening instrument. The individual studies contributing to each summary estimate are reported in Figures 2 through 6. The area of each diamond is proportional to the inverse variance of the estimate. Horizontal extremes of the diamonds indicate 95% CIs of the estimate.

[95% CI, 13.0%-40.5%]; Q = 37.2, τ^2 = 0.42, I^2 = 94.6%) over the past 12 months for studies using the 28-item General Health Questionnaire.

The median prevalence of suicidal ideation over the past 12 months reported by 7 studies using variably worded short-form screening instruments was 10.2% (723/8636 individuals [95% CI, 6.8%-15.0%]; Q = 176.5, τ^2 = 0.33, I^2 = 96.6%). Among the full set of studies, no statistically significant differences in prevalence estimates were noted by country (United States vs other countries), conti-

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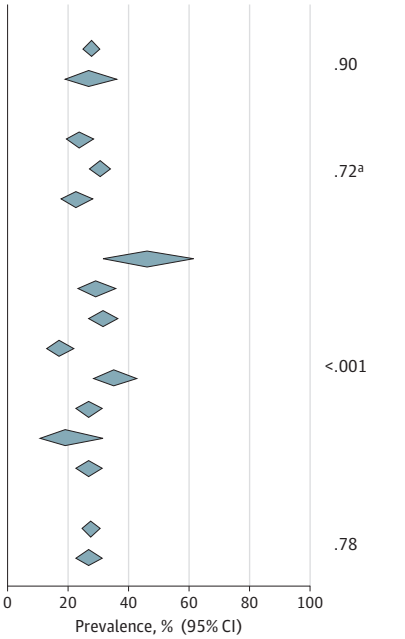
Figure 8. Meta-analyses of the Prevalence of Depression or Depressive Symptoms Among Medical Students Stratified by Study-Level Characteristics

	No. of Studies	Study Sample: No. Depressed	Study Sample: Total No.	Prevalence, % (95% CI)	P Value for Difference
Type of Study					
Cross-sectional (I^2 = 99.0%, τ^2 = 0.78, P < .001)	167	36 632	116 628	27.3 (24.7-30.1)	.90
Longitudinal (I^2 = 97.5%, τ^2 = 0.75, P < .001)	16	1301	5728	26.7 (19.1-36.1)	
Academic Year					
Preclinical (I^2 = 97.8%, τ^2 = 0.68, P < .001)	45	4866	25 462	23.7 (19.5-28.5)	
Both (I^2 = 99.0%, τ^2 = 0.67, P < .001)	108	29 273	79 966	30.4 (27.2-33.9)	.72[a]
Clinical (I^2 = 96.4%, τ^2 = 0.35, P < .001)	17	2917	13 172	22.4 (17.6-28.2)	
Continent or Region					
Africa (I^2 = 97.5%, τ^2 = 0.58, P < .001)	6	853	1860	46.3 (31.7-61.6)	
Asia (I^2 = 99.4%, τ^2 = 1.14, P < .001)	51	13 435	49 602	29.1 (23.4-35.6)	
Eurasia (I^2 = 90.4%, τ^2 = 0.12, P < .001)	10	1288	3958	31.5 (26.8-36.6)	
Europe (I^2 = 97.8%, τ^2 = 0.65, P < .001)	26	2728	12 604	16.9 (12.8-21.9)	
Middle East (I^2 = 97.0%, τ^2 = 0.49, P < .001)	20	2414	6610	35.2 (28.5-42.7)	<.001
North America (I^2 = 99.0%, τ^2 = 0.61, P < .001)	49	15 238	40 655	26.7 (22.5-31.2)	
Oceania (I^2 = 89.5%, τ^2 = 0.31, P < .001)	3	107	580	19.0 (10.8-31.4)	
South America (I^2 = 93.6%, τ^2 = 0.22, P < .001)	18	1870	6487	26.6 (22.4-31.2)	
Country					
All other countries (I^2 = 98.8%, τ^2 = 0.83, P < .001)	141	23 577	86 107	27.4 (24.5-30.6)	.78
United States (I^2 = 98.9%, τ^2 = 0.53, P < .001)	42	14 356	36 249	26.7 (22.5-31.3)	



The area of each diamond is proportional to the inverse variance of the estimate. Horizontal extremes of the diamonds indicate 95% CIs of the estimate.

[a] Comparison of studies reporting only on preclinical students with those studies reporting only on clinical students.

nent or region, level of training, baseline survey year, average age, proportion of male study participants, or total Newcastle-Ottawa score (P > .05 for all comparisons). Within-instrument heterogeneity was not examined because there were not enough studies using identical screening instruments (≤4 for each assessment modality), precluding meaningful analysis.

Assessment of Publication Bias

Visual inspection of the funnel plot of studies reporting on depression or depressive symptoms revealed significant asymmetry (eFigure 2 in the Supplement). There was evidence of publication bias, with smaller studies yielding more extreme prevalence estimates (P = .001 using the Egger test). The funnel plot of studies reporting on suicidal ideation revealed minimal asymmetry (eFigure 3 in the Supplement), suggesting the absence of significant publication bias (P = .49 using the Egger test).

Discussion

This systematic review and meta-analysis of 195 studies involving 129 123 medical students in 47 countries demonstrated that 27.2% (range, 9.3%-55.9%) of students screened positive for depression and that 11.1% (range, 7.4%-24.2%) reported suicidal ideation during medical school. Only 15.7% of students who screened positive for depression reportedly sought treatment. These findings are concerning given that the development of depression and suicidality has been linked to an increased short-term risk of suicide as well as a higher long-term risk of future depressive episodes and morbidity.[211,212]

The present analysis builds on recent work demonstrating a high prevalence of depression among resident physicians, and the concordance between the summary prevalence estimates (27.2% in students vs 28.8% in residents) suggests that depression is a problem affecting all levels of medical training.[13,213] Taken together, these data suggest that depressive and suicidal symptoms in medical trainees may adversely affect the long-term health of physicians as well as the quality of care delivered in academic medical centers.[214-216]

When interpreting these findings, it is important to recognize that the data synthesized in this study were almost exclusively derived from self-report inventories of depressive symptoms that varied substantially in their sensitivity and specificity for diagnosing major depressive disorder (eTable 6 in the Supplement).[217] Instruments such as the PHQ-9 have high sensitivity and specificity for diagnosing major depression, whereas others such as the Primary Care Evaluation of Mental Disorders (PRIME-MD) have low specificity and should be viewed as screening tools. Although these self-report measures of depressive symptoms have limitations, they are essential tools for accurately measuring depression in medical trainees because they

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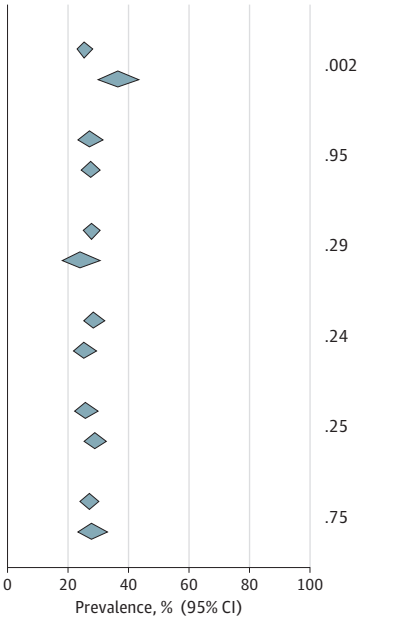
Figure 9. Meta-analyses of the Prevalence of Depression or Depressive Symptoms Among Medical Students Stratified by Newcastle-Ottawa Scale Components and Total Score

Newcastle-Ottawa Scale Components	No. of Studies	Study Sample: No. Depressed	Study Sample: Total No.	Prevalence, % (95% CI)	*P* Value for Difference
Sample Representativeness					
Less representive (I^2 = 97.8%, τ^2 = 0.77, *P* < .001)	150	13 567	53 663	25.4 (22.8-28.2)	.002
More representive (I^2 = 99.7%, τ^2 = 0.73, *P* < .001)	33	24 366	68 693	36.3 (29.9-43.3)	
Sample Size					
<200 Participants (I^2 = 93.6%, τ^2 = 0.62, *P* < .001)	57	2274	7632	27.2 (23.2-31.6)	.95
≥200 Participants (I^2 = 99.2%, τ^2 = 0.79, *P* < .001)	126	35 659	114 724	27.3 (24.3-30.6)	
Respondent-Nonrespondent Comparability					
Less comparable (I^2 = 99.0%, τ^2 = 0.81, *P* < .001)	165	34 774	113 260	27.6 (24.9-30.5)	.29
More comparable (I^2 = 97.6%, τ^2 = 0.52, *P* < .001)	18	3159	9096	23.8 (18.1-30.6)	
Ascertainment of Depression					
Less valid (I^2 = 99.0%, τ^2 = 0.78, *P* < .001)	102	22 566	71 291	28.6 (25.2-32.3)	.24
More valid (I^2 = 98.8%, τ^2 = 0.81, *P* < .001)	81	15 367	51 065	25.5 (21.9-29.5)	
Descriptive Statistics Reporting					
Less thorough (I^2 = 99.0%, τ^2 = 0.94, *P* < .001)	97	18 595	60 300	25.8 (22.2-29.7)	.25
More thorough (I^2 = 98.8%, τ^2 = 0.66, *P* < .001)	86	19 338	62 056	28.8 (25.4-32.6)	
Total Newcastle-Ottawa Score					
<3 points (I^2 = 98.7%, τ^2 = 0.91, *P* < .001)	138	21 518	69 789	27.0 (23.9-30.3)	.75
≥3 points (I^2 = 99.3%, τ^2 = 0.64, *P* < .001)	45	16 415	52 567	27.9 (23.4-32.9)	



Full details regarding Newcastle-Ottawa risk of bias scoring are provided in eMethods 2 in the Supplement. Component scores for all individual studies are presented in eTable 2 in the Supplement. The area of each diamond is proportional to the inverse variance of the estimate. Horizontal extremes of the diamonds indicate 95% CIs of the estimate.

protect anonymity in a manner that is not possible through formal diagnostic interviews.[218] To control for the differences in these inventories, we stratified our analyses by survey instrument and cutoff score, identifying a range of estimates not captured in another evidence synthesis.[219]

The prevalence of depressive symptoms among medical students in this study was higher than that reported in the general population.[220-222] For example, the National Institute of Mental Health study of behavioral health trends in the United States, including 67 500 nationally representative participants, found that the 12-month prevalence of a major depressive episode was 9.3% among 18- to 25-year-olds and 7.2% among 26- to 49-year-olds.[220] In contrast, the BDI, CES-D, and PHQ-9 summary estimates obtained in the present study were between 2.2 and 5.2 times higher than these estimates. These findings suggest that depressive symptom prevalence is substantially higher among medical students than among individuals of similar age in the general population.

How depression levels in medical students compare with those in nonmedical undergraduate students and professional students is unclear. One review concluded that depressive symptom prevalence did not statistically differ between medical students and nonmedical undergraduate students.[223] However, this conclusion may be confounded because the analysis did not control for assessment modality and did not include a comprehensive or representative set of studies (only 12 studies and 4 studies exclusively composed of medical students and nonmedical students, respectively). Two large, representative epidemiological studies have estimated that depressive symptom prevalence in nonmedical students ranges from 13.8% to 21.0%, lower than the estimates reported by many studies of medical students in the present meta-analysis.[224,225]

Some professional students, such as law students, may not markedly differ from medical students in their susceptibility to depression, although firm conclusions cannot be drawn from the currently available data.[226,227] Together, these findings suggest that factors responsible for depression in medical students may also be operative in other undergraduate and professional schools. The finding in the longitudinal analysis of an increase in depressive symptom prevalence with the onset of medical school suggests that it is not just that medical students (and other students) are prone to depression, but that the school experience may be a causal factor.

This analysis identified a pooled prevalence of suicidal ideation of 11.1%. Endorsement of suicidal ideation as assessed by the PHQ-9 or other similar instruments increases the cumulative risk of a suicide attempt or completion over the next year by 10- and 100-fold, respectively.[228] Combined with the finding that only 15.7% of medical students who screened positive for depression sought treatment, the high prevalence of suicidal ideation underscores the need for effective preven-

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Table 3. Secondary Analysis of 9 Longitudinal Studies Reporting Depression or Depressive Symptom Prevalence Estimates Both Before and During Medical School

Source[a]	Screening Instrument	Cutoff Score	Follow-up, mo	Baseline			Follow-up			Comparison	
				No. Depressed	Sample Size	Prevalence, % (95% CI)	No. Depressed	Sample Size	Prevalence, % (95% CI)	Absolute Increase, % (95% CI)	Relative Increase, Ratio (95% CI)
Walkiewicz et al,[209] 2012	MMPI-D	>70	12	31	178	17.4 (11.8 to 23.0)	32	178	18.0 (12.4 to 23.6)	0.6 (−7.4 to 8.5)	1.0 (0.6 to 1.8)
Quince et al,[206] 2012	HADS-D	≥8	12	38	665	5.7 (3.9 to 7.5)	36	429	8.4 (5.8 to 11.0)	2.7 (−0.4 to 6.1)	1.5 (0.9 to 2.4)
Levine et al,[202] 2006	21-item BDI	≥8	20	64	376	17.0 (13.2 to 20.8)	80	330	24.2 (19.6 to 28.8)	7.2 (1.3 to 13.2)	1.4 (1.0 to 2.0)
Camp et al,[198] 1994	Zung-SDS	≥50	3	14	232	6.0 (2.9 to 9.1)	42	232	18.1 (13.2 to 23.1)	12.1 (6.2 to 18.0)	3.0 (1.6 to 5.6)
Vitaliano et al,[208] 1988	BDI	≥5	8	36	312	11.5 (8.0 to 15.0)	78	312	25.0 (20.2 to 29.8)	13.5 (7.4 to 19.4)	2.2 (1.4 to 3.3)
Clark and Zeldow,[199] 1988	21-item BDI	≥8	14	11	116	9.5 (4.2 to 14.8)	24	88	27.3 (18.0 to 36.6)	17.8 (7.2 to 28.7)	2.9 (1.3 to 6.2)
Rosal et al,[207] 1997	CES-D	≥80th[b]	18	48	264	18.2 (13.6 to 22.9)	67	171	39.2 (31.9 to 46.5)	21.0 (12.3 to 29.6)	2.2 (1.4 to 3.3)
Aktekin et al,[196] 2001	GHQ	≥4	12	21	119	17.6 (10.8 to 24.4)	57	119	47.9 (38.9 to 56.9)	30.3 (18.5 to 40.9)	2.7 (1.5 to 4.8)
Yusoff et al,[210] 2013	DASS-21	≥10	12	10	170	5.9 (2.4 to 9.4)	70	170	41.2 (33.8 to 48.6)	35.3 (26.8 to 43.3)	7.0 (3.5 to 14.0)

Abbreviations: BDI, Beck Depression Inventory; CES-D, Center for Epidemiological Studies Depression Scale; DASS-21, 21-item Depression Anxiety Stress Scale; GHQ, General Health Questionnaire; HADS-D, Hospital Anxiety and Depression Scale; MMPI-D, Minnesota Multiphasic Personality Inventory-Depression Scale; Zung-SDS, Zung Self-Rating Depression Scale.

[a] Studies are sorted by the percentage increase in depressive symptoms from baseline to the follow-up survey. The median percentage increase among the studies was 13.5%.

[b] Indicates 80th percentile.

tive efforts and increased access to care that accommodate the needs of medical students and the demands of their training.

Limitations

This study has important limitations. First, the data were derived from studies that had different designs, screening instruments, and trainee demographics. The substantial heterogeneity among the studies remained largely unexplained by the variables inspected. Second, many subgroup analyses relied on unpaired cross-sectional data collected at different medical schools, which may cause confounding. Third, because the studies were heterogeneous with respect to screening inventories and student populations, the prevalence of major depression could not be determined. Fourth, the analysis relied on aggregated published data. A multicenter, prospective study using a single validated measure of depression and suicidal ideation with structured diagnostic interviews in a random subset of participants would provide a more accurate estimate of the prevalence of depression and suicidal ideation among medical students.

Future Directions

Because of the high prevalence of depressive and suicidal symptomatology in medical students, there is a need for additional studies to identify the root causes of emotional distress in this population. To provide more relevant information, future epidemiological studies should consider adopting prospective study designs so that the same individuals can be assessed over time, use commonly used screening instruments with valid cutoffs for assessing depression in the community (eg, the BDI, CES-D, or PHQ-9), screen for comorbid anxiety disorders, and completely and accurately report their data, for example, by closely following the Strengthening the Reporting of Observational Studies in Epidemiology guidelines.[229]

Possible causes of depressive and suicidal symptomatology in medical students likely include stress and anxiety secondary to the competitiveness of medical school.[62] Restructuring medical school curricula and student evaluations (such as using a pass-fail grading schema rather than a tiered grading schema and fostering collaborative group learning through a "flipped-classroom" education model) might ameliorate these stresses.[230,231] Future research should also determine how strongly depression in medical school predicts depression during residency and whether interventions that reduce depression in medical students carry over in their effectiveness when those students transition to residency.[232] Furthermore, efforts are continually needed to reduce barriers to mental health services, including addressing the stigma of depression.[146,233]

Conclusions

In this systematic review, the summary estimate of the prevalence of depression or depressive symptoms among medical students was 27.2% and that of suicidal ideation was 11.1%. Further research is needed to identify strategies for preventing and treating these disorders in this population.

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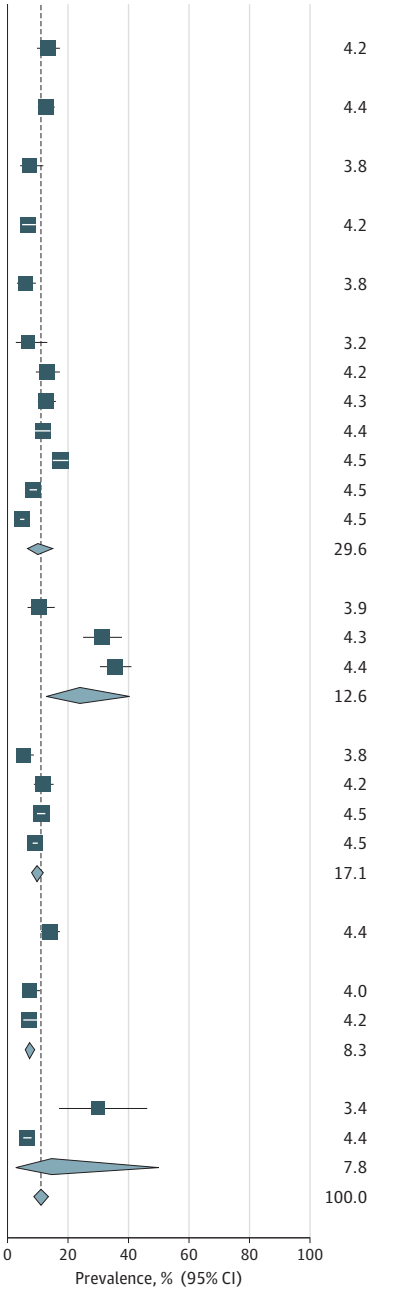
Figure 10. Meta-analysis of the Prevalence of Suicidal Ideation Among Medical Students

Source	No. Suicidal	Total No.	Prevalence, % (95% CI)	Weight, %
Score >0 on Beck Scale for Suicidal Ideation				
Alexandrino-Silva et al,[34] 2009	45	336	13.4 (9.9-17.5)	4.2
Score >24 on Beck Scale for Suicidal Ideation				
Ahmed et al,[185] 2016	78	612	12.7 (10.2-15.6)	4.4
Mini International Neuropsychiatric Interview				
de Melo Cavestro and Rocha,[65] 2006	16	213	7.5 (4.4-11.9)	3.8
Score ≥7 on Revised Suicidial Behaviors Questionnaire				
Tan et al,[167] 2015	36	517	7.0 (4.9-9.5)	4.2
Suicidal Ideation Over Past Month				
Alem et al,[186] 2005	16	273	5.9 (3.4-9.3)	3.8
Suicidal Ideation Over Past 12 mo				
Amiri et al,[187] 2013	8	115	7.0 (3.1-13.2)	3.2
Wallin and Runeson,[195] 2003	40	305	13.1 (9.5-17.4)	4.2
Okasha et al,[192] 1981	66	516	12.8 (10.0-16.0)	4.3
Eskin et al,[189] 2011	75	646	11.6 (9.2-14.3)	4.4
Chen et al,[188] 2004	156	892	17.5 (15.1-20.1)	4.5
Tran et al,[193] 2015	179	2099	8.5 (7.4-9.8)	4.5
Wan et al,[4] 2012	199	4063	4.9 (4.3-5.6)	4.5
Summary Prevalence $I^2 = 96.6\%$, $\tau^2 = 0.33$, $P < .001$	723	8636	10.2 (6.8-15.0)	29.6
Suicidal Ideation Over Past 12 mo (28-Item General Health Questionnaire)				
Menezes et al,[191] 2012	22	206	10.7 (6.8-15.7)	3.9
Khokher and Khan,[190] 2005	68	217	31.3 (25.2-38.0)	4.3
Osama et al,[5] 2014	118	331	35.6 (30.5-41.1)	4.4
Summary Prevalence $I^2 = 94.6\%$, $\tau^2 = 0.42$, $P < .001$	208	754	24.2 (13.0-40.5)	12.6
Suicidal Ideation Over Past 12 mo (Meehan Inventory)				
Dahlin et al,[62] 2005	16	296	5.4 (3.1-8.6)	3.8
MacLean et al,[112] 2016	45	385	11.7 (8.7-15.3)	4.2
Dyrbye et al,[73] 2008	249	2230	11.2 (9.9-12.5)	4.5
Dyrbye et al,[74] 2014	375	4032	9.3 (8.4-10.2)	4.5
Summary Prevalence $I^2 = 77.7\%$, $\tau^2 = 0.03$, $P = .004$	685	6943	9.7 (8.0-11.7)	17.1
Suicidal Ideation Over Past 12 mo (Paykel Inventory)				
Tyssen et al,[194] 2001	74	522	14.2 (11.3-17.5)	4.4
Suicidal Ideation Over Past 2 wk (9-Item Patient Health Questionnaire)				
Sobowale et al,[160] 2014	26	348	7.5 (4.9-10.8)	4.0
Wege et al,[174] 2016	43	590	7.3 (5.3-9.7)	4.2
Summary Prevalence $I^2 = 0\%$, $\tau^2 = 0$, $P = .92$	69	938	7.4 (5.9-9.2)	8.3
Suicidal Ideation Over Past 2 wk (Primary Care Evaluation of Mental Disorders)				
Thompson et al,[165] 2010	13	43	30.2 (17.2-46.1)	3.4
Goebert et al,[79] 2009	80	1215	6.6 (5.3-8.1)	4.4
Summary Prevalence $I^2 = 96.3\%$, $\tau^2 = 1.59$, $P < .001$	93	1258	14.5 (2.8-50.2)	7.8
Pooled Summary Estimate $I^2 = 95.8\%$, $\tau^2 = 0.32$, $P < .001$	2043	21.002	11.1 (9.0-13.7)	100.0



Contributing studies are stratified by screening modality and sorted by increasing sample size. The dotted line marks the overall summary estimate for all studies, 11.1% (2043/21 002 individuals; 95% CI, 9.0%-13.7%; $Q = 547.1$, $\tau^2 = 0.32$, $I^2 = 95.8\%$, $P < .001$). The area of each square is proportional to the inverse variance of the estimate. Horizontal lines indicate 95% CIs of the estimate.

ARTICLE INFORMATION

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