Meta-Analysis of Observational Studies in Epidemiology

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Prevalence of burnout in medical students in China

A meta-analysis of observational studies

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Abstract

This meta-analysis aimed to estimate the prevalence of burnout among medical students in China.

A systematic search from the following electronic databases: China National Knowledge Infrastructure, Wangfang database, VIP database, Chinese biomedical literature database, PubMed, Embase, Web of Science, and Google Scholar was independently conducted by 2 reviewers from inception to September 2019. The data were analyzed using stata software Version 11. Heterogeneity was assessed using I^2 tests, and publication bias was evaluated using funnel plots and Egger's test. The source of heterogeneity among subgroups was determined by subgroup analysis of different parameters.

A total of 48 articles with a sample size of 29,020 met the inclusion criteria. The aggregate prevalence of learning burnout was 45.9% (95% confidence interval [CI] = 38.1%–53.8%). The prevalence rate of high emotional exhaustion was 37.5% (95% CI: 21.4%–53.7%). The percentage was 44.0% (95% CI: 29.2%–58.8%) for low personal accomplishment. The prevalence rate was 36.0% (95% CI: 23.0%–48.9%) in depersonalization dimension. In the subgroup analysis by specialty, the prevalence of burnout was 30.3% (95% CI: 28.6%–32.0%) for clinical medicine and 43.8% (95% CI: 41.8%–45.8%) for other medical specialties. The total prevalence of burnout between men and women was 46.4% (95% CI: 44.8%–47.9%) and 46.6% (95% CI: 45.5%–47.6%), respectively. The prevalence of burnout with Rong Lian's scale was 43.7% (42.1%–45.2%), and that with the other scales was 51.4% (50.4%–52.4%). The prevalence rates were 62.9% (61.3%–64.6%), 58.7% (56.3%–61.1%), 46.5% (42.9%–50.2%), and 56.0% (51.6%–60.4%) from Grades 1 to 4, respectively. There was a statistically significant difference among the different grades ($P = .000$).

Our findings suggest a high prevalence of burnout among medical students. Society, universities, and families should take appropriate measures and allot more care to prevent burnout among medical students.

Abbreviation: CI = confidence interval.

Keywords: burnout, medical students, meta-analysis, prevalence

1. Introduction

According to Maslach and Jackson, burnout is a psychological syndrome involving emotional exhaustion, depersonalization, and reduced personal accomplishment that occurs among individuals from a specific environment.[1] Emotional exhaustion in humans is defined as a state of overextension and feeling emotionally drained. Individuals who experience burnout feel empty, lack energy, and fail to communicate well with others. Depersonalization refers to the attitude of employees interacting with colleagues in a negative, cold, and indifferent manner. Gradually, they develop contemptuous conceptions of cynicism. The personal achievement category is affected by low self-esteem, reflecting the feeling of being ineffective at work and not being up for the position.[2,3] Burnout mainly includes job/professional and study/academic/learning burnout.

The learning burnout of students includes: emotional exhaustion, which refers to the fatigue caused by students' strong study needs; depersonalization, considered a development of skepticism and apathy toward the research; and low professional efficacy, manifested as the low learning efficiency of students.[4,5] Presently, the study of medicine is more complex, which highlights the characteristics of professionalism, autonomy, and exploration. Medical students are in a critical period of physical and mental development, while learning knowledge and skills. Given that most medical students will inevitably become doctors and specialize in a particular profession, they experience more mental stress and academic pressure than other college students.[6]

Editor: Chiedu Eseadi.

YL and LC contributed equally to this work.

This study was funded from the National Natural Science Foundation of China (NSFC-81960583).

All relevant data are within the paper and its Supporting Information files.

The authors have no conflict of interest to disclose.

Supplemental Digital Content is available for this article.

All data generated or analyzed during this study are included in this published article [and its supplementary information files]. The datasets generated during and/or analyzed during the current study are publicly available.

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How to cite this article: Li Y, Cao L, Mo C, Tan D, Mai T, Zhang Z. Prevalence of burnout in medical students in China: A meta-analysis of observational studies. Medicine 2021;100:26(e26329).

Received: 17 August 2020 / Received in final form: 29 April 2021 / Accepted: 26 May 2021

http://dx.doi.org/10.1097/MD.0000000000026329

If medical students are not able to relieve themselves of pressure, negative effects may occur. For example, burnout has been linked to medical errors, job failures, substance abuse, depression and suicidal ideation, and the rates of burnout among doctors have been rising in recent years.[7,8] Previous studies, among residents and medical students,[9,10] have found that the prevalence of burnout ranged from 17.6% to 82%. Although China has the highest number of medical practitioners worldwide, studies on the experiences of Chinese medical students are poorly represented in the English language literature.[11]

The characteristics and influencing factors in Chinese medical students' learning burnout must be explored, and possible solutions must be developed to prevent learning burnout among medical students. Through this, medical students can better adapt to the environment and serve in their future careers.

2. Materials and methods

2.1. Literature search

A systematic search from the following electronic databases: China National Knowledge Infrastructure, Wangfang database, VIP database, Chinese biomedical literature database, PubMed, Embase, Web of Science, and Google Scholar was independently conducted by 2 reviewers. Literature retrieval included relevant research papers published in English or Chinese from inception to September 2019. Primary studies with all possible combinations of the Medical Subject Heading terms burnout, burn out, professional burnout, study burnout, medicine, medical students, and China were identified. Published articles were chosen; hence, ethical approval was not required.

2.2. Inclusion criteria and exclusion criteria

These studies were included in this meta-analysis if:

(1) studies on learning burnout were published in China and abroad;
(2) medical students (including all medical specialties);
(3) the study was designed as a cross-sectional study;
(4) the literature reported the sample number of medical students and the prevalence rate of learning burnout, or the prevalence rate could be calculated from the data in the light of the articles.

The exclusion criteria were as follows:

(1) repeated publications;
(2) literature whose data cannot be used;
(3) literature with incomplete information; and
(4) non-Chinese or English literature.

Discrepancies were resolved through discussion.

2.3. Data extraction

The following data were recorded:

(1) name of the first author,
(2) year of publication,
(3) sample size,
(4) prevalence rate of learning burnout,
(5) name of journal, and
(6) questionnaire return ratio.

Additional information was extracted when required. The collection information is shown in supplementary Table 1, http://links.lww.com/MD2/A256. When necessary, the original authors were contacted for additional information.

2.4. Quality assessment

The Newcastle–Ottawa Scale for nonrandomized studies was used to assess the quality of our study.[12] The criteria were divided into 3 categories:

(1) selection (4 items),
(2) comparability (1 item), and
(3) exposure in case–control studies (2 items).

A study was awarded a maximum of 1 star for each item. This is true for every term, except for the comparability of the 2 stars. The higher the score, the better the quality. Scores of 0 to 3, 4 to 6, and 7 to 9 were regarded as reflecting low, medium, and high quality, respectively.

2.5. Statistical analysis

The data were analyzed using Stata version 11.0 (Stata Corporation, College Station, TX). The prevalence of burnout and 95% confidence intervals (CIs) were calculated using a random-effects model. I^2 represents the proportion of total variation attributable to between-study heterogeneity rather than random error or chance. I^2 values were 25%, 50%, and 75%, indicating low, medium, and high heterogeneity, respectively. Generally, a random-effect model was selected to calculate the corresponding parameters if the value of I^2 was greater than 50%.[13,14] Otherwise, a fixed-effects model was used. Funnel plot and Egger's test were used to evaluate publication bias and the statistical publication bias was set at $P < .10$.[15] The source of heterogeneity among subgroups was determined by subgroup analysis of different parameters.

3. Results

3.1. Characteristics of the studies

The search strategy obtained 1008 articles from all the databases. A total of 89 studies remained and 919 papers were excluded because they were reviews, duplicates, or irrelevant studies. After reading the full text of the 89 papers, 48 articles meeting the inclusion criteria in our meta-analysis were selected (Fig. 1).[16–63] The characteristics of the included studies are summarized in Table 1. The included studies were graded as moderate or high according to the Newcastle–Ottawa Scale (Table 2).

3.2. Aggregate prevalence of burnout

A heterogeneity test was carried out for 48 studies, and the P value was $<.10$, and I^2 was 99.6%, indicating that considerable heterogeneity was present. Therefore, the random-effects model was used for the meta-analysis. The aggregate prevalence of learning burnout was 45.9% (95% CI = 38.1%–53.8%), as shown in Figure 2.

3.3. Analysis of 3 subitems of the incidence of burnout

1) *Emotional exhaustion*

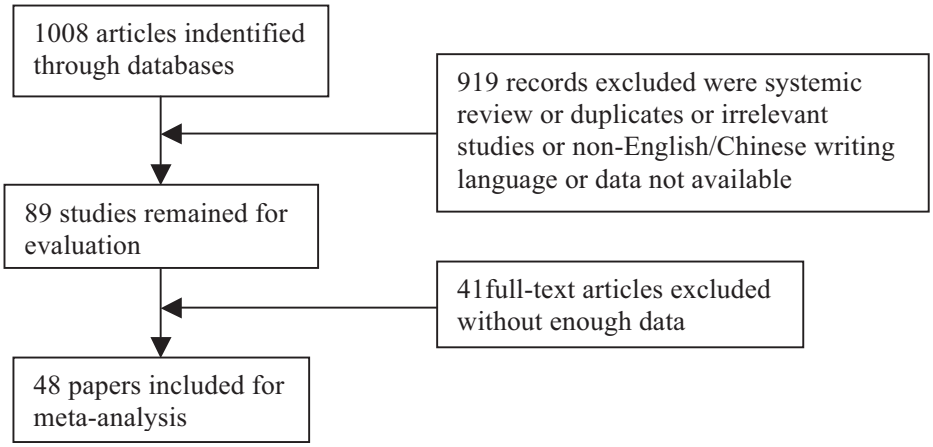

Figure 1. A flowchart of study selection.

Table 1

Basic characteristics of the studies in the meta-analysis.

Study	Sample size	Number of burnout	Response rate (%)	Mean age	Prevalence of burnout (%)	Specialty	Investigation table
YC Zhang, 2017	248	113	93.94	20.51 ± 1.71	45.56	Medicine	Rong Lian
YM Wei, 2016	304	187	95	22.16 ± 1.5	61.5	Clinical medicine	Rong Lian
LJ Yang, 2015	289	205	94.5	NM	70.9	Medicine	Yongxin Li
K Li, 2018	586	72	100	NM	12.3	Medicine	Rong Lian
Y Liao, 2011	627	627	98.9	NM	52.15	Medicine	Rong Lian
K Zhang, 2017	283	119	81	NM	42.05	Clinical medicine	Rong Lian
H Liu, 2015	400	158	100	NM	39.5	Medicine	Rong Lian
H Wu, 2015	739	739	92.61	NM	45.06	Rural oriented medical students	Rong Lian
HC Zhu, 2012	87	62	87	NM	71.1	Medical students(7 yrs)	MBI-GS
X Wang, 2018	1211	934	90.24	NM	77.13	Nurse	MBI-SS
TP Wang, 2017	600	224	91.88	NM	37.3	Examination and pharmacy	Rong Lian
XH Yang, 2015	775	441	96.9	NM	57.35	Medicine	Rong Lian
SX Zhang, 2016	771	344	86	NM	44.6	Medicine	Rong Lian
PY Su, 2018	944	684	99.16	17–22	72.5	Medicine	Rong Lian
L Liu, 2018	619	216	95.2	NM	34.9	Medicine	Rong Lian
SJ Yu, 2018	355	355	88.75	NM	78.9	Medicine	Rong Lian
L Li, 2018	1368	492	93.25	NM	36	Medicine	Rong Lian
JH Zhai, 2014	635	264	90.71	NM	41.65	Medicine	Rong Lian
L Li, 2017	600	224	91.88	NM	37.3	Medicine	Rong Lian
PY Liang, 2017	634	243	90.1	NM	38.33	Medicine	Rong Lian
Y Zhu, 2012	184	69	76.2	20–25	37.5	Medicine	Rong Lian
XF Zeng, 2014	523	142	97.39	NM	27.15	Medicine	Qizhi Zhang
YZ Li, 2014	260	67	96.3	NM	25.8	Medicine	Rong Lian
Y Zhang, 2018	350	178	91.1	17–24	50.8	Nurse	Rong Lian
Tian L, 2019	1814	1516	37	NM	83.6	Neurology postgraduates	Maslach C
Liu H, 2018	453	42	58.08	20.21 ± 1.46	9.27	Medicine	MBI-SS
Zukelatalaiti, 2012	637	153	96.51	NM	45.13	Medicine	Rong Lian
DL Yang, 2011	576	210	96	NM	36.46	Medicine	Rong Lian
P Xu, 2009	610	241	93.8	17–24	39.5	Medicine	Rong Lian
YJ Hui, 2012	1835	1218	95.32	NM	66.4	Nurse	Rong Lian
LH Lu, 2018	2431	1134	97.24	NM	46.65	Medicine	Rong Lian
L Chen, 2013	443	68	98.44	NM	15.3	Nurse	Rong Lian
YY Li, 2017	282	278	88.1	NM	98.6	Nurse	Rong Lian
R Sun, 2012	350	120	100	NM	34.4	Nurse	Rong Lian
P Hao, 2015	1092	314	96.98	19.34 ± 1.42	28.75	Nurse	Rong Lian
YX Li, 2007	90	69	NM	NM	76.7	Medicine	Yongxin Li
DB Li, 2016	483	216	96.6	NM	44.72	Medicine	NM
HJ Ma, 2018	586	72	100	NM	12.3	Medicine	Rong Lian
ZP Li, 2013	367	109	93.62	NM	29.7	Medicine	Rong Lian
P Hao, 2013	592	179	97.21	NM	30.24	Nurse	Rong Lian

(*continued*)

Table 1

(continued).

Study	Sample size	Number of burnout	Response rate (%)	Mean age	Prevalence of burnout (%)	Specialty	Investigation table
SX Lv, 2014	927	697	91.2	NM	75.19	Medicine	Rong Lian
F Jiang, 2009	309	117	96.56	NM	37.86	Nurse	Rong Lian
T Tang, 2019	588	128	90.46	NM	21.77	Medicine	Yongxin Li
XF Yu, 2015	290	137	93.55	NM	47.24	Medicine	Rong Lian
L Yang, 2014	202	83	84	NM	41.09	Nurse	Rong Lian
Y Pan, 2012	170	117	94.4	NM	68.82	Medicine	NM
JH Ma, 2014	192	81	96	21.4 ± 0.5	42.19	Nurse	Rong Lian
LY Zhou, 2010	309	112	96.56	19–23	36.25	Nurse	Rong Lian

NM = not mentioned.

Table 2

Quality assessment of included studies using the Newcastle-Ottawa scale.

	Selection				Comparability		Outcome			
Study	Is the case definition adequate	Representativeness of the cases	Selection of controls	Definition of controls	Study controls for ———	Study controls for any additional factor	Ascertainment of exposure	Same method of ascertainment for cases and controls	Non-response rate	Score
YC Zhang, 2017	★	★	—	★	★	—	★	★	—	6
YM Wei, 2016	★	★	—	★	★	★	★	★	—	7
LJ Yang, 2015	★	★	—	★	★	—	★	★	—	6
K Li, 2018	★	★	—	★	★	—	★	★	★	7
Y Liao, 2011	★	★	—	★	★	—	★	★	—	6
K Zhang, 2017	★	★	—	★	★	★	★	★	—	7
H Liu, 2015	★	★	—	★	★	—	★	★	★	7
H Wu, 2015	★	★	—	★	★	—	★	★	—	6
HC Zhu, 2012	★	★	—	★	★	★	★	★	—	7
X Wang, 2018	★	★	—	★	★	—	★	★	—	6
TP Wang, 2017	★	★	—	★	★	—	★	★	—	6
XH Yang, 2015	★	★	—	★	★	—	★	★	—	6
SX Zhang, 2016	★	★	—	★	★	—	★	★	—	6
PY Su, 2018	★	★	—	★	★	—	★	★	—	6
L Liu, 2018	★	★	—	★	★	—	★	★	—	6
SJ Yu, 2018	★	★	—	★	★	—	★	★	—	6
L Li, 2018	★	★	—	★	★	—	★	★	—	6
JH Zhai, 2014	★	★	—	★	★	—	★	★	—	6
L Li, 2017	★	★	—	★	★	—	★	★	—	6
PY Liang, 2017	★	★	—	★	★	—	★	★	—	6
Y Zhu, 2012	★	★	—	★	★	—	★	★	—	6
XF Zeng, 2014	★	★	—	★	★	—	★	★	—	6
YZ Li, 2014	★	★	—	★	★	—	★	★	—	6
Y Zhang, 2018	★	★	—	★	★		★	★	—	6
Tian L, 2019	★	★	—	★	★	★	★	★	—	7
Liu H, 2018	★	★	—	★	★	—	★	★	—	6
Zukelatalaiti, 2012	★	★	—	★	★	—	★	★	—	6
DL Yang, 2011	★	★	—	★	★	—	★	★	—	6
P Xu, 2009	★	★	—	★	★	—	★	★	—	6
YJ Hui, 2012	★	★	—	★	★	—	★	★	—	6
LH Lu, 2018	★	★	—	★	★	—	★	★	—	6
L Chen, 2013	★	★	—	★	★	—	★	★	—	6
YY Li, 2017	★	★	—	★	★	—	★	★	—	6
R Sun, 2012	★	★	—	★	★	—	★	★	★	7
P Hao, 2015	★	★	—	★	★	—	★	★	—	6
YX Li, 2007	★	★	—	★	★	—	★	★	—	6
DB Li, 2016	★	★	—	★	★	—	★	★	—	6
HJ Ma, 2018	★	★	—	★	★	—	★	★	★	7
ZP Li, 2013	★	★	—	★	★	—	★	★	—	6
P Hao, 2013	★	★	—	★	★	—	★	★	—	6

(*continued*)

Table 2

(continued).

Study	Selection				Comparability		Outcome			
	Is the case definition adequate	Representativeness of the cases	Selection of controls	Definition of controls	Study controls for ———	Study controls for any additional factor	Ascertainment of exposure	Same method of ascertainment for cases and controls	Non-response rate	Score
SX Lv, 2014	★	★	—	★	★	—	★	★	—	6
F Jiang, 2009	★	★	—	★	★	—	★	★	—	6
T Tang, 2019	★	★	—	★	★	—	★	★	—	6
XF Yu, 2015	★	★	—	★	★	—	★	★	—	6
L Yang, 2014	★	★	—	★	★	—	★	★	—	6
Y Pan, 2012	★	★	—	★	★	—	★	★	—	6
JH Ma, 2014	★	★	—	★	★	—	★	★	—	6
LY Zhou, 2010	★	★	—	★	★	—	★	★	—	6

The prevalence rate of high emotional exhaustion was 37.5% (95% CI: 21.4%–53.7%). Figure 3 shows a forest plot with high EE.

2) *Low personal accomplishment*

The percentage was 44% (95% CI: 29.2%–58.8%) for low personal accomplishment. Figure 4 illustrates the forest plot of low PA.

3) *Depersonalization*

The prevalence rate was 36.0% (95% CI: 23.0%–48.9%) in the depersonalization dimension. A forest plot of a high DP is shown in Figure 5.

3.4. Total publication bias

Publication bias was found through the asymmetric funnel plot and the results of the Egger's test (Fig. 6) (Begg's score <0.1).

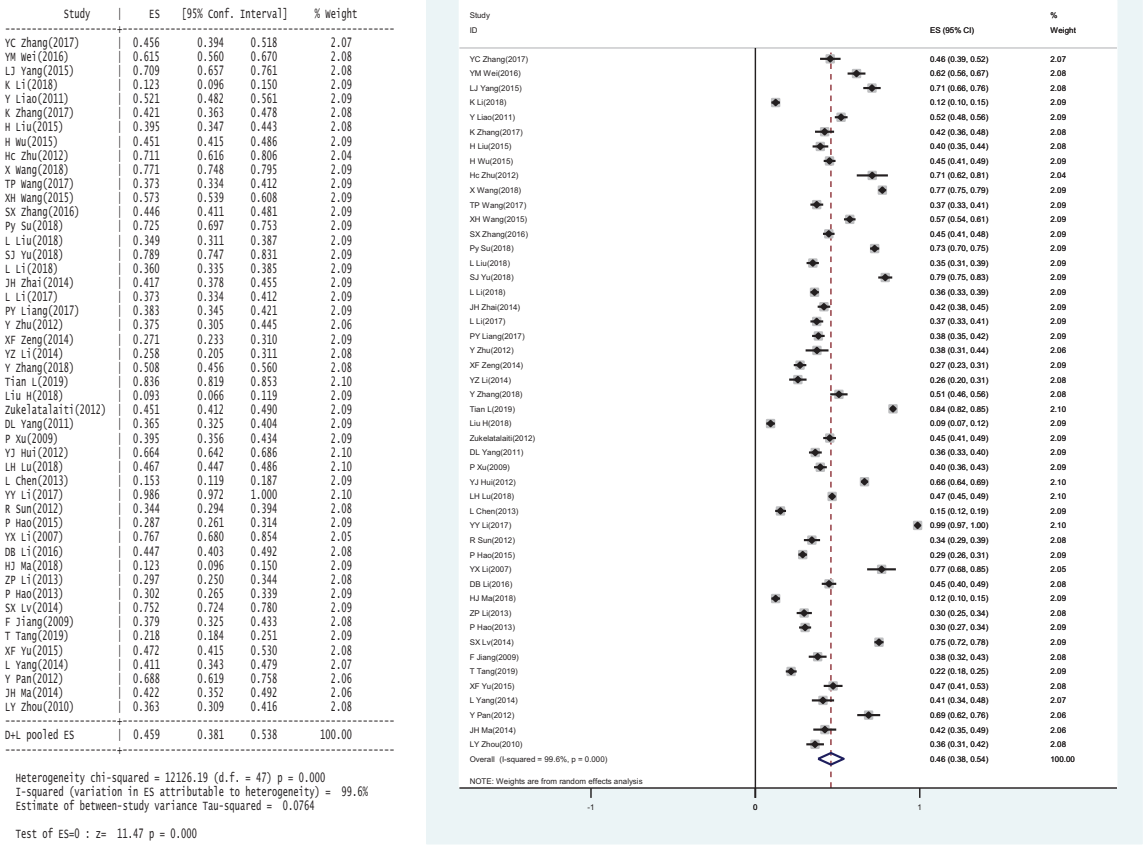

Figure 2. The aggregate prevalence of burnout in all residents.

Study	ES	[95% Conf.	Interval]	% Weight
YM Wei(2016)	0.421	0.366	0.476	8.29
K Li(2018)	0.247	0.212	0.282	8.34
Y Liao(2011)	0.549	0.510	0.588	8.33
H Wu(2015)	0.349	0.315	0.384	8.34
Hc Zhu(2012)	0.069	0.016	0.122	8.30
X Wang(2018)	0.765	0.741	0.789	8.36
SX Zhang(2016)	0.565	0.530	0.600	8.34
LH Lu(2018)	0.509	0.489	0.529	8.36
L Chen(2013)	0.025	0.010	0.040	8.37
R Sun(2012)	0.311	0.263	0.359	8.31
HJ Ma(2018)	0.247	0.212	0.282	8.34
F Jiang(2009)	0.443	0.388	0.499	8.29
D+L pooled ES	0.375	0.214	0.537	100.00

Heterogeneity chi-squared = 3732.76 (d.f. = 11) p = 0.000
I-squared (variation in ES attributable to heterogeneity) = 99.7%
Estimate of between-study variance Tau-squared = 0.0812

Test of ES=0 : z= 4.55 p = 0.000

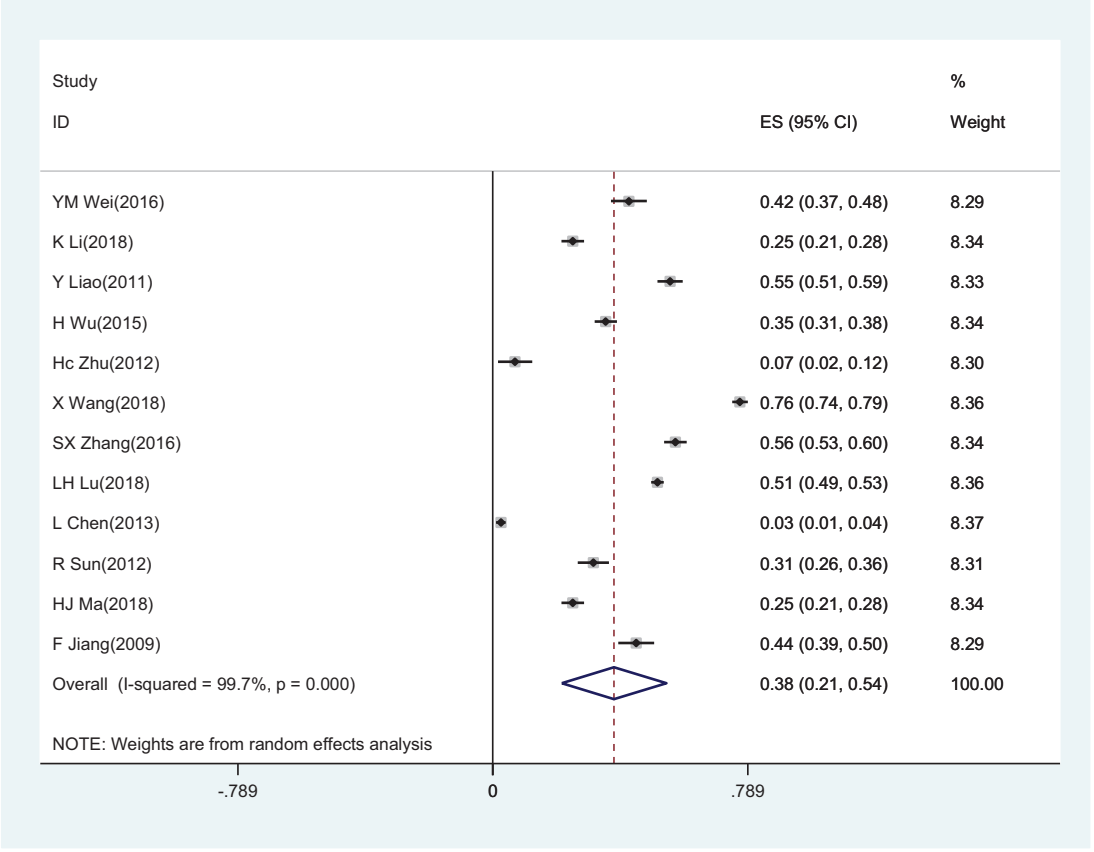

Figure 3. The aggregate prevalence of emotional exhaustion.

3.5. The result of trim and filling

The following figure shows the funnel plot obtained after the addition of the 11 studies. The "squares" in the figure are additional studies. The funnel plot obtained after the addition of 11 studies showed no obvious asymmetry, indicating no publication bias (Fig. 7).

3.6. The results of combined effect before trim and filling

The results of fixed- and random-effects were all statistically different ($P = .0000$) in the values before and after trim and filling. The estimated values of the combined effect did not change significantly, indicating that the effect of publication bias was not significant and the results were relatively stable (Fig. 8).

3.7. Subgroup analysis

Factors that may lead to heterogeneity were analyzed, such as gender, specialty, and the scale of burnout by subgroup. The results showed high heterogeneity; hence, the random-effects model was adopted to combine the effect size.

In the subgroup analysis by specialty, the prevalence of burnout was 30.3% (95% CI: 28.6%–32.0%) for clinical medicine and 43.8% (95% CI: 41.8%–45.8%) for other medical

Study	ES	[95% Conf.	Interval]	% Weight
YM Wei(2016)	0.135	0.097	0.173	8.33
K Li(2018)	0.184	0.153	0.215	8.35
Y Liao(2011)	0.640	0.602	0.677	8.33
H Wu(2015)	0.444	0.408	0.480	8.34
Hc Zhu(2012)	0.966	0.928	1.004	8.33
X Wang(2018)	0.794	0.772	0.817	8.36
SX Zhang(2016)	0.446	0.411	0.481	8.34
LH Lu(2018)	0.330	0.312	0.349	8.37
L Chen(2013)	0.325	0.281	0.369	8.32
R Sun(2012)	0.406	0.355	0.457	8.30
HJ Ma(2018)	0.184	0.153	0.215	8.35
F Jiang(2009)	0.424	0.369	0.479	8.28
D+L pooled ES	0.440	0.292	0.588	100.00

Heterogeneity chi-squared = 2685.44 (d.f. = 11) p = 0.000
I-squared (variation in ES attributable to heterogeneity) = 99.6%
Estimate of between-study variance Tau-squared = 0.0679

Test of ES=0 : z= 5.83 p = 0.000

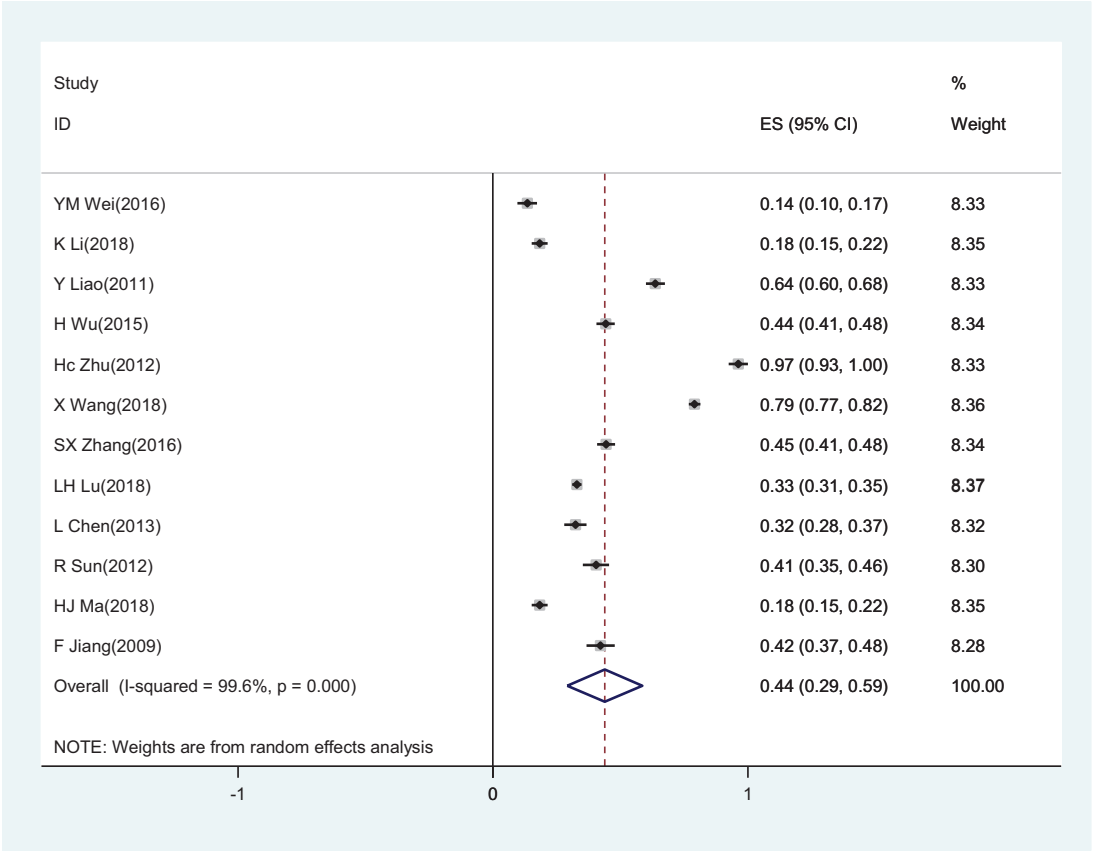

Figure 4. The aggregate prevalence of low personal accomplishment.

specialties. There was a statistically significant difference in the prevalence rate between different specialties. In the subgroup analysis by gender, the prevalence of burnout was 46.4% (95% CI: 44.8%–47.9%) for males and 46.6% (95% CI: 45.5%–47.6%) for females. The difference in the prevalence rate between men and women was not statistically significant ($P = .093$). In the subgroup analysis by selecting the scale, the prevalence of burnout was 43.7% (42.1%–45.2%) with the scale conducted by Rong Lian, and the prevalence of burnout was 51.4% (50.4%–52.4%) with the other scale. The difference in prevalence rates with different scales was statistically significant ($P = .000$). The prevalence rates were 62.9% (61.3%–64.6%), 58.7% (56.3%–61.1%), 46.5% (42.9%–50.2%), and 56.0% (51.6%–60.4%) from Grades 1 to 4, respectively. Statistical significance was observed among the different grades ($P = .000$) (Table 3).

4. Discussion

The results of our meta-analysis, which included 48 articles and 29,020 subjects, can be summarized as follows: 45.9% (95% CI: 38.1%–53.8%) of Chinese medical students reported burnout syndrome. The results showed that low personal accomplishment was the most widespread dimension affecting medical students' learning burnout accounting for 44% of the sample. This was followed by high emotional exhaustion, which occurred in 37.5% of the medical students in our meta-analysis. The lowest prevalence was depersonalization, which affected 36% of medical students. These mean that students showed high levels of emotional exhaustion, low personal accomplishment, and high depersonalization. The burnout prevalence among medical students is around 44% in the worldwide according to the findings of Frajerman et al.[64] The prevalence of learning burnout among Chinese medical students is on par with the worldwide burnout prevalence. The prevalence and trend of burnout in personal accomplishment, emotional exhaustion, and depersonalization were similar to Kansoun Ziad's study of French physicians.[65] The prevalence of burnout was higher than that of medical students (35% in Germany),[66] 40.4% for medical students in 2016 (in Spanish),[67] in Australia (6%),[68]

Study	ES	[95% Conf.	Interval]	% Weight
YM Wei(2016)	0.059	0.033	0.085	8.39
K Li(2018)	0.084	0.062	0.106	8.40
Y Liao(2011)	0.405	0.367	0.444	8.36
H Wu(2015)	0.617	0.581	0.652	8.37
Hc Zhu(2012)	0.529	0.424	0.634	7.98
X Wang(2018)	0.323	0.297	0.349	8.39
SX Zhang(2016)	0.441	0.406	0.476	8.37
LH Lu(2018)	0.580	0.560	0.600	8.40
L Chen(2013)	0.325	0.281	0.369	8.34
R Sun(2012)	0.482	0.430	0.534	8.31
HJ Ma(2018)	0.084	0.062	0.106	8.40
F Jiang(2009)	0.401	0.347	0.456	8.30
D+L pooled ES	0.360	0.230	0.489	100.00

Heterogeneity chi-squared = 2291.59 (d.f. = 11) p = 0.000
I-squared (variation in ES attributable to heterogeneity) = 99.5%
Estimate of between-study variance Tau-squared = 0.0519

Test of ES=0 : z= 5.44 p = 0.000

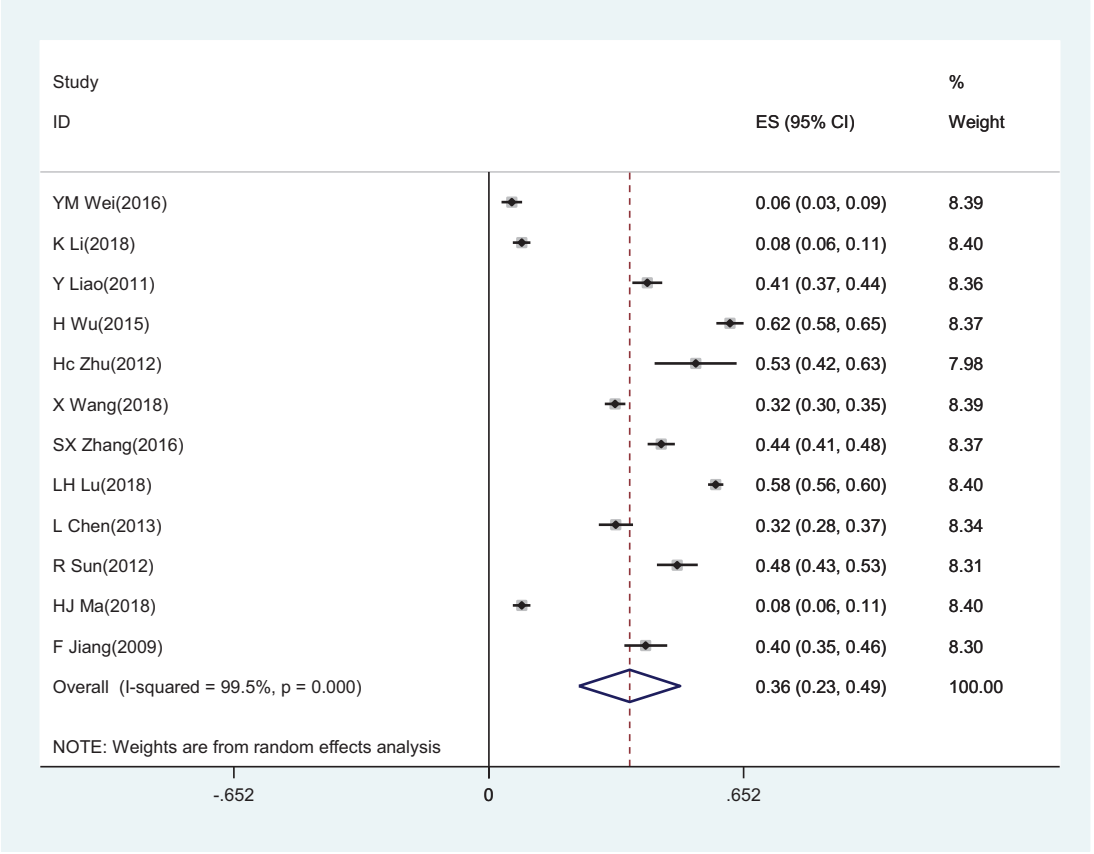

Figure 5. The aggregate prevalence of depersonalization.

and in Brazil (26.4%).[69] It was lower than dental students (50.3%),[67] medical students (55%, 56% in the US),[70,71] and (52%) in Trinidad and Tobago.[72] The rate of learning burnout is similar to that of foreign medical students. Concurrently, there are also higher and lower rates. These differences may be related to differences in the educational system between domestic and foreign medical students. The reason for this is that differences exist in the curriculum and the essential requirements of medical students in various countries. For example, some medical schools require a preliminary bachelor's degree.[73] However, some medical staff begin their studies without any preliminary higher education.[74,75] Concurrently, medical students have greater study pressure than do other professional college students.

The asymmetric funnel plot and the results of Egger's test in our meta-analysis showed that publication bias was present. The research found that publication bias may affect the main conclusions of at least 15% to 21% of the meta-analysis. The main conclusions were obtained by correcting for potential publication bias using the trim and fill method.[76] Thus, the trim and fill method was chosen to reanalyze the publication bias and found that the estimated value of the combined effect size did not change significantly, indicating that publication bias had little effect and the result was relatively stable.

In the subgroup analysis, male participants reported lower levels of burnout than female participants, which is consistent with many beliefs that burnout is more commonly experienced by female employees. However, further studies are needed to elucidate the relationship between gender and burnout among medical students. The prevalence of burnout was 30.3% (28.6%–32.0%) and 43.8% (41.8%–45.8%) for clinical medicine and other medical specialties, respectively, in the subgroup analysis. The prevalence was lower for clinical medicine than for

Begg's Test

adj. Kendall's Score (P-Q) = -312
Std. Dev. of Score = 112.51 (corrected for ties)
Number of Studies = 48
z = -2.77
Pr > |z| = 0.006
z = 2.76 (continuity corrected)
Pr > |z| = 0.006 (continuity corrected)

Egger's test

Std_Eff	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
slope	.0146262	.0365596	0.40	0.691	-.0589645	.0882169
bias	-16.08793	1.277418	-12.59	0.000	-18.65924	-13.51662

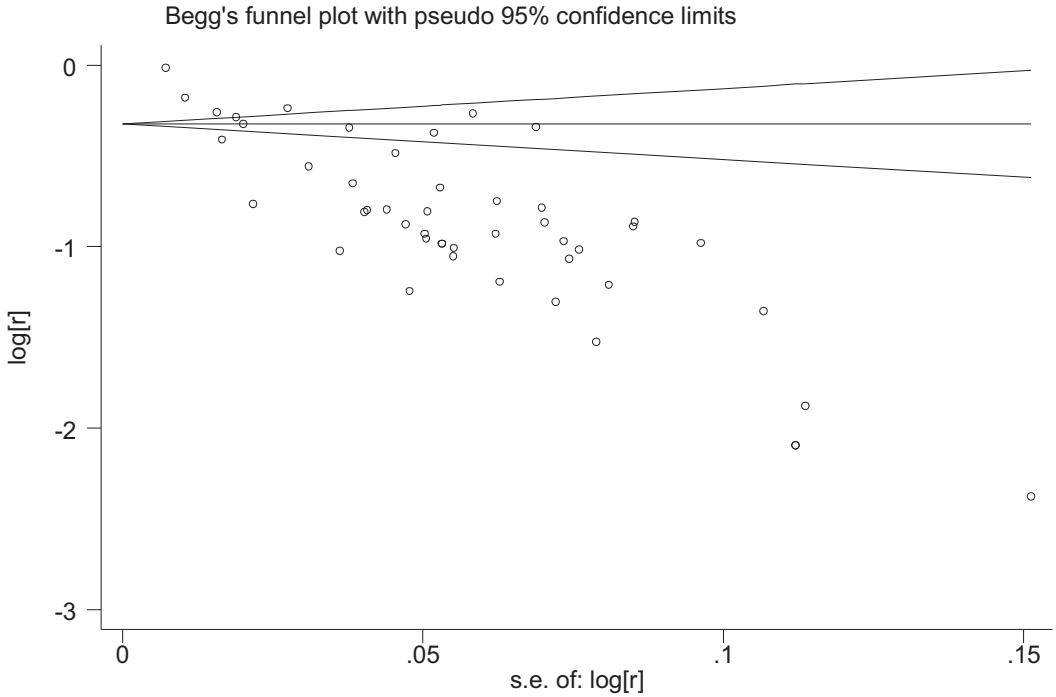

Figure 6. The asymmetric funnel plot of publication bias.

other medical specialties. This trend was consistent with other studies conducted by Montiel-Company José María[70] and Montiel-Company.[67] In the subgroup analysis, the prevalence of burnout was 43.7% and 51.4% for selecting the scale by Rong Lian et al. In our meta-analysis, the vast majority of researchers selected Rong-Lian scale. Based on the burnout scale by Marlach, Rong Lian compiled a burnout scale suitable for Chinese college students according to their characteristics. The prevalence of burnout was different, partly due to the different scales. The investigators mainly chose the Maslach Burnout Inventory (MBI-SS) to study the burnout of college students in foreign papers.[77,78] Our results showed that the burnout rate was the highest at 62.9% (61.3%–64.6%) in freshman year and the lowest at 46.5% (42.9%–50.2%) in junior year. Ultimately, a statistically significant difference was observed. This is similar to Altannir Youssef's results that the first-year medical students have higher levels of burnout compared with other year medical students.[79] It may be concerned with the freshmen merely entering the campus and not adapting well to the environment. The results of Thun-Hohenstein et al showed that the first-year medical students have lower levels of burnout compared with other year medical students. This is the opposite of what we found. The cause may be related with feeling for good fairness and high values, that is, motivation for the first-year students before a high workload (e.g., information to be learned) coming.[80]

5. Limitations

This meta-analysis has several limitations. First, high heterogeneity existed in the subgroup analysis of all influencing factors. Second, certain specialties in this meta-analysis were underrepresented. The distribution of the number of residents per specialty is uneven. Many references were included for the selected scale, and few were included for the major and gender, which had some influence on the results of the subgroup analysis. Third, publication bias was present because unpublished literature or data were not collected. Therefore, subgroup analysis based on continents should be interpreted with caution.

6. Conclusions

Our findings suggest a high prevalence of burnout among medical students. Society, universities, and families should take appropriate measures and allot more care to prevent burnout among medical students.

```
Meta-analysis

       |  Pooled      95% CI         Asymptotic      No. of
Method |     Est   Lower   Upper  z_value  p_value   studies
-------+-----------------------------------------------------
Fixed  |  -0.323  -0.331  -0.315  -78.253    0.000     48
Random |  -0.876  -0.987  -0.766  -15.532    0.000

Test for heterogeneity: Q= 7396.045 on 47 degrees of freedom (p= 0.000)
Moment-based estimate of between studies variance =  0.149

Trimming estimator: Linear
Meta-analysis type: Random-effects model

iteration |  estimate    Tn    # to trim     diff
----------+-----------------------------------------
    1     |   -0.876    613         1        1176
    2     |   -0.893    645         2          64
    3     |   -0.909    673         4          56
    4     |   -0.940    725         6         104
    5     |   -0.971    763         7          76
    6     |   -0.987    786         8          46
    7     |   -1.003    811         9          50
    8     |   -1.020    833        10          44
    9     |   -1.037    850        11          34
   10     |   -1.051    861        11          22
   11     |   -1.051    861        11           0

Warning: iterative algorithm did not converge

Filled
Meta-analysis (exponential form)

       |  Pooled      95% CI         Asymptotic      No. of
Method |     Est   Lower   Upper  z_value  p_value   studies
-------+-----------------------------------------------------
Fixed  |   0.357   0.355   0.360 -331.156    0.000     59
Random |   0.346   0.275   0.435   -9.051    0.000

Test for heterogeneity: Q=  7.5e+04 on 58 degrees of freedom (p= 0.000)
Moment-based estimate of between studies variance =  0.807
```

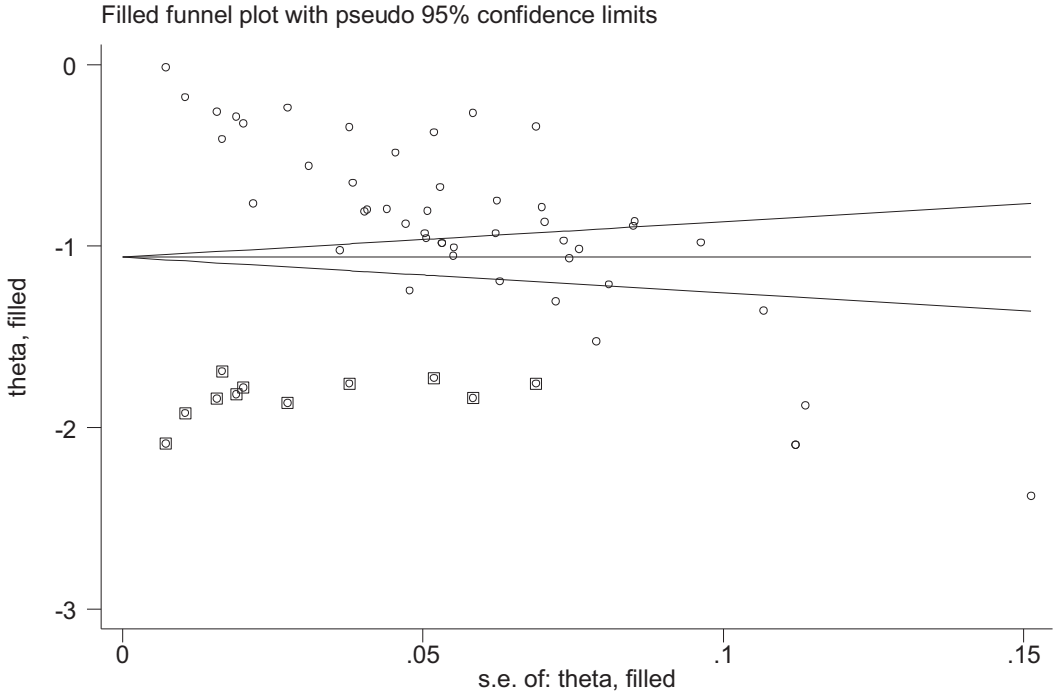

Figure 7. The asymmetric funnel plot of publication bias after trim and filling.

Table 3

Prevalence of burnout in residents by subgroup analysis.

Parameter	Document number	Sample size (n)	Burnout prevalence (%) and 95% CI	I^2 (%)	*P*	Pz
Gender						
Male	11	2443	46.4% (44.8–47.9)	99.0	.000	0.093
Female	11	5016	46.6% (45.5–47.6)	99.6	.000	
Specialty						
Clinical medicine	5	1659	30.3% (28.6–32.0)	99.3	.000	0.000
Other medicine	5	1343	43.8% (41.8–45.8)	99.4	.000	
Scale						
Rong Lian	38	23,312	43.7% (42.1–45.2)	99.6	.000	0.000
Other scale	10	5708	51.4% (50.4–52.4)	99.7	.000	
Grade						
1	8	2716	62.9% (61.3–64.6)	98.9	.000	0.000
2	6	1322	58.7% (56.3–61.1)	98.3	.000	
3	4	555	46.5% (42.9–50.2)	98.3	.000	
4	3	380	56.0% (51.6–60.4)	98.2	.000	

CI, confidence interval; Pz, the comparison between subgroups.

```
Meta-analysis

       |  Pooled      95% CI          Asymptotic      No. of
Method |     Est   Lower   Upper  z_value  p_value   studies
-------+-----------------------------------------------------
Fixed  |  -0.323  -0.331  -0.315  -78.253    0.000     48
Random |  -0.876  -0.987  -0.766  -15.532    0.000

Test for heterogeneity: Q= 7396.045 on 47 degrees of freedom (p= 0.000)
Moment-based estimate of between studies variance =  0.149

Trimming estimator: Linear
Meta-analysis type: Random-effects model

iteration |  estimate    Tn    # to trim     diff
----------+-------------------------------------
     1    |   -0.876   613         1        1176
     2    |   -0.893   645         2          64
     3    |   -0.909   673         4          56
     4    |   -0.940   725         6         104
     5    |   -0.971   763         7          76
     6    |   -0.987   786         8          46
     7    |   -1.003   811         9          50
     8    |   -1.020   833        10          44
     9    |   -1.037   850        11          34
    10    |   -1.051   861        11          22
    11    |   -1.051   861        11           0

Warning: iterative algorithm did not converge

Filled
Meta-analysis (exponential form)

       |  Pooled      95% CI          Asymptotic      No. of
Method |     Est   Lower   Upper  z_value  p_value   studies
-------+-----------------------------------------------------
Fixed  |   0.357   0.355   0.360 -331.156    0.000     59
Random |   0.346   0.275   0.435   -9.051    0.000

Test for heterogeneity: Q=  7.5e+04 on 58 degrees of freedom (p= 0.000)
Moment-based estimate of between studies variance =  0.807

. meta r _LCI _UCI, ci eform

Meta-analysis (exponential form)

       |  Pooled      95% CI          Asymptotic      No. of
Method |     Est   Lower   Upper  z_value  p_value   studies
-------+-----------------------------------------------------
Fixed  |   0.724   0.718   0.730  -78.253    0.000     48
Random |   0.416   0.373   0.465  -15.532    0.000

Test for heterogeneity: Q= 7396.045 on 47 degrees of freedom (p= 0.000)
Moment-based estimate of between studies variance =  0.149
```

Figure 8. The results of combined effect before trim and filling.

Acknowledgments

We would like to thank all the authors.

Author contributions

Conceptualization: You Li, Zhiyong Zhang.
Data curation: Liang Cao, Chunbao Mo, Dechan Tan, Tingyu Mai.
Formal analysis: Liang Cao.
Investigation: Liang Cao.
Methodology: Chunbao Mo.
Supervision: Dechan Tan.
Validation: Tingyu Mai.
Visualization: Liang Cao.
Writing – original draft: You Li.
Writing – review & editing: Zhiyong Zhang.

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