

## Appendix 1: Search strategy

### EMBASE search strategy

Available via <https://www.embase.com>

Search number	Query	Results
#1	'migraine'/exp	82,546
#2	'familial migraine' OR 'headache, migrainous' OR 'hemicrania' OR 'migraine disorders' OR 'migrainous headache' OR 'status hemicanicus' OR 'migraine':ab,kw,ti	107,936
#3	'acupuncture'/exp	58,759
#4	'acupuncture therapy' OR 'shonishin' OR 'acupuncture':ab,kw,ti	40,235
#5	'needle':ab,ti,kw	183,066
#6	'electroacupuncture':ab,ti,kw	8,640
#7	'transcutaneous auricular vagus nerve stimulation':ab,ti,kw	314
#8	'tavns':ab,ti,kw	367
#9	'functional magnetic resonance imaging'/exp	103,718
#10	'fmri' OR 'functional mri' OR 'magnetic resonance imaging, functional' OR 'r-fmri' OR 'resting state functional magnetic resonance imaging' OR 'rsfmri' OR 'functional magnetic resonance imaging':ab,kw,ti	107,936
#11	'positron emission tomography'/exp	240,905
#12	'p.e.t.' OR 'pet scan' OR 'pet scanning' OR 'positron emission tomographic scan' OR 'positron emission tomographic scanning' OR 'positron tomography' OR 'positron-emission tomography' OR 'tomography, positron' OR 'positron emission tomography':ab,kw,ti	256,794
#13	#1 OR #2	90,950
#14	#3 OR #4 OR #5 OR #6 OR #7 OR #8	241,715
#15	#9 OR #10	128,250
#16	#11 OR #12	258,706
#17	#15 OR #16	378,972
#18	#13 AND #14 AND #17	101

Filters: date 2000.01–2023.10.

### CNKI search strategy

Available via <https://www.cnki.net/>

Search number	Query
#1	SU = ('偏头痛')
#2	FT=('针刺' + '针灸' + '电针' + '迷走神经')
#3	FT=('功能磁共振成像' + 'fMRI' + '正电子发射成像' + 'PET')
#4	#1 and #2 and #3

Filters: date 2000.01–2023.10, synonym expansion. CNKI, China National Knowledge Infrastructure; SU, subject; FT, full title; fMRI, functional magnetic resonance imaging; PET, positron emission tomography.

**Table S1** Assessment criteria for the included studies

Category	Item	Assessment content	Score
Category 1: sample characteristics (total score 10)	1	Patients were evaluated with specific standardized diagnostic criteria	1
	2	Important demographic data (age and gender) were reported with a mean (or median) and standard deviations (or range)	2
	3	Healthy comparison subjects were evaluated to exclude psychiatric and medical illnesses, and demographic data were reported	1
	4	Important clinical variables [e.g., illness duration, onset time, medication status, pain scores were reported with a mean (or median) and standard deviations (or range)]	4
	5	Sample size per group >10	2
Category 2: methodology and reporting (total score 10)	1	Whole brain analysis was automated with no a priori regional selection	3
	2	Magnet strength at least 1.5-T or marked with a clear PET manufacturer and a standardized PET scanning process	1
	3	At least 5 minutes of resting state acquisition	1
	4	Whole brain coverage of resting scans	1
	5	The acquisition and preprocessing techniques were clearly described so that they could be reproduced	1
	6	Coordinates reported in standard space	1
	7	Significant results are reported after correction for multiple testing using a standard statistical procedure (FDR, FWE, or permutation-based methods)	1
	8	Conclusions were consistent with the results obtained, and the limitations were discussed	1

PET, positron emission tomography; FDR, false discovery rate; FWE, family-wise error.

Table S2 Supplementary information of included studies

Study	Year	TA methods	TA points	Frequency and duration of treatment	SA methods	SA points	Dropout status and reason for dropout
Li C (29)	2023	Disposable sterile acupuncture needles (0.30 mm × 40 mm) were inserted vertically into the skin, and then the needle insertion angle was adjusted (lateral insertion for GV20 and EX-HN1; oblique insertion for EX-HN5). Advance the needle until the patient feels a sense of qi, which is characterized by acidity, numbness, distension and heaviness	1: GB20; 2: LR3; 3: EX-HN5; 4: GV20; and 5: EX-HN1	Treatment was performed once a day for 30 minutes each time (pushing amplitude: 0.3–0.5 cm; pushing time: 30 minutes); lifting and inserting amplitude: 0.3–0.5 cm; frequency: 60–90 times/minute; twisting angle: 90–180°)	Disposable sterile acupuncture needles are inserted horizontally into the skin to a depth of 4 mm. No qi sensation, no therapeutic manipulation	1: the midpoint of the line between the tip of the elbow and the armpit; 2: the midpoint of the line between the medial epicondyle of the humerus and the ulnar side of the wrist; 3: the junction of the deltoid muscle and the biceps muscle at the anterior border of the upper arm; 4: 2 cm adjacent to the foot-sanli point (ST36). Disposable sterile acupuncture needles were pierced horizontally into the skin to a depth of 4 mm	Seven patients withdrew and three were lost to follow-up
Feng M (30)	2022	Stimulation was performed by a trained practitioner using an MRI-compatible electronic acupuncture therapeutic device (SDZII, Suzhou Huatuo). The stimulation intensity was adjusted to approximately 1.5–5 mA at a frequency of 1 Hz and a duration of 0.2 ms, which was the strongest sensation that the patient could tolerate without pain	Electrical stimulation of the auricular vagus nerve was performed at the left cymba concha	During each treatment session, stimulation was continued for 30 minutes. A total of 12 treatments were performed during the 4-week treatment period	–	–	No dropout
Zhang Y (40)	2021	1: oblique puncture 0.8 to 1.2 centimeters into the tip of the nose; 2: horizontal puncture 0.5 to 0.8 cm; 3: vertical puncture 0.5 to 1 cm; 4: vertical puncture 0.5 to 1.5 cm; 5: vertical puncture 0.5 to 1 cm. All points were punctured bilaterally using disposable stainless steel filament needles (Hua Tuo Needle, Sino-foreign joint venture Suzhou Hua Tuo Medical Instrument Co., Ltd., Suzhou, China) with a needle length of 25–40 mm and a diameter of 0.25–0.30 mm. Depth of needle insertion varied but was approximately 0.5–1.5 cm. Needles were twisted and rotated at a frequency of 1–2 Hz (90°< amplitude <180°). Repeat the stimulation one to three times to obtain a “gotcha” sensation (soreness, numbness, distension, or radial sensation indicating that the needling is effective)	1: GB20; 2: GB8; 3: PC6; 4: SP6; 5: LR3	Depending on the menstrual cycle, each group received 27 or 27±6 sessions of 28 or 28±7 days of treatment, each session lasting 30 minutes. The intervention was performed 1 week before menstruation, every other day, for a total of three treatments. Two treatments were given at the onset of menstruation and 2 per week for the rest of the week	1: vertical puncture 0.5 to 1 cm; 2: vertical puncture 0.5 to 1 cm; 3: vertical puncture 0.5 to 1 cm; 4: vertical puncture 0.5 to 1 cm; 5: vertical puncture 0.5 to 1 cm. Not experienced with De-qi	1: at the medial arm of the anterior border of the deltoid insertion at the junction of the deltoid and biceps muscles; 2: medial to the mid-thigh, 2 cm lateral to half the distance from the anterior superior iliac spine to the lateral superior angle of the patella on the rectus femoris muscle; 3: 1 to 2 cm lateral to the edge of the tibia at the level of the point of Zusanli (ST36); 4: the midpoint between the tip of the elbow and the axilla; 5: the midpoint between the medial epicondyle of the humerus and the ulnar aspect of the wrist bilaterally	There was one patient in the TA group and five patients in the SA group who withdrew due to non-compliance with the treatment plan or unavailability of contact
Liu S (41)	2021	With two licensed acupuncturists in charge of all acupuncture treatments. The sterile, single-use acupuncture needles were 25–40 mm in length and 0.25 mm in diameter to achieve the sensation of De-qi. Applied electrical stimulation at GB20 and GB8 bilaterally; the stimulation frequency was 2 Hz and the intensity was varied between 0.1 and 1.0 mA until the patient felt comfortable	GV20, EX-HN5, bilateral GB20, GB8, GB5, GB15, LI4, and LR3	Acupuncture was performed 12 times for 20 minutes twice a week for 6 weeks	–	–	With three patients lost to follow-up, there were 37 patients with clinical data available for analysis. A total of three patients with MwoA and one patient with HC were excluded due to excessive head movement during scanning. As a result, fMRI data from 37 patients and 15 HCs were included in the analysis
Jia JN (42)	2021	A probe is used to press on the point to find the sensitive point, which is usually a point of severe pain, and then the needle is inserted with the coughing, with the millimeter needle being rapidly inserted 0.2–0.3 mm and twisted rapidly for 3–5 s	Acupuncture points were selected according to the location of the headache, e.g., the Zuciaoyin point for Shaoyang headache, the Lidui point for Yangming headache, the Zhiyin point for Taiyang headache, and the Dadun point for Jueyin headache, in addition to one to three local Ashi points	Three times a week for 4 weeks	–	–	No dropout
Wang ZW (31)	2021	Select bilateral acupoints for each needling, and carry out the method of lifting and inserting, twisting and replenishing and draining after De-qi from needling	(I) GB20. (II) GB8. (III) PC6. (IV) LR3	Acupuncture treatment was started 1 week before the onset of menstruation, every other day for 3 times; 1 week at the onset of menstruation and the rest of the time, 2 times a week, for a total of 3 menstrual cycles. According to the change of menstrual cycle 28±7 days, the number of acupuncture treatments was 27±6 times	–	–	Two patients were lost during treatment in the Taichong group, one patient was lost during treatment in the Neiguan group, and one patient was removed by head movement
Wang YH (43)	2019	Stimulation intensity was adjusted to approximately 1.5–2.5 mA, the frequency was 1 Hz with the duration of 0.2 ms, the strongest sensation that patients could tolerate without pain, 8 min continuous stimulation	Pancreatic/biliary and lung points inside the left cymba concha (rich in vagal nerve fibers)	8 min continuous stimulation	Same with TA	Wrist and shoulder points in the left ear canals (no vagal nerve fibers)	No dropout
Luo WT (44)	2019	Stimulation frequency was 1 Hz with the duration of 0.2 ms, 8 min continuous stimulation	Pancreatic/biliary and lung points inside the left cymba concha (rich in vagal nerve fibers)	8 min continuous stimulation	Same with TA	Wrist and shoulder points in the left ear canals (no vagal nerve fibers)	No dropout
Li Z (45)	2017	Bilateral puncture is performed on all acupuncture and non-acupuncture points. Needle is inserted vertically 5 to 15 mm and gently manipulated to obtain “qi sensation” (complex sensation consisting of soreness, numbness, heaviness, distension, or dull pain at the site of the needle puncture)	VA1: acupuncture of GB34, GB40, and SJ5. VA2: acupuncture of GB33, GB42, and SJ8. VA3” acupuncture of the ST36, ST42, and LI6	The acupuncture group’s treatment consisted of 20 acupuncture sessions of 30 minutes each, each lasting 4 weeks (5 sessions per week)	Same with TA	NAP1, NAP2, and NAP3	There were four HCs who were excluded because of excessive head movement (head movement of more than 2 mm in any axis or head rotation of more than 2°). Seven patients did not participate in the second fMRI scan due to scheduling conflicts (two in the VA1 group, two in the VA2 group, one in the VA3 group, and two in the SA group). Of the 81 patients who participated in both fMRI scans, 9 were excluded from data analysis because of incomplete scans (lack of resting-state fMRI or T1 anatomy; 3 in group V1, 1 in group V2, 2 in group V3, 2 in group SA, and 1 in group WT), and 10 were excluded from data analysis because of excessive head movement (head movement of more than 2 mm on any axis or head rotation of more than 2°; 1 in group V1, 3 in group V2, 2 in group V3, 2 in group SA, and 2 in group WT) were excluded from data analysis
Ning YZ (46)	2017	A single-use sterile silver needle (25 mm long, 0.30 mm diameter) was inserted vertically into the GB41 to a depth of 2–3 cm. Stimulation consisted of rotating the needle clockwise and counterclockwise at a frequency of 1 Hz with uniform intensifying and diminishing operations for 60 seconds	GB41 (located in the depression between the fourth and fifth metatarsal bones on the dorsum of the foot)	Needle manipulation was performed for 1 minute prior to the 1-minute resting time, followed by an 8-minute resting scan (no needle manipulation)	–	–	No dropout
Han X (47)	2017	The needle was inserted at a depth of about 0.5–0.8 inches, using flat tonic and flat diarrhea techniques, and the needles were inserted bilaterally at the same time	GB41: lateral aspect of the dorsum of the foot, behind the 4 <sup>th</sup> metatarsophalangeal joint, lateral depression of the extensor tendon of the little toe	–	–	–	No dropout
Zhao L (48)	2014	Bilateral puncture was performed using a disposable stainless steel filament needle (Huatuo Needle, Sino-foreign joint venture Suzhou Huatuo Medical Instrument Co., Suzhou, China). The needles are 25–40 mm long and 0.25–0.30 mm in diameter. The insertion depth of the needle is approximately 2.5–3.5 cm. The needle was rotated at a frequency of 1–2 Hz (90 U, amplitude, 180 U). Repeat the stimulation 1–3 times to obtain qi sensation	Group A active treatment was administered on bilateral SJ5, GB20, GB34, and GB40. Group B non-active control, implemented on bilateral SJ22, PC7, GB37, and SP3	Treatment in each group consisted of 32 acupuncture sessions over an 8-week period (every other day, preferably 4 sessions per week), with each session lasting 30 minutes	Same with TA	Choosing inactive points was based on anatomical location, correspondence with TCM meridians, proximity to true points, and role in treating disease	During the course of the study, two patients in the active acupuncture group and five patients in the non-active acupuncture group withdrew, all for personal reasons: non-compliance with the treatment plan or unavailability
Yang M (49)	2014	Disposable sterile acupuncture needles (25–40 mm long, 0.30 mm in diameter, manufactured by Suzhou Huatuo Acupuncture Needle Co., Ltd., Suzhou, China) were inserted laterally or obliquely into the acupoints to a depth of 15–30 mm. After the needles were inserted, they were twisted evenly within the AG needles to induce the sensation of De-qi (soreness, numbness, distension, heaviness, dull pain, etc.). After the De-qi occurred and was reported by the patient, an auxiliary needle was inserted vertically at a depth of 2 mm lateral to the acupuncture point without manual manipulation. An acupuncturist then connected the electrodes of the HANS (model LH 200A; TENS, Nanjing, China) to the needles	The combination of points for the AG included three subspecific points on the Shaoyang meridian: TE19, TE8, and GB33	Nerve stimulators are attached to needles that are left in the body for 30 minutes	SAG HANS is inserted and connected to the needle without eliciting De-qi sensation. The intensity of the electrical stimulation is manually adjusted according to the level of comfort felt by the patient, ranging from 0.1 mA to 1.0 mA at a stimulation frequency of 100 Hz	Sham points: 1: on the medial side of the arm, at the anterior edge of the deltoid insertion at the junction of the deltoid and biceps muscles; 2: on the edge of the tibia, 1–2 cm from the lateral and horizontal line of the zusanli, ST36; 3: on the ulnar side of the arm, halfway between the medial lateral epicondyle of the humerus and the ulnar side of the wrist	No dropout
Yang J (50)	2012	Single-use sterile acupuncture needles were used for stimulation (25–40 mm long, 0.30 mm in diameter, manufactured by Suzhou Medical Supplies Co., Ltd., Suzhou, China). Subjects obtained the sensation of De-qi (soreness, numbness, distension and heaviness) by lifting and twisting. After all acupoints were needled, an auxiliary needle was inserted vertically 2 mm lateral to the acupoint at a depth of 2 mm without manual manipulation. Electroacupuncture (HANS; HANS-200, Nanjing, China) was applied to the acupoints by an experienced acupuncturist. The stimulation frequency was 2/100 Hz, and the stimulation intensity was 0.1 to 1.0 mA, to the extent that the patient felt comfortable	TE5, GB34, and GB20 on the Shaoyang meridians	Each needle and its auxiliary needles were electrically connected via HANS for 30 minutes	Same with TA	Yangming meridians: ST8, LI6, ST36	No dropout
Li XZ (51)	2008	The needles were Hua-tuo brand one-time needles manufactured by Suzhou Medical Supplies Co., Ltd., with a size of 0.3 mm × 25–50 mm. After rapid insertion into the acupoints, twisting and lifting were used, with the angle of twisting between 90° and 180° and the frequency of twisting between 60 and 90 times/min; the amplitude of lifting and inserting was between 0.3 and 0.5 cm	GB20, TE5, and GB34 on the Shaoyang meridians	After De-qi, the needle was left in place for 30 min, and after 15 min of needle retention, the needle was performed once of about 10 s for each point	–	–	No dropout

GV20 (Baihui), EX-HN1 (Sishengcong), EX-HN5 (Taiyang), GB20 (Fengchi), LR3 (Taichong), ST36 (Zusanli), GB8 (Shuigou), PC6 (Neiguan), SP6 (Sanyinjiao), GB5 (Xuanlu), GB15 (Toulingqi), LI4 (Hegu), GB34 (Yanglingquan), GB40 (Qiuxu), SJ5 (Waiguan), GB33 (Xiyangguan), GB42 (Diwuhui), SJ8 (Sanyangluo), ST42 (Chongyang), GB41 (Zulinqi), SJ22 (Erheliao), PC7 (Guangming), SP3 (Taibai), TE19 (Luxi), TE8 (Sanyangluo), ST8 (Touwei), and LI6 (Pianli). TA, true acupuncture; SA, sham acupuncture; MRI, magnetic resonance imaging; MwoA, migraine without aura; fMRI, functional magnetic resonance imaging; HC, health control; VA, verum acupuncture; NAP, non-acupoint; WT, waiting list; TCM, traditional Chinese medicine; AG, acupuncture group; SAG, sham acupuncture group; HANS, Han acupoint nerve stimulator.