Validation of the Chinese Version of ID-Migraine in Medical Students and Systematic Review with Meta-Analysis Concerning Its Diagnostic Accuracy

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Aims: To validate the Chinese version of Migraine Screener (ID-Migraine) in medical students in mainland China and to estimate the diagnostic accuracy of ID-Migraine by means of a systematic review with meta-analysis. **Methods:** A total of 555 medical university students participated in the clinical study. Of these, 190 volunteered to take part in a face-to-face consultation and 365 in a telephone interview to diagnose the presence of migraine according to the criteria of the International Classification of Headache Disorders. The correctness of the diagnosis made clinically and by telephone was assessed by Cohen's kappa statistics. Twenty-two studies were included in the meta-analysis. Sensitivity and specificity were calculated for the clinical study and the meta-analysis. **Results:** The overall sensitivity and specificity of the Chinese version of ID-Migraine was 84.0% (95% confidence intervals [CI]: 75.0%–90.0%) and 64.0% (95% CI: 59.0%–68.0%), respectively. The Cohen's kappa value of the diagnosis obtained by the face-to-face consultation and the telephone interview was 0.85 (95% CI: 0.69–1.00). A total of 8,682 participants from the 22 studies were included in the meta-analysis. The pooled sensitivity, specificity, and diagnostic odds ratio were 81.0% (95% CI: 80.0%–82.0%), 68.0% (95% CI: 66.0%–69.0%) and 17.03 (95% CI: 9.94-29.18), respectively. **Conclusions:** The accurate recognition of migraine by the medical students suggests that the Chinese ID-Migraine version is a valid screening tool. In addition the meta-analysis confirmed the high diagnostic accuracy of this screening tool. *J Oral Facial Pain Headache 2015;29:265–278. doi: 10.11607/ofph.1341*

Keywords: *ID-Migraine, meta-analysis, migraine, screening, validation*

The prevalence of migraine is about 15.0% in Europe and 10.0% in Asia. It is more common in women, who are two to three times more frequently affected than men.[1] Migraine affects subjects both socially and economically due to the high frequency of recurrence and accompanying morbidity.[2] Although severe and disabling, migraine remains unrecognized, underdiagnosed, and undertreated even in developed countries. Reports have shown that about 48% of migraine sufferers in America and 26.8% in Italy were diagnosed by their physician, and only a small proportion of these patients received prophylactic therapy and drug treatments.[2,3]

Screening tools for migraine diagnosis at an initial stage could improve its early recognition and improve its treatment.[4] Migraine Screener (ID-Migraine)[5] has been reported to be an effective tool for migraine diagnosis, with a sensitivity of 81.0% and specificity of 75.0% in primary care settings. The ID-Migraine diagnosis tool has been validated in different populations.[5–23] Epidemiologic studies of the recognition of migraine have been carried out using the ID-Migraine tool,[24] and similar studies have been conducted on university students due to the strong impact of migraine on academic performance.[25] However, no studies concerning the validation of ID-Migraine have been conducted among university students in China. Furthermore, although a meta-analysis validated the questionnaire's validity in 2011,[26] eight subsequently published studies have provided inconsistent results.[12–17,21,22] Accordingly, the aims of the present study were twofold: *(1)* to validate the Chinese

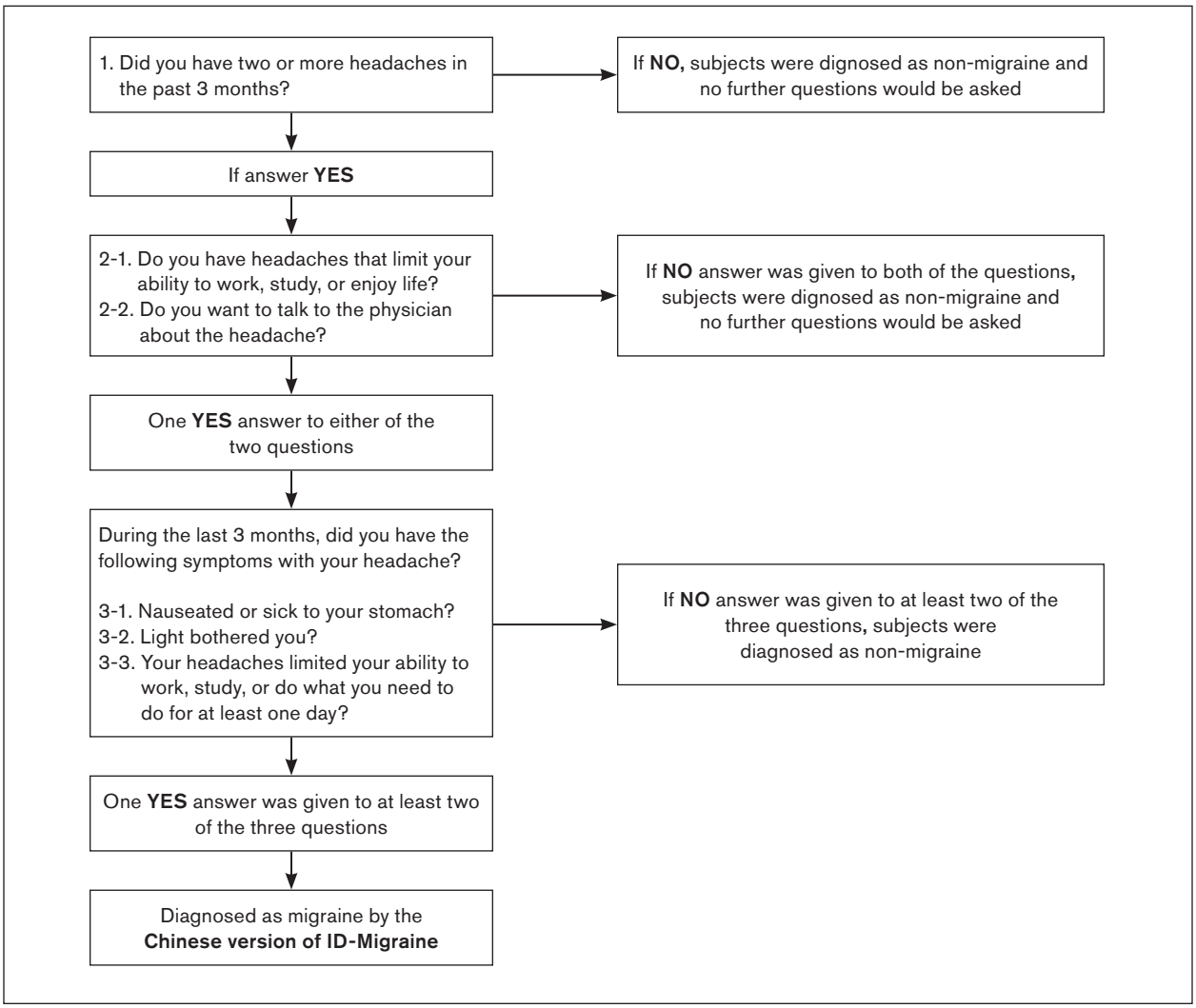


Fig 1 Flowchart of the screening process of the Chinese version of ID-Migraine.

version of ID-Migraine in medical students in mainland China and *(2)* to estimate the diagnostic accuracy of ID-Migraine by means of a systematic review with meta-analysis.

Materials and Methods

Study Outline

The study followed the same procedure used by Oztora and colleagues[27] to screen students for migraine (Fig 1). The screening stage was conducted between April 1 and June 30, 2012, and the validation stage was conducted from November 3 to December 21, 2012. Students from all 12 faculties at the Harbin Medical University (5,129 total) were asked to complete a questionnaire based on the Chinese version of ID-Migraine after having signed a consent form. Of these students, 4,406 (85.9%) completed the questionnaire. The questionnaire consisted of three parts: the first part included the participant's informed consent, the second part had 14 questions about sociodemographic parameters, and the third part contained the 6 questions of the Chinese version of ID-Migraine. It took about 10 minutes to fill out the questionnaire. Out of the 4,406 students who completed the questionnaire, 555 students could be recruited either for a face-to-face consultation (190 students) or a telephone interview (365 students) to diagnose whether they suffered from migraine (see below). The reasons for the dropout and the details of the participants' selection are outlined in Fig 2. In addition, a sample of 130 (10.0%) students in grade 2 was randomly selected by student number, using a simple random sampling method with the randomization process of SAS (SAS Institute), to fill out the questionnaire again, 12 days later, to test the reliability of responses to the questionnaire.

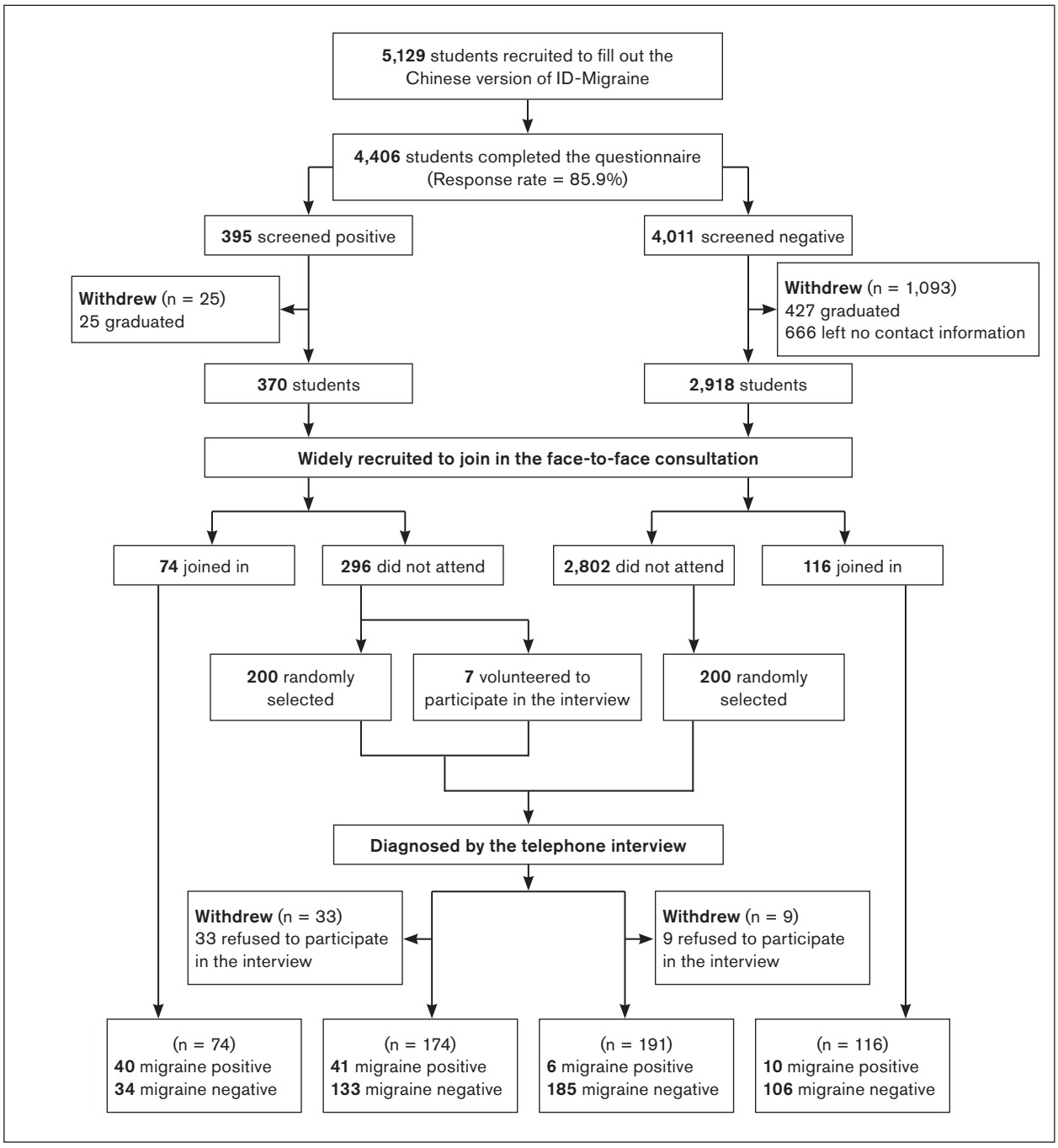


Fig 2 Flowchart of the subject selection.

Migraine Diagnosis

The criteria described in the International Classification of Headache Disorders, Second Edition (ICHD-II)[28] was used as the gold standard for diagnosis. The diagnostic process was implemented in two different ways: by a face-to-face consultation or a telephone interview. Of the 555 students, 190 had a face-to-face consultation (between November 3 and 18, 2012) and neurologic examination with a neurologist who was blinded to the results of the screening. The other 365 students, who had refused to take part in the face-to-face consultation, were interviewed by telephone between December 6 and 21, 2012, by the same neurologist with the aid of an investigator. This investigator made the telephone calls and asked participants for their oral consent to be questioned by the neurologist over the phone.

To test the concurrence between the diagnosis made by the face-to-face consultations and the telephone interview, 40 students (20 migraineurs and 20 non-migraineurs) who had been diagnosed by the neurologist face-to-face were randomly selected using

a simple random sampling method with randomization process of SAS to participate in the telephone interview. The neurologist who was blinded to the face-to-face diagnosis gave a second diagnosis based on the telephone interview.

The procedures were approved by the Ethics Committee of Harbin Medical University for human experimentation ([2011] # 004). All participants gave their written informed consent for inclusion in the study.

Systematic Review and Meta-analysis

The terms *migraine disorders* and *ID-migraine/ID-MS* were searched by two investigators (XW, HBZ) as medical subject headings (MeSH) in Medline and Embase for all publications that appeared between January 1, 2003 and June 30, 2013. The references of all included articles were also checked for relevant papers. Papers describing the diagnostic accuracy of ID-Migraine that were written in English and provided sufficient information for calculating sensitivity and specificity were included. When different publications concerned the same population, the most complete one was included.

Two investigators (XW and YS) independently extracted data that included the first author's name, the area where the study had been performed, the year of publication, the study settings, the sample size, and the mean age of the participants; they also recorded the number of true positive (TP), false negative (FN), false positive (FP), and true negative (TN) values. Data that could not be obtained from the publications were acquired by contacting the authors by email. The two investigators assessed the quality of each study by using Quality Assessment of Diagnostic Accuracy Studies (QUADAS),[29] which consists of 14 questions. Any discrepancies were resolved by consensus.

Statistical Analysis

Continuous variables were summarized as mean values (± standard deviation). The degree of concordance between the ID-Migraine questionnaires that were filled out twice as well as that between the diagnosis obtained by the face-to-face consultation and the telephone interview were evaluated by Cohen's kappa statistics. The diagnostic accuracy of ID-Migraine was evaluated by calculating the sensitivity and specificity, and these were also tested for any difference among interview techniques, gender, study grade, and major of the participants.

The pooled estimations of sensitivity, specificity, and the diagnostic odds ratio (DOR) presented as the ratio of positive odds in migraineurs relative to that in controls were calculated using DerSimonian and Laird's random-effects model.[30] The pooled sensitivity and specificity data were used to construct the summary receiver operating characteristic curve (SROC), and the area under the curve (AUC) was presented as the overall accuracy of the ID-Migraine model.[31]

The Fagan nomogram was also constructed by using the positive likelihood ratio and negative likelihood ratio for interpreting the diagnostic test results into clinical practice.[32]

Heterogeneity among the studies was measured by I^2, and subgroup analyses were carried out to explore the source of the heterogeneity.[33,34] A sensitivity analysis was also conducted to assess the effect of each study on the pooled diagnostic effect by sequentially omitting each data set.[35] In addition, cumulative meta-analyses were launched to investigate the trend of DOR by ranking the sample size, quality of the study, mean age of the participants, and the publishing year. Finally, publication bias was detected by Deeks funnel plot asymmetry test.[36] To calculate the log (DOR), 0.5 was added to each cell in the 2×2 table that contained zero values.

All the statistical significance levels were two-tailed and set at $P < .05$. Pooled values of the meta-analysis were synthesized by Meta-DiSc for Windows XI (Cochrane Colloquium). The sensitivity analysis, cumulative meta-analysis, funnel plot, and Fagan nomogram were conducted with Stata statistical software version 12 (StataCorp). Other statistical analyses were conducted using SAS statistical software, version 9.1 (SAS Institute).

Results

Validity of the Chinese version of ID-Migraine

Of the 555 students who agreed to participate in the face-to-face consultation or the telephone interview, 157 (28.3%) were male and 398 (71.7%) were female; the mean age was 22.03 ± 1.53 years. According to the screening performed with the ID-Migraine questionnaire, 74 of the 190 students who participated in the face-to-face consultation were diagnosed with migraine and 116 without migraine. Of the 365 students who took part in the telephone interview, 174 screened positive and 191 negative.

In total, 97 students were diagnosed with migraine according to the ICHD-II criteria.[28] The overall sensitivity and specificity of the Chinese version of ID-Migraine was 84.0% (95% CI: 75.0%–90.0%) and 64.0% (95% CI: 59.0%–68.0%), respectively, with a false-positive rate of 36.5%. The sensitivity showed no differences between the different interview techniques ($P = .33$) and gender ($P = .71$); significant differences were found in the specificity between different interview techniques ($P < .001$) but not in gender of the participants ($P = .38$) (Table 1). The test-retest re-

Table 1 Validity of the Chinese Version of ID–Migraine Compared with ICHD-II Criteria in Different Subgroups

Subgroup	ICHD-II Migraine+ n (%)	Migraine– n (%)	Total n (%)	Sensitivity (%) (95% CI)	Sensitivity (%) *P* value	Specificity (%) (95% CI)	Specificity (%) *P* value
Interview techniques					.33		< .001
Telephone interview							
Migraine+ (ID-Migraine)	41 (23.6)	133 (76.4)	174 (47.7)				
Migraine– (ID-Migraine)	6 (3.1)	185 (96.9)	191 (52.3)				
Subtotal	47 (12.9)	318 (87.1)	365 (100.0)	87.2 (74.8–94.0)		58.2 (52.7–63.5)	
Face-to-face consultation							
Migraine+ (ID-Migraine)	40 (54.0)	34 (46.0)	74 (39.0)				
Migraine– (ID-Migraine)	10 (8.6)	106 (91.4)	116 (61.0)				
Subtotal	50 (26.3)	140 (73.7)	190 (100.0)	80.0 (67.0–88.8)		75.7 (68.0–82.1)	
Gender					.71		.38
Male							
Migraine+ (ID-Migraine)	24 (35.8)	43 (64.2)	67 (42.7)				
Migraine– (ID-Migraine)	4 (4.4)	86 (95.6)	90 (57.3)				
Subtotal	28 (17.8)	129 (82.2)	157 (100.0)	85.7 (68.5–94.3)		66.7 (58.2–74.2)	
Female							
Migraine+ (ID-Migraine)	57 (31.49)	124 (68.51)	181 (45.48)				
Migraine– (ID-Migraine)	12 (5.53)	205 (94.47)	217 (54.52)				
Total	69 (17.34)	329 (82.66)	398 (100.00)	82.6 (72.0–89.8)		62.3 (57.0–67.4)	
Total							
Migraine+ (ID-Ms)	81 (32.7)	167 (67.3)	248 (44.7)				
Migraine– (ID-Ms)	16 (5.2)	291 (94.8)	307 (55.3)				
Total	97 (17.5)	458 (82.5)	555 (100.0)	84.0 (75.0–90.0)		64.0 (59.0–68.0)	

ICHD-II = International Classification of Headache Disorders, 2nd edition.

liability for subjects who filled out the questionnaire twice was 0.68 (95% CI: 0.43–0.92). The Cohen's kappa value between the diagnosis obtained by the face-to-face consultation and the telephone interview was 0.85 (95% CI: 0.69–1.00).

Of the 29 students who had one positive answer to the three-item ID-Migraine questionnaire and, therefore, were defined as suspected migraineurs and not as migraineurs according to the questionnaire, 2 were migraineurs and 27 were non-migraineurs according to the ICHD-II criteria. When these students were excluded from the analysis, the sensitivity changed from 84.0% to 85.3% ($P = .74$) and the specificity changed from 64.0% to 61.3% ($P = .48$), which did not significantly affect the results.

Systematic Review and Meta-analysis

Twenty-two articles with a total of 8,682 individuals were included in this systematic review and meta-analysis. Two studies were conducted in the United States,[5,15] five in Italy,[7,14,16,19,20] two in Portugal,[8,22] one in Belgium,[17] four in Turkey,[6,9,11,23] one in Brazil,[21] one in Korea,[10] one in Singapore,[18] and three (including the present study) in China.[12,13] The mean age of the study subjects ranged from 11.7 to 47.7 years. The data collected from the studies are shown in Table 2.

The pooled sensitivity, specificity, DOR, and AUC data were 81.0% (95% CI: 80.0%–82.0%), 68.0% (95% CI: 66.0%–69.0%), 17.03 (95% CI: 9.94–29.18), and 0.87 (95% CI: 0.82–0.92), respectively (Fig 3). Given a pre-test probability of 20.0%, the Fagan nomogram showed that when the screening test was positive, the post-test probability was 45.0%, and when negative it was 4.0%.

Substantial heterogeneity existed in the pooled sensitivity ($I^2 = 97.2\%$, $P < .001$), pooled specificity ($I^2 = 94.0\%$, $P < .001$) and pooled DOR ($I^2 = 94.9\%$, $P < .001$) data. When subgrouped by the geographic location of the study ($P = .04$), the I^2 for DOR decreased, and the I^2 in the American and European groups (83.5%) was much lower than that in the Asian (97.3%) and Turkish groups (93.6%). The results of stratified analyses by the quality ($P = .001$) and sample size of the included studies ($P = .06$) and the inclusion criteria ($P = .17$) of the eligible studies are listed in Table 3.

The sensitivity analysis suggested that the pooled sensitivity, specificity, and DOR (with 95% CI) were not significantly altered before and after omitting each study (Table 4). Furthermore, the cumulative meta-analysis suggested that by increasing the number of subjects by continually enlarging the sample size, by elevating the quality of the study, and by increasing the mean age of the participants, the 95% CI for pooled DOR became narrower, which indicates that the precision of the pooled DOR gradually improved (Fig 4). Finally, the *P* value of the Deeks' funnel plot asymmetry test was found to be .14, which indicated no apparent publication bias.

Table 2 Characteristics of 22 Included Studies from 20 Publications

Study ID	Authors	Publication year	Country	Study setting	Sample size	Mean age ± SD (y)
1	Lipton et al[5]	2003	USA	Primary care practice sites	443	39.30 ± 10.10
2	Kim and Kim[10]	2006	Korea	TMJ and or facial clinic	176	30.70 ± 9.30
3	Karli et al[9]	2007	Turkey	Neurology outpatients	1,816	45.20 ± 17.00
4	Brighina et al[7]	2007	Italy	Headache center	222	38.68 ± 12.02
5	Di Piero et al[19]	2007	Italy	Primary care	195	40.50 ± 15.80
6	Ertaş et al[23]*	2009	Turkey	Neurology outpatients	530	46.50
7	Ertaş et al[23]*	2009	Turkey	Ophthalmology outpatients	228	47.30
8	Ertaş et al[23]*	2009	Turkey	ENT outpatients	263	43.30
9	Siva et al[11]	2008	Turkey	Workplace	227	31.90 ± 5.90
10	Zarifoğlu et al[6]	2008	Turkey	Middle school	1,014	14.67 ± 1.74
11	Khu et al[18]	2008	Singapore	Primary care	584	37.00 ± 11.00
12	Maizels and Houle[15]	2008	USA	Primary care	68	NA
13	Wang et al[13]	2008	China	Neurology outpatients	755	37.00 ± 15.00
14	Di Paolo et al[20]	2009	Italy	Dental clinic	37	34.00 ± 11.00
15	Mostardini et al[14]	2009	Italy	ED outpatients	230	37.00 ± 15.00
16	Gil-Gouveia and Martins[8]	2010	Portugal	Headache outpatients	131	38.20 ± 13.20
17	Villani et al[16]	2011	Italy	Multiple sclerosis center	144	37.80 ± 9.50
18	Gil-Gouveia[22]	2011	Portugal	Portuguese clinicians	348	47.70
19	Mehuys et al[17]	2012	Belgium	Community pharmacies	629	46.30
20	Jurno et al[21]	2012	Brazil	Outpatient clinic	320	38.30
21	Jin et al[12]	2013	China	Junior schools	466	11.70
22	Wang et al†	2015	China	Medical university	555	22.03 ± 1.53

*Studies 6 to 8 were reported in the same article.
†Present study.
QUADAS = Quality Assessment of Diagnostic Accuracy Studies (items considered "yes" scored 1, "no" scored –1, and "unclear" scored 0; maximum score was 14); NA = not available; TP = true positive; FN = false negative; FP = false positive; TN = true negative.

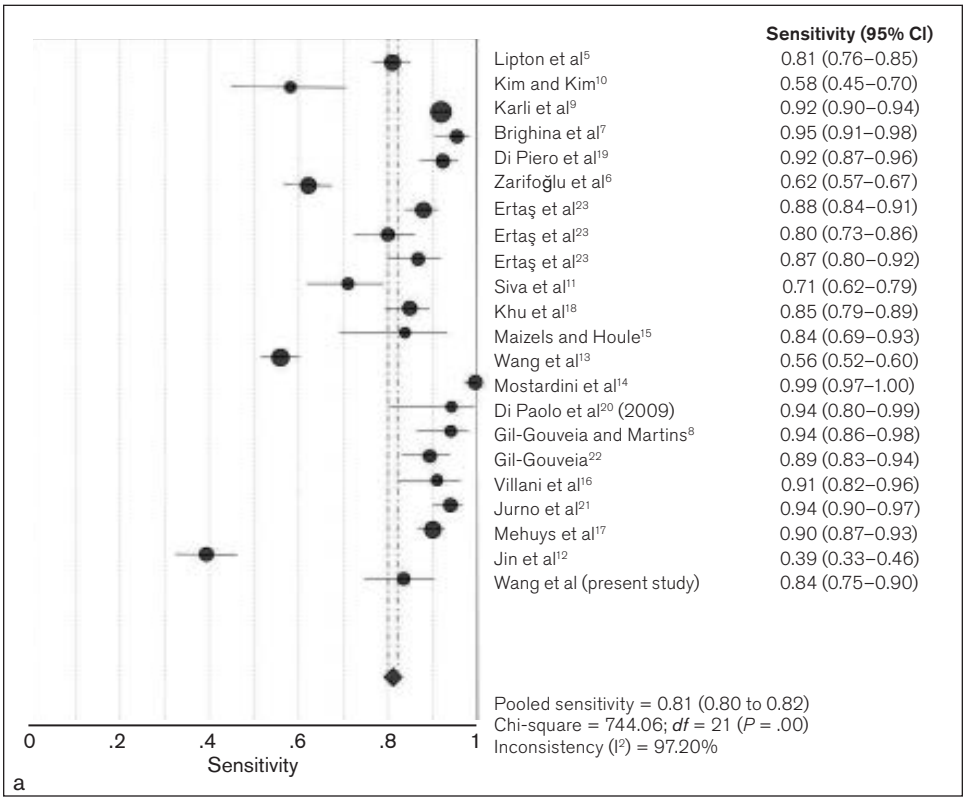
Table 3 Subgroup Analysis for the Pooled Diagnostic Accuracy of ID-Migraine and Heterogeneity of the Included Studies

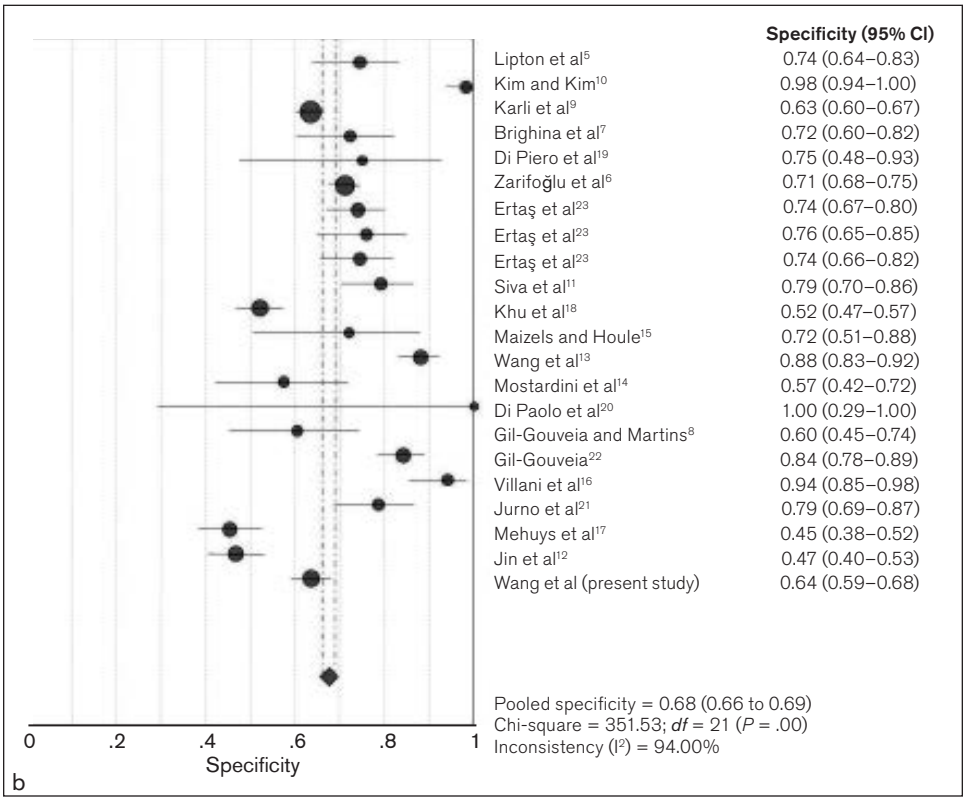
Subgroup	No. of studies	Pooled values (95% CI)		
		Sensitivity (%)	Specificity (%)	DOR
All studies	22	81.0 (80.0–82.0)	68.0 (66.0–69.0)	17.03 (9.94–29.18)
Geographic location				
Asia	5	61.0 (58.0–64.0)	64.0 (62.0–67.0)	6.72 (1.70–26.51)
Turkey	6	84.0 (82.0–85.0)	69.0 (67.0–71.0)	12.23 (6.19–24.18)
America and Europe	11	90.0 (89.0–92.0)	70.0 (67.0–73.0)	33.76 (17.37–65.64)
Quality*				
≥ 10	9	90.0 (89.0–91.0)	70.0 (68.0–72.0)	28.97 (18.78–44.70)
< 10	11	72.0 (70.0–74.0)	64.0 (62.0–66.0)	7.46 (3.82–14.60)
Sample size				
≥ 320	11	79.0 (78.0–80.0)	65.0 (64.0–67.0)	9.87 (4.74–20.54)
< 320	11	88.0 (86.0–89.0)	79.0 (76.0–82.0)	30.43 (17.05–54.33)
Inclusion criteria†				
1–3	9	0.87 (0.86–0.88)	0.70 (0.68–0.73)	18.71 (13.66–25.63)
1–2	6	0.78 (0.76–0.80)	0.61 (0.57–0.64)	11.08 (6.59–18.63)
1	3	0.88 (0.83–0.92)	0.68 (0.63–0.72)	43.49 (4.23–446.70)

*Two studies were meeting abstracts that could not be evaluated by QUADAS.
†Inclusion criteria: *(1)* age ≥ 17 years; *(2)* experienced one or more headaches during the last 3 months or visited doctor for headache complaint; *(3)* headaches limited the ability to work, study, or enjoy life, or wanted to talk to the physician about the headache.
Two studies were meeting abstracts for which inclusion criteria details could not be obtained.

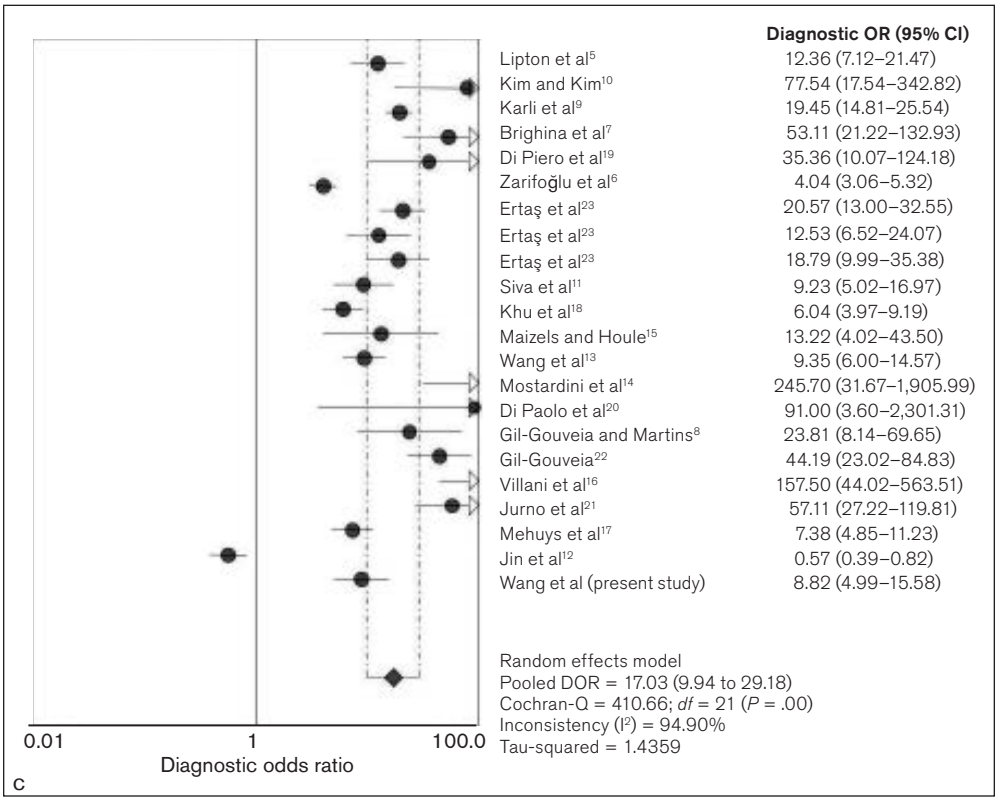
TP	FP	FN	TN	Sensitivity, % (95% CI)	Specificity, % (95% CI)	QUADAS score
289	22	68	64	81.0 (76.0–85.0)	74.0 (64.0–83.0)	8
36	2	26	112	58.0 (45.0–70.0)	98.0 (94.0–100.0)	10
842	329	75	570	92.0 (90.0–94.0)	63.0 (60.0–67.0)	11
143	20	7	52	95.0 (91.0–98.0)	72.0 (60.0–82.0)	12
165	4	14	12	92.0 (87.0–96.0)	75.0 (48.0–93.0)	8
297	50	41	142	88.0 (84.0–91.0)	74.0 (67.0–80.0)	12
119	19	30	60	80.0 (73.0–86.0)	76.0 (65.0–85.0)	12
123	31	19	90	87.0 (80.0–92.0)	74.0 (66.0–82.0)	12
83	23	34	87	71.0 (62.0–79.0)	79.0 (70.0–86.0)	8
208	196	127	483	62.0 (57.0–67.0)	71.0 (68.0–75.0)	6
189	173	34	188	85.0 (79.0–89.0)	52.0 (47.0–57.0)	8
36	7	7	18	84.0 (69.0–93.0)	72.0 (51.0–88.0)	5
300	26	237	192	56.0 (52.0–60.0)	88.0 (83.0–92.0)	8
32	0	2	3	94.0 (80.0–99.0)	100.0 (29.0–100.0)	7
182	20	1	27	99.0 (97.0–100.0)	57.0 (42.0–72.0)	12
78	19	5	29	94.0 (86.0–98.0)	60.0 (45.0–74.0)	10
70	4	7	63	91.0 (82.0–96.0)	94.0 (85.0–98.0)	12
125	33	15	175	89.0 (83.0–94.0)	84.0 (78.0–89.0)	NA
383	111	43	92	90.0 (87.0–93.0)	45.0 (38.0–52.0)	3
217	19	14	70	94.0 (90.0–97.0)	79.0 (69.0–87.0)	NA
82	137	127	120	39.0 (33.0–46.0)	47.0 (40.0–53.0)	5
81	167	16	291	84.0 (75.0–90.0)	64.0 (59.0–68.0)	8

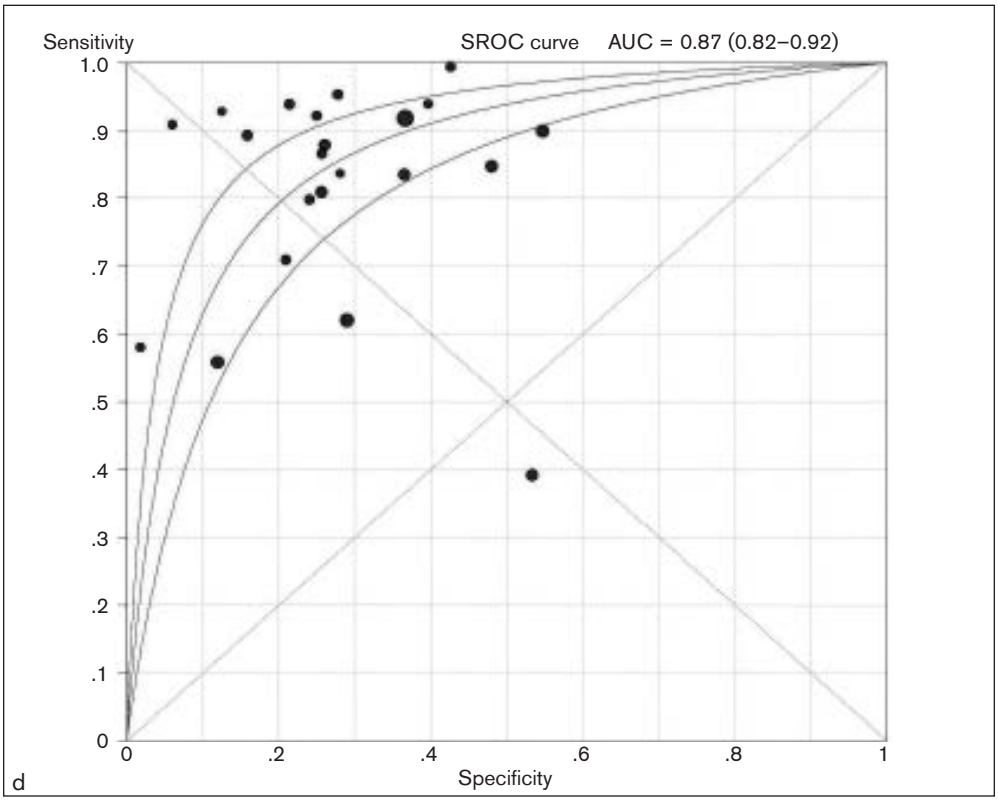
AUC (95% CI)	Heterogeneity values of I^2			*P* value for DOR
	Sensitivity (%)	Specificity (%)	DOR (%)	
0.87 (0.82–0.92)	97.2	94.0	94.9	
				.04
0.76 (0.57–0.95)	96.9	98.0	97.3	
0.81 (0.76–0.86)	96.9	80.5	93.6	
0.91 (0.85–0.97)	86.1	91.1	83.5	
				.001
0.92 (0.88–0.96)	92.1	93.1	67.8	
0.78 (0.70–0.86)	97.2	94.6	94.4	
				.06
0.80 (0.70–0.90)	98.3	95.5	97.0	
0.91 (0.87–0.95)	92.0	86.9	70.5	
				.17
0.87 (0.85–0.89)	92.5	91.3	56.6	
0.81 (0.71–0.91)	98.2	95.6	71.8	
0.95 (0.92–0.98)	47.4	94.1	88.6	





Figs 3a and 3b Forest plots of the pooled sensitivity and specificity for ID-Migraine.



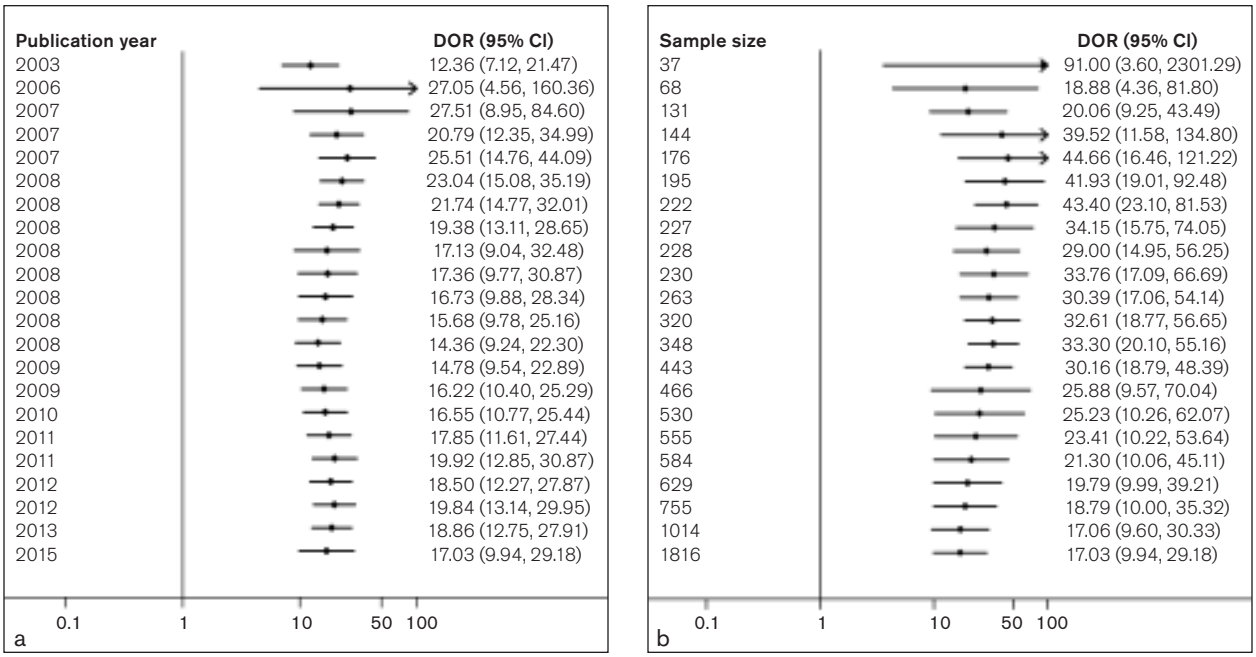


Figs 3c and 3d Forest plots of the pooled DOR, and the SROC curve for ID-Migraine. DOR = diagnostic odds ratio; AUC = area under the curve; SROC = summary receiver operating characteristic curve.

Table 4 Sensitivity Analysis of the Pooled Sensitivity, Specificity, and DOR by Sequentially Omitting Each Data

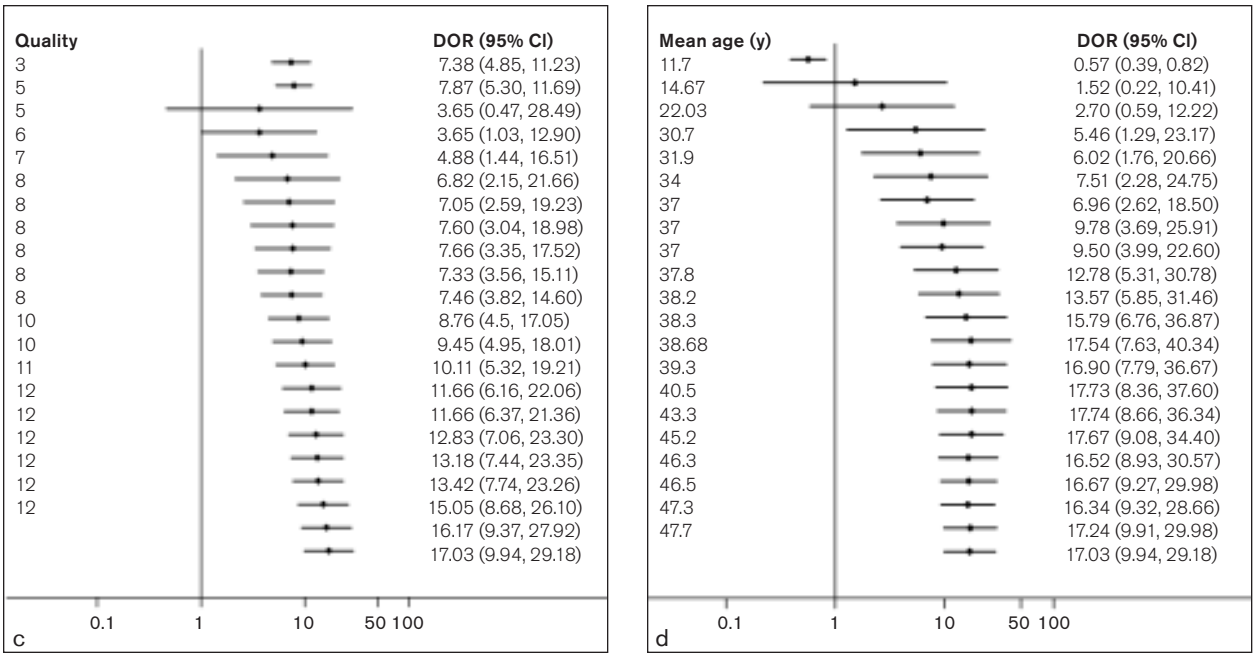
Study omitted	Pooled sensitivity (95% CI)	Pooled specificity (95% CI)	Pooled DOR (95% CI)
Liptonet al[5]	0.81 (0.80–0.82)	0.67 (0.66–0.69)	17.4 (9.9–30.6)
Kim and Kim[10]	0.81 (0.80–0.82)	0.67 (0.65–0.68)	16.0 (9.3–27.7)
Karli et al[9]	0.79 (0.77–0.80)	0.69 (0.67–0.70)	17.1 (9.6–30.3)
Brighina et al[7]	0.81 (0.80–0.82)	0.67 (0.66–0.69)	16.1 (9.3–27.8)
Di Piero et al[19]	0.81 (0.80–0.82)	0.68 (0.66–0.69)	16.5 (9.5–28.6)
Ertaş et al[23]*	0.81 (0.79–0.82)	0.67 (0.66–0.69)	16.9 (9.6–29.7)
Ertaş et al[23]*	0.81 (0.80–0.82)	0.67 (0.66–0.69)	17.4 (9.9–30.4)
Ertaş et al[23]*	0.81(0.80–0.82)	0.67 (0.66–0.69)	17.0 (9.7–29.7)
Siva et al[11]	0.81 (0.80–0.82)	0.67 (0.66–0.69)	17.7 (10.1–31.0)
Zarifoglu et al[6]	0.82 (0.81–0.84)	0.67 (0.65–0.68)	18.6 (10.5–33.0)
Khu et al[18]	0.81 (0.80–0.82)	0.69 (0.67–0.70)	18.1 (10.2–32.2)
Maizels and Houle[15]	0.81 (0.80–0.82)	0.68 (0.66–0.69)	17.2 (9.9–30.0)
Wang et al[13]	0.84 (0.83–0.85)	0.66 (0.65–0.68)	17.7 (10.0–31.4)
Di Paolo et al[20]	0.81 (0.80–0.82)	0.68 (0.66–0.69)	16.5 (9.6–28.4)
Mostardini et al[14]	0.80 (0.79–0.82)	0.68 (0.66–0.69)	15.7 (9.1–27.0)
Gil-Gouveia and Martins[8]	0.81 (0.80–0.82)	0.68 (0.66–0.69)	16.8 (9.7–29.2)
Villani et al[16]	0.81(0.80–0.82)	0.67 (0.66–0.69)	15.4 (9.0–26.5)
Gil-Gouveia[22]	0.81 (0.80–0.82)	0.67 (0.65–0.68)	16.2 (9.4–27.9)
Mehuys et al[17]	0.80 (0.79–0.81)	0.69 (0.67–0.70)	18.0 (10.1–31.9)
Jurno et al [21]	0.81 (0.80–0.82)	0.67 (0.66–0.69)	16.0 (9.3–27.5)
Jin et al[12]	0.83 (0.82–0.84)	0.69 (0.67–0.70)	18.9 (12.8–27.9)
Wang et al†	0.81 (0.80–0.82)	0.68(0.67–0.69)	17.7 (10.1–31.2)

*I^2 was calculated to assess the heterogeneity of pooled values after eliminating the study.
†*P* value of heterogeneity for pooled values before and after eliminating the study.
‡Present study.



Figs 4a and 4b Cumulative meta-analysis for the diagnostic accuracy of ID-Migraine. **(a)** Cumulative forest plot based on the publication year. **(b)** Cumulative forest plot based on the sample size. DOR = diagnostic odds ratio; 95% CI = 95% confidence intervals.

I^2 (%)* of pooled			*P* value for heterogeneity of pooled†		
Sensitivity	Specificity	DOR	Sensitivity	Specificity	DOR
97.3	94.3	95.10	.99	.99	.96
97.2	92.8	95.00	.99	.99	.88
96.9	94.2	94.60	.99	.99	.99
97.2	94.3	94.90	.99	.99	.89
97.2	94.3	95.10	.99	.99	.94
97.3	94.2	95.00	.99	.99	.99
97.3	94.3	95.10	.99	.99	.96
97.3	94.3	95.10	.99	.99	.99
97.3	94.2	95.10	.99	.99	.93
97.0	94.2	94.60	.99	.99	.83
97.3	93.6	95.10	.99	.99	.88
97.3	94.3	95.10	.99	.99	.98
96.3	93.3	95.10	.99	.99	.92
97.3	94.3	95.10	.99	.99	.94
97.0	94.3	95.00	.99	.99	.83
97.3	94.3	95.10	.99	.99	.97
97.3	93.8	94.90	.99	.99	.80
97.3	93.8	94.80	.99	.99	.90
97.2	93.5	95.10	.99	.99	.90
97.2	94.2	94.80	.99	.99	.87
96.4	93.4	88.70	.99	.99	.76
97.3	94.2	95.10	.99	.99	.92



Figs 4c and 4d Cumulative meta-analysis for the diagnostic accuracy of ID-Migraine. **(c)** Cumulative forest plot based on the quality of the study. (Quality of two meeting abstracts could not be evaluated.) **(d)** Cumulative forest plot based on the mean age of the participants. (Mean age of the participants could not be acquired in one study.) DOR = diagnostic odds ratio; 95% CI = 95% confidence intervals.

Discussion

This is the first study addressing the validation of the Chinese version of ID-Migraine conducted in university students in mainland China. The results of the study, combined with the updated meta-analysis, indicate that ID-Migraine is a valid screening tool.

The Chinese version of ID-Migraine had a sensitivity of 84.0% and a specificity of 64.0% when ICDH-II criteria were used as the gold standard to diagnose migraine in medical university students. The false-positive rate was 36.5%, which is an acceptable level for a screening test but not for a diagnostic tool.[11]

The sensitivity of 84.0% of this study was higher than that of studies conducted among teenagers.[6,12] This could be due to the screening tool being a self-administered questionnaire and to certain demographic features of the subjects, such as age, that may affect performance on ID-Migraine.[37] In the current study, the participants were all well-educated university students who were majoring in medical science; they may have a better understanding of the questions of the screening tool and ability to communicate effectively with the neurologist. However, the sensitivity recorded in this study was slightly lower than that reported in studies conducted in Italy,[7,14,16,19,20] Turkey,[9,23] Portugal,[8,22] and Brazil.[21] There may be several reasons for this difference, such as the sample type, the severity of the condition, and the inclusion criteria. For instance, the present study was conducted in a medical university, whereas the other studies were mostly carried out in neurology or headache clinics,[7,9,14,20,21] which could introduce a referral bias. Symptoms of clinical patients could be more severe, leading to a higher likelihood for subjects to be more accurately identified as migraineurs, which in turn may increase the sensitivity. Indeed, it has been reported that the severity of the condition may have a positive impact on the sensitivity of the test.[37,38] In addition, different inclusion criteria were used in the present study. The other studies included patients who reported to have experienced two or more headaches during the past 3 months,[7–9,19,23] and/or those that fulfilled one of the two prescreening criteria: "Do you have headaches that limit your ability to work, study, or enjoy life?" or "Do you want to talk to the physician about the headache?" The students of the present study were included regardless of whether or not they fulfilled the prescreening criteria. This suggests that subjects with a less severe migraine were included in this study, which could account for the lower sensitivity.

The specificity found in this study was also lower than that of studies conducted using the Italian,[7,16,19,20] Portuguese,[21,22] Korean,[10] English,[5,15] and Turkish,[6,11,23] versions of ID-Migraine. This difference could be due to the Chinese version of ID-Migraine beginning with the question "Did you have two or more headaches in the last 3 months?" Students who had a cough or other condition such as coryza, which can be accompanied by headache, may have answered positively to the question and therefore were misdiagnosed as migraine; this would increase the rate of false positives and therefore decrease the specificity value. It is possible that changing the question to "Did you have two or more headaches in the last 3 months excluding one associated with a cough, fever, or other condition?" could have improved the specificity.

In a meta-analysis published in 2011, which included 13 studies, the pooled sensitivity and specificity values were 84.0% (95% CI: 75.0%–90.0%) and 76.0% (95% CI: 69.0%–83.0%), respectively, which confirmed ID-Migraine as a practical diagnostic tool.[26] However, substantial heterogeneity existed in the meta-analysis, and the effect of the different covariates on the total heterogeneity was not assessed. Furthermore, three studies conducted before 2010 were not included,[13–15] and another five studies concerning the validation of ID-Migraine have since been published.[12,16,17,21,22] The updated meta-analysis presented here comprised 22 studies (including the current study). The quality of the included studies was assessed by QUADAS and ranged from 3 to 12. The quality difference between the studies would affect the heterogeneity of the meta-analysis to some extent.

Several limitations of the present study should be pointed out. First, the current study was conducted among medical university students who were young and well-educated, which limits the external validity. Further studies among the general population should be conducted to confirm the results. Secondly, the period between the screening and examination by the neurologist was about 9 months. Although migraine is a chronic condition, it has a favorable long-term prognosis with an average remit rate of 3.5% to 5.8%[39–41] and an average incidence of 0.4% per year.[42] Therefore, patients could have been misclassified due to spontaneous recovery or progression to become a migraineur during the waiting time, which may have affected both the sensitivity and specificity values. Assuming an incidence rate of 0.4% and a remission rate from 3.5% to 5.8%, the sensitivity would have increased from 83.0% to 85.0%, but without change in the specificity. Accordingly, the interval had no significant impact on the specificity. Furthermore, patients in the present study with a diagnosis of probable migraine[28] (ICHD-II codes 1.6.1 and 1.6.2), eg, patients who had headache attacks that lacked one of the features needed to fulfill all criteria for migraine, and who may have provided posi-

tive answers to the Chinese version of ID-Migraine, were diagnosed as non-migraineurs, thus likely affecting the estimate of the number of migraineurs. Further studies should classify this category and compare the validity of subjects who have probable migraine with those who have strict migraine as well as non-migraine groups to obtain a more accurate estimate. Finally, the current analysis identified substantial heterogeneity in the included studies that was partially explained by the geographic location and the quality of the studies. Even so, the heterogeneity of the present study likely affected the evaluation of the pooled sensitivity, specificity, and DOR of ID-Migraine screener. Lastly, the present study included only publications in English, which may have introduced an English language bias. However, the Deeks' funnel plot asymmetry test suggested that no publication bias existed in the study. Accordingly, the meta-analysis most likely provided a precise estimate of the diagnostic accuracy of ID-Migraine screener.

Conclusions

The current study and the updated meta-analysis have confirmed that ID-Migraine is a valid screening tool for recognizing migraineurs.

Acknowledgments

The authors report no conflicts of interest related to this study.

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