frontiers

Supplementary Material

Multidimensional evaluation of teaching strategies for pharmacology based on a comprehensive analysis involving 21,269 students

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1 Supplementary Tables

Table S1. Search strategy for the PubMed.

No.	Search terms
#1	education (mesh terms)
#2	teaching method (mesh terms)
#3	teaching strategy (mesh terms)
#4	(((((PBL[tiab]) OR (problem-based learning[tiab])) OR (case-based learning[tiab])) OR (CBL[tiab])) OR (TBL[tiab])) OR (team-based learning[tiab])
#5	((((((((((((((((((flipped classroom[tiab]) OR (FC[tiab])) OR (MC[tiab])) OR (micro classroom[tiab])) OR (flipped class[tiab])) OR (flipped class[tiab])) OR (active learning[tiab])) OR (evidence-based medicine[tiab])) OR (EBM[tiab])) OR (TDL[tiab])) OR (task driven learning[tiab])) OR (computer-based learning[tiab])) OR (blending learning[tiab])) OR (mixed teaching mode[tiab])) OR (MTM[tiab])) OR (BOPPPS[tiab])) OR (scaffolding teaching method[tiab])) OR (STM[tiab])
#6	#1 or #2 or #3 or #4 or #5
#7	Groups [tiab]
#8	Trial [tiab]
#9	Comparison [tiab]
#10	Comparative study [tiab]
#11	Randomized [tiab]
#12	Randomly [tiab]
#13	Randomized controlled trial [pt]
#14	#7 or #8 or #9 or #10 or #11 or #12 or #13
#15	pharmacology [tiab]
#16	#6, #14 and #15

Table S2. Characteristics of the included studies.

Study	Student major	Student degree	Student equivalence	Sample size (interv./Cont.)	Interv	Cont	Outcome measurements
Sajjad et al 2021[1]	Nursing	Undergraduate	NR	118/140	FC	LBL	①
Lockman et al 2017[2]	Pharmacy	Doctor	NSSD	162/156	FC	LBL	①
Wu et al 2022[3]	Medicine	Undergraduate	NSSD	73/85	FC+MC	LBL	①④⑤
El-Banna et al 2017[4]	Nursing	Undergraduate	NSSD	36/40	FC	LBL	①④
Guo et al 2018[5]	Nursing	Junior college student	NSSD	42/42	FC	LBL	①⑤
Wang et al 2017[6]	Medicine	Graduate	NSSD	148/152	FC	LBL	①③⑤
Liang et al 2019[7]	Nursing	Undergraduate	NSSD	50/50	FC	LBL	①④
Wang ZC et al 2020[8]	Medicine	Undergraduate	NSSD	38/34	FC	LBL	①
Ge et al 2019[9]	Pharmacy	Undergraduate	NR	35/34	FC	LBL	②⑤
Wang JN et al 2020[10]	Pharmacy	Junior college student	NSSD	27/27	FC	LBL	①②⑤
Fu et al 2022[11]	Medicine	Undergraduate	NSSD	64/66	FC	LBL	①④
Zhao XM et al 2019[12]	Pharmacy	Undergraduate	NR	22/29	FC+PBL	LBL	①
Wong et al 2014[13]	Pharmacy	Undergraduate	NSSD	101/103	FC	LBL	①
Zhao et al 2018[14]	Nursing	Junior college student	NSSD	80/78	FC	LBL	①
Fan et al 2020[15]	Medicine	Junior college student	NSSD	106/108	FC	LBL	①③
Wang H et al 2021[16]	Medicine	Junior college student	NR	41/41	FC+MC	LBL	①④
Ding et al 2022[17]	Medicine	Undergraduate	NR	80/80	FC	LBL	①③
Jia et al 2020[18]	Nursing	Junior college student	NSSD	180/180	FC	LBL	①⑤
Bao et al 2018[19]	Medicine	Undergraduate	NSSD	38/38	FC	LBL	①④
Yang XY et al 2021[20]	Medicine	Undergraduate	NR	32/32	FC	LBL	①⑤
Qin Z et al 2020[21]	Pharmacy	Undergraduate	NSSD	10/10	FC+BOPPPS +TBL	LBL	④
Ma et al 2022[22]	Medicine	Undergraduate	NSSD	45/45	MC+PBL	LBL	①③④
Song et al 2018[23]	Medicine	Undergraduate	NSSD	56/56	MC+PBL	LBL	①④⑤
Qin X et al 2020[24]	Pharmacy	Undergraduate	NSSD	30/29	MC+PBL	LBL	①⑤
Bai et al 2018[25]	Medicine	Undergraduate	NR	60/59	MC	LBL	⑤
Yang et al 2016[26]	Nursing	Junior college student	NSSD	80/80	MC	LBL	①②⑤
Yang LJ et al 2021[27]	Pharmacy	Undergraduate	NSSD	58/56	MC	LBL	①②
Ruan et al 2019[28]	Nursing	Junior college student	NSSD	72/74	MC	LBL	②
Fan et al 2019[29]	Pharmacy	Undergraduate	NSSD	47/47	MC	LBL	①⑤
Qin et al 2018[30]	Nursing	Junior college student	NSSD	68/72	MC	LBL	①
Kaur et al 2020[31]	Medicine	Undergraduate	NSSD	47/47	CBL	LBL	①
Vora et al 2015[32]	Medicine	Undergraduate	NR	34/34	CBL	LBL	①
Li S et al 2014[33]	Medicine	Undergraduate	NR	96/89	CBL	LBL	①

Kamat et al 2012[34]	Medicine	Undergraduate	NSSD	82/61	CBL	LBL	①
Chiranjeevi et al 2022[35]	Medicine	Undergraduate	NSSD	30/30	CBL	LBL	①
Xia et al 2017[36]	Medicine	Undergraduate	NSSD	56/56	CBL	LBL	①③⑤
Chen MJ et al 2015[37]	Medicine	Undergraduate	NR	135/135	CBL	LBL	①⑤
Wang JH et al 2012[38]	Medicine	Undergraduate	NR	98/95	CBL	LBL	①
Yang et al 2020[39]	Pharmacy	Undergraduate	NSSD	77/83	CBL	LBL	①
Li et al 2022[40]	Pharmacy	Undergraduate	NSSD	29/29	CBL	LBL	①④
Chen et al 2014[41]	Nursing	Junior college student	NSSD	116/122	CBL	LBL	①⑤
Liu XJ et al 2015[42]	Medicine	Junior college student	NSSD	30/31	CBL	LBL	①④
Yuan et al 2013[43]	Pharmacy	Undergraduate	NR	40/40	CBL	LBL	①⑤
Sui et al 2009[44]	Nursing	Junior college student	NR	141/129	CBL	LBL	①
Huang W et al 2017[45]	Medicine	Junior college student	NR	35/35	CBL	LBL	①⑤
Zheng et al 2020[46]	Pharmacy	Undergraduate	NSSD	39/39	CBL	LBL	①②③
Song et al 2010[47]	Pharmacy	Undergraduate	NSSD	55/43	CBL	LBL	①④
Wang et al 2014[48]	Nursing	Undergraduate	NR	89/90	CBL	LBL	①③⑤
Yin et al 2013[49]	Pharmacy	Junior college student	NR	100/100	CBL	LBL	①
Zou et al 2014[50]	Pharmacy	Junior college student	NR	50/50	CBL	LBL	①⑤
Wang et al 2010[51]	Nursing	Undergraduate	NR	65/63	CBL	LBL	①③
Song et al 2014[52]	Pharmacy	Junior college student	NSSD	60/62	CBL	LBL	⑤
Liu P et al 2014[53]	Medicine	Undergraduate	NSSD	149/141	CBL	LBL	①
Wang GP et al 2017[54]	Nursing	Junior college student	NSSD	48/49	CBL	LBL	①③
Yang et al 2017[55]	Medicine	Undergraduate	NSSD	30/32	CBL	LBL	①
Nie et al 2006[56]	Medicine	Undergraduate	NR	60/60	CBL	LBL	①
Feldman et al 1989[57]	Medicine	Undergraduate	NR	25/15	CoBL	LBL	①
MacFadyen et al 1993[58]	Medicine	Undergraduate	NSSD	26/28	CoBL	LBL	①④⑤
Hahne et al 2005[59]	Medicine	Undergraduate	NSSD	70/97	CoBL	LBL	①
Joseph et al 2021[60]	Medicine	Undergraduate	NSSD	40/40	CoBL	LBL	②⑤
Cui et al 2013[61]	Medicine	Undergraduate	NR	25/25	bilingual PBL	PBL	①
Yu et al 2016[62]	Medicine	Undergraduate	NR	156/156	bilingual CBL	CBL	①
Huang et al 2015[63]	Medicine	Undergraduate	NSSD	51/53	bilingual CBL	LBL	①③
Liu et al 2016[64]	Pharmacy	Undergraduate	NSSD	165/77	PBL+CBL vs.PBL	LBL	①④
Croteau et al 2011[65]	Nursing	Undergraduate	NSSD	53/110	PBL+CBL	LBL	①
Song et al 2021[66]	Medicine	Junior college student	NSSD	52/52	PBL+CBL	CBL	①②⑤
Wang SC et al 2021[67]	Pharmacy	Junior college student	NSSD	60/60	PBL+CBL	LBL	①②⑤
Li C et al 2019[68]	Medicine	Undergraduate	NR	100/50	PBL+CBL/PBL	LBL	①③⑤
Li HY et al 2019[69] Li HY et al 2020[70]	Medicine	Junior college student	NSSD	201/203	CBL+TBL	LBL	①②④

Ma et al 2017[71]	Medicine	Undergraduate	NR	48/48	PBL+CBL+TBL	LBL	②
Dai et al 2016[72]	Pharmacy	Undergraduate	NR	184/92	PBL+CBL+TBL	LBL	①
James et al 2016[73]	Medicine	Undergraduate	NR	116/70	TBL	LBL	④⑤
Zhou et al 2020[74]	Medicine	Junior college student	NSSD	50/50	TBL	LBL	①
Xia et al 2022[75]	Medicine	Undergraduate	NSSD	96/94	TBL	LBL	②⑤
Wu et al 2017[76]	Medicine	Undergraduate	NSSD	20/20	TBL	LBL	①④
Li et al 2013[77]	Pharmacy	Junior college student	NSSD	60/60	TBL	LBL	⑤
Carrasco et al 2021[78]	Medicine	Undergraduate	NSSD	403/266	TBL	LBL	①
Palappallil et al 2019[79]	Medicine	Undergraduate	NR	96/49	TDL/CBL	LBL	①
McCartney et al 2020[80]	Pharmacy	Undergraduate	NSSD	104/69	TBL	LBL	①
El-Banna et al 2020[81]	Nursing	Undergraduate	NSSD	36/40	TBL	LBL	①
Zgheib et al 2010[82]	Medicine	Undergraduate	NR	13/12	TBL	LBL	①
Persky et al 2012[83]	Pharmacy	Doctor	/	154	TBL	LBL	①
Kim et al 2020[84]	Medicine	Undergraduate	NSSD	49/43	TBL	LBL	①
Nguyen et al 2016[85]	Medicine	Undergraduate	NR	33/36	TBL	LBL	①
Dong et al 2019[86]	Nursing	Undergraduate	NR	50/50	TBL+MC	LBL	①②⑤
Xiang S et al 2015[87]	Nursing	Junior college student	NSSD	114/58	PBL	LBL	①⑤
Liu LJ et al 2014[88]	Nursing	Junior college student	NR	108/108	PBL	LBL	①
Wang XL et al 2012[89]	Nursing	Junior college student	NSSD	124/63	PBL	LBL	①⑤
Yang et al 2008[90]	Nursing	Undergraduate	NR	26/30	PBL	LBL	①
Yang et al 2021[91]	Nursing	Undergraduate	NR	150/150	PBL	LBL	①②
Yang et al 2015[92]	Nursing	Junior college student	NSSD	50/50	PBL	LBL	①⑤
Li et al 2020[93]	Medicine	Undergraduate	NSSD	28/28	CoBL	LBL	⑤
Jia et al 2021[94]	Pharmacy	Junior college student	NSSD	48/48	PBL	LBL	①
Li J et al 2014[95]	Medicine	Junior college student	NSSD	186/302	PBL	LBL	①②
Liang T et al 2017[96]	Nursing	Undergraduate	NSSD	25/25	PBL	LBL	①③④
Zhao et al 2014[97]	Medicine	Junior college student	NSSD	151/133	PBL	LBL	①⑤
Xiang S(2) et al 2015[98]	Medicine	Junior college student	NSSD	92/92	PBL	LBL	①⑤
Wang et al 2008[99]	Medicine	Undergraduate	NR	189/120	PBL	LBL	①③
Cao et al 2011[100]	Medicine	Undergraduate	NSSD	61/65	PBL	LBL	①
Zhao et al 2015[101]	Pharmacy	Undergraduate	NR	70/70	PBL	LBL	①
Chen et al 2007[102]	Medicine	Undergraduate	NSSD	45/39	PBL	LBL	①
Liang et al 2008[103]	Nursing	Undergraduate	NSSD	89/90	PBL	LBL	①③⑤
Wang YL et al 2017[104]	Nursing	Junior college student	NSSD	60/58	PBL	LBL	①
Chen et al 2017[105]	Pharmacy	Junior college student	NR	51/55	PBL	LBL	①②
Miller et al 2003[106]	Nursing	Undergraduate	NR	10/12	PBL	LBL	①④

Sengupta et al 2021[107]	Medicine	Undergraduate	NSSD	46/45	PBL+MTM	PBL	①④
Liang T(2) et al 2017[108]	Medicine	Undergraduate	NSSD	40/40	PBL	LBL	①③④
Herzig et al 2003[109]	Medicine	Undergraduate	NR	55/57	PBL	LBL	①
Chen L et al 2015[110]	Medicine	Undergraduate	NR	82/63	PBL	LBL	①
Fu et al 2016[111]	Medicine	Undergraduate	NR	54/134	PBL	LBL	①⑤
Yang Y et al 2018[112]	Pharmacy	Junior college student	NR	32/32	PBL	LBL	①
Guo et al 2013[113]	Nursing	Junior college student	NR	27/29	PBL	LBL	①
Li W et al 2014[114]	Medicine	Junior college student	NSSD	40/40	PBL	LBL	①⑤
Zhou et al 2012[115]	Pharmacy	Undergraduate	NR	34/34	PBL	LBL	①
Huang W(2) et al 2017[116]	Medicine	Junior college student	NR	40/40	PBL	LBL	①⑤
Li et al 2011[117]	Pharmacy	Undergraduate	NR	54/54	PBL	LBL	②
Song et al 2015[118]	Pharmacy	Undergraduate	NSSD	90/93	PBL	LBL	①⑤
Qin et al 2012[119]	Medicine	Undergraduate	NR	40/40	PBL	LBL	⑤
Jia et al 2013[120]	Pharmacy	Junior college student	NSSD	45/46	PBL	LBL	①②⑤
Gao et al 2015[121]	Pharmacy	Undergraduate	NSSD	60/58	PBL	LBL	①②⑤
Yang M et al 2018[122]	Medicine	Undergraduate	NSSD	30/30	PBL	LBL	①④
Song et al 2008[123]	Medicine	Undergraduate	NR	85/31	PBL	LBL	①⑤
Li et al 2017[124]	Pharmacy	Undergraduate	NSSD	98/96	PBL	LBL	①
Huo et al 2016[125]	Medicine	Undergraduate	NSSD	56/57	PBL	LBL	①⑤
Michel et al 2002a[126]	Medicine	Undergraduate	NR	28/56	PBL	LBL	①④
Michel et al 2002b[126]	Medicine	Undergraduate	NR	40/102	PBL	LBL	①④
Antepohl et al 1999[127]	Medicine	Undergraduate	NR	63/60	PBL	LBL	①③
Cheng et al 2021[128]	Medicine	Undergraduate	NR	124/120	PBL+CBL	LBL	①
Brinkman et al 2021[129]	Medicine	Undergraduate	NR	54/36	PBL	LBL	①④
MacDougall et al 2017[130]	Pharmacy	Undergraduate	/	360//360	AL	LBL	①
Tripathi et al 2015[131]	Medicine	Undergraduate	NSSD	45/45	AL	LBL	①⑤
Sumanasekera et al 2020[132]	Pharmacy	Undergraduate	NSSD	156/91	AL	LBL	①
Kennedy et al 2019[133]	Pharmacy	Undergraduate	NR	150/150	AL	LBL	①
Wei et al 2019[134]	Pharmacy	Undergraduate	NSSD	45/42	BOPPPS	LBL	④
Wang et al 2022[135]	Pharmacy	Junior college student	NSSD	30/30	BOPPPS	LBL	④
Zhang et al 2016[136]	Pharmacy	Undergraduate and Graduate	NR	60/60	EBM	LBL	①③⑤
Long et al 2011[137]	Pharmacy	Undergraduate	NSSD	80/80	EBM	LBL	①③
Song et al 2020[138]	Nursing	Junior college student	NSSD	120/120	MTM	LBL	①
Wang QY et al 2021[139]	Medicine	Undergraduate	NSSD	58/60	MTM	LBL	①
Zhao et al 2021[140]	Medicine	Junior college student	NSSD	102/105	MTM	LBL	①④
Yang XY(2) et al 2021[141]	Medicine	Undergraduate	NR	30/30	MTM	LBL	①⑤
Zhao J et al 2019[142]	Medicine	Junior college student	NSSD	78/85	MTM	LBL	①

Xing et al 2020[143]	Medicine	Junior college student	NSSD	55/55	MTM	LBL	①⑤
Yu et al 2020[144]	Medicine	Junior college student	NSSD	30/30	MTM	LBL	①②⑤
Sukhlecha et al 2016[145]	Pharmacy	Undergraduate	NSSD	65/65	AL	LBL	①
Liu JM et al 2015[146]	Medicine	Junior college student	NSSD	108/109	STM	LBL	①④
Jiang et al 2016[147]	Nursing	Junior college student	NR	20/15	STM	LBL	①
Gao et al 2021[148]	Medicine	Junior college student	NSSD	50/50	STM	LBL	①④
Wei et al 2009[149]	Pharmacy	Junior college student	NSSD	138/107	STM	LBL	①
He et al 2012[150]	Nursing	Junior college student	NSSD	50/48	TDL	LBL	①③

AL, active learning; BOPPPS, bridge-in, objective, pre-assessment, participatory learning, post-assessment, and summary; CBL, case-based learning; CoBL, computer-based learning; Cont, control; EBM, evidence-based medicine; FC, flipped classrooms; Interv, intervention; LBL, lecture based learning; MC, micro classrooms; MTM, mixed teaching mode; NR, not reported; NSSD, no statistically significant difference in baseline data; PBL, problem-based learning; STM, scaffolding teaching method; TBL, team-based learning; TDL, task driven learning. ① The theoretical test score. ② The experimental test score. ③ The subjective test score. ④ The satisfaction score. ⑤ The proportion of satisfaction.

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Table S3. The first ranking method in different specialties subgroups and their surface under the cumulative ranking (SUCRA) probabilities.

Specialties	Medicine	Pharmacy	Nursing
The theoretical test score			
Methods	PBL&CBL	FC	PBL
SUCRA probabilities	87.50%	91.45%	73.98%
The satisfaction score			
Methods	TBL	FC&BOPPPS	FC
SUCRA probabilities	82.02%	99.61%	74.33%
The proportion of satisfaction			
Methods	FC	TBL	FC
SUCRA probabilities	75.62%	99.72%	74.92%

BOPPPS, bridge-in, objective, pre-assessment, participatory learning, post-assessment, and summary; CBL, case-based learning; FC, flipped classrooms; PBL, problem-based learning; TBL, team-based learning.

2 Supplementary Figures

Study	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Bao et al 2018	unclear	unclear	NA	unclear	low	low	low
Guo et al 2018	low	unclear	NA	unclear	low	low	low
Jia et al 2020	low	unclear	NA	unclear	low	low	low
Wang et al 2017	low	unclear	NA	unclear	low	low	low
Liang et al 2019	low	unclear	NA	unclear	low	low	low
Wang ZC et al 2020	unclear	unclear	NA	unclear	low	low	low
Ge et al 2019	unclear	unclear	NA	unclear	low	low	low
Ding et al 2022	low	unclear	NA	low	low	low	low
Wang H et al 2021	unclear	unclear	NA	unclear	low	low	low
Wang JN et al 2020	low	unclear	NA	unclear	low	low	low
Fan et al 2020	unclear	unclear	NA	unclear	low	low	low
Zhao et al 2018	unclear	unclear	NA	low	low	low	low
Fu et al 2022	unclear	unclear	NA	unclear	low	low	low
Zhao XM et al 2019	unclear	unclear	NA	unclear	low	low	low
Yang XY et al 2021	low	unclear	NA	unclear	low	low	low
Wong et al 2014	unclear	unclear	NA	low	low	low	low
Sajjad et al 2021	unclear	unclear	NA	unclear	low	low	low
Lockman et al 2017	unclear	unclear	NA	low	low	low	low
Wu et al 2022	low	unclear	NA	unclear	low	low	low
El-Banna et al 2017	unclear	unclear	NA	unclear	low	low	low
Qin Z et al 2020	low	unclear	NA	unclear	low	low	low
Ma et al 2022	low	unclear	NA	unclear	low	low	low
Song et al 2018	unclear	unclear	NA	unclear	low	low	low
Qin X et al 2020	low	unclear	NA	unclear	low	low	low
Bai et al 2018	low	unclear	NA	low	low	low	low
Yang et al 2016	unclear	unclear	NA	unclear	low	low	low
Yang LJ et al 2021	low	unclear	NA	unclear	low	low	low
Ruan et al 2019	unclear	unclear	NA	unclear	low	low	low
Fan et al 2019	low	unclear	NA	unclear	low	low	low
Qin et al 2018	low	unclear	NA	low	low	low	low
Li et al 2022	unclear	unclear	NA	unclear	low	low	low

Study	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Chen et al 2014	unclear	unclear	NA	unclear	low	low	low
Liu XJ et al 2015	unclear	unclear	NA	unclear	low	low	low
Yuan et al 2013	low	unclear	NA	unclear	low	low	low
Sui et al 2009	unclear	unclear	NA	unclear	low	low	low
Huang W et al 2017	low	unclear	NA	low	low	low	low
Xia et al 2017	unclear	unclear	NA	unclear	low	low	low
Zheng et al 2020	unclear	unclear	NA	unclear	low	low	low
Song et al 2010	low	unclear	NA	unclear	low	low	low
Wang et al 2014	unclear	unclear	NA	low	low	low	low
Chen MJ et al 2015	unclear	unclear	NA	unclear	low	low	low
Yin et al 2013	low	unclear	NA	low	low	low	low
Wang JH et al 2012	low	unclear	NA	unclear	low	low	low
Zou et al 2014	low	unclear	NA	unclear	low	low	low
Wang et al 2010	unclear	unclear	NA	unclear	low	low	low
Song et al 2014	low	unclear	NA	unclear	low	low	low
Yang et al 2020	unclear	unclear	NA	unclear	low	low	low
Liu P et al 2014	unclear	unclear	NA	low	low	low	low
Wang GP et al 2017	unclear	unclear	NA	unclear	low	low	low
Yang et al 2017	low	unclear	NA	low	low	low	low
Nie et al 2006	unclear	unclear	NA	unclear	low	low	low
Kaur et al 2020	low	unclear	NA	unclear	low	low	low
Vora et al 2015	low	unclear	NA	low	low	low	low
Li S et al 2014	low	unclear	NA	low	low	low	low
Kamat et al 2012	low	unclear	NA	low	low	low	low
Chiranjeevi et al 2022	low	unclear	NA	low	low	low	low
Joseph et al 2021	low	unclear	NA	unclear	low	low	low
Cui et al 2013	low	unclear	NA	unclear	low	low	low
Yu et al 2016	low	unclear	NA	low	low	low	low
Huang et al 2015	unclear	unclear	NA	low	low	low	low
Liu et al 2016	unclear	unclear	NA	unclear	low	low	low
Croteau et al 2011	unclear	unclear	NA	low	low	low	low

Study	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Song et al 2021	low	unclear	NA	unclear	low	low	low
Wang SC et al 2021	unclear	unclear	NA	unclear	low	low	low
Li C et al 2019	low	unclear	NA	unclear	low	low	low
Li HY et al 2019	low	unclear	NA	unclear	low	low	low
Li et al 2020	unclear	unclear	NA	low	low	low	low
Ma et al 2017	low	unclear	NA	low	low	low	low
Dai et al 2016	unclear	unclear	NA	low	low	low	low
James et al 2016	unclear	unclear	NA	unclear	low	low	low
Zhou et al 2020	low	unclear	NA	unclear	low	low	low
Xia et al 2022	unclear	unclear	NA	unclear	low	low	low
Wu et al 2017	unclear	unclear	NA	unclear	low	low	low
Li et al 2013	low	unclear	NA	unclear	low	low	low
Carrasco et al 2021	unclear	unclear	NA	unclear	low	low	low
Palappallil et al 2019	unclear	unclear	NA	low	low	low	low
McCartney et al 2020	unclear	unclear	NA	low	low	low	low
El-Banna et al 2020	low	unclear	NA	low	low	low	low
Zgheib et al 2010	unclear	unclear	NA	low	low	low	low
Persky et al 2012	low	unclear	NA	low	low	low	low
Kim et al 2020	unclear	unclear	NA	low	low	low	low
Nguyen et al 2016	unclear	unclear	NA	low	low	low	low
Dong et al 2019	unclear	unclear	NA	unclear	low	low	low
Xiang S et al 2015	low	unclear	NA	unclear	low	low	low
Liu LJ et al 2014	low	unclear	NA	low	low	low	low
Wang XL et al 2012	low	unclear	NA	unclear	low	low	low
Yang et al 2021	low	unclear	NA	unclear	low	low	low
Yang et al 2008	low	unclear	NA	low	low	low	low
Yang et al 2015	low	unclear	NA	low	low	low	low
Li et al 2020	low	unclear	NA	unclear	low	low	low
Jia et al 2021	low	unclear	NA	unclear	low	low	low
Li J et al 2014	unclear	unclear	NA	unclear	low	low	low
Liang T et al 2017	unclear	unclear	NA	low	low	low	low

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Study	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Zhao et al 2014	low	unclear	NA	unclear	low	low	low
Xiang S(2) et al 2015	unclear	unclear	NA	unclear	low	low	low
Wang et al 2008	unclear	unclear	NA	unclear	low	low	low
Cao et al 2011	low	unclear	NA	unclear	low	low	low
Zhao et al 2015	low	unclear	NA	low	low	low	low
Chen et al 2007	low	unclear	NA	low	low	low	low
Liang et al 2008	low	unclear	NA	low	low	low	low
Wang YL et al 2017	unclear	unclear	NA	unclear	low	low	low
Chen et al 2017	low	unclear	NA	low	low	low	low
Miller et al 2003	unclear	low	NA	low	low	low	low
Sengupta et al 2021	low	unclear	NA	unclear	low	low	low
Liang T(2) et al 2017	unclear	unclear	NA	unclear	low	low	low
Herzig et al 2003	low	unclear	NA	low	low	low	low
Chen L et al 2015	unclear	unclear	NA	unclear	low	low	low
Fu et al 2016	unclear	unclear	NA	unclear	low	low	low
Yang Y et al 2018	low	unclear	NA	low	low	low	low
Guo et al 2013	unclear	unclear	NA	low	low	low	low
Li W et al 2014	low	unclear	NA	low	low	low	low
Zhou et al 2012	low	unclear	NA	unclear	low	low	low
Huang W(2) et al 2017	low	unclear	NA	low	low	low	low
Li et al 2011	unclear	unclear	NA	unclear	low	low	low
Song et al 2015	unclear	unclear	NA	low	low	low	low
Qin et al 2012	low	unclear	NA	unclear	low	low	low
Jia et al 2013	unclear	unclear	NA	unclear	low	low	low
Gao et al 2015	unclear	unclear	NA	unclear	low	low	low
Yang M et al 2018	low	unclear	NA	unclear	low	low	low
Song et al 2008	low	unclear	NA	unclear	low	low	low
Li et al 2017	low	unclear	NA	low	low	low	low
Huo et al 2016	low	unclear	NA	low	low	low	low
Michel et al 2002	low	unclear	NA	unclear	low	low	low
Antepohl et al 1999	low	low	NA	low	low	low	low

Study	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Cheng et al 2021	unclear	unclear	NA	unclear	low	low	low
Brinkman et al 2021	unclear	unclear	NA	unclear	low	low	low
MacDougall et al 2017	low	unclear	NA	low	low	low	low
Tripathi et al 2015	low	unclear	NA	low	low	low	low
Sumanasekera et al 202	unclear	unclear	NA	low	low	low	low
Kennedy et al 2019	unclear	unclear	NA	unclear	low	low	low
Feldman et al 1989	low	unclear	NA	unclear	low	low	low
MacFadyen et al 1993	low	unclear	NA	low	low	low	low
Hahne et al 2005	low	unclear	NA	low	low	low	low
Wei et al 2019	low	unclear	NA	unclear	low	low	low
Wang et al 2022	low	unclear	NA	unclear	low	low	low
Zhang et al 2016	low	unclear	NA	unclear	low	low	low
Long et al 2011	low	unclear	NA	low	low	low	low
Song et al 2020	unclear	unclear	NA	low	low	low	low
Wang QY et al 2021	low	unclear	NA	unclear	low	low	low
Zhao et al 2021	unclear	unclear	NA	unclear	low	low	low
Yang XY(2) et al 2021	low	unclear	NA	low	low	low	low
Zhao J et al 2019	unclear	unclear	NA	unclear	low	low	low
Xing et al 2020	low	unclear	NA	low	low	low	low
Yu et al 2020	low	unclear	NA	low	low	low	low
Sukhlecha et al 2016	low	unclear	NA	low	low	low	low
Liu JM et al 2015	unclear	unclear	NA	unclear	low	low	low
Jiang et al 2016	low	unclear	NA	low	low	low	low
Gao et al 2021	low	unclear	NA	unclear	low	low	low
Wei et al 2009	low	unclear	NA	low	low	low	low
He et al 2012	unclear	unclear	NA	unclear	low	low	low

NA: not applicable

Supplementary Figure 1. The individual assessment of risk of bias.