

# Cluster headache care gaps among primary healthcare physicians in the Middle East, North Africa, and Türkiye: a multinational study

Ahmed Dahshan<sup>ID</sup> · Marwa Ibrahim Mahfouz Khalil<sup>ID</sup> · Merve Ceren Akgor<sup>ID</sup> · Derya Uludüz<sup>ID</sup> · Mahmood Khalifa Al Hinai · Ahmed Abdelfattah Nassar · Mahmoud Ali Khazbak<sup>ID</sup> · Kamal Khaled Hamad<sup>ID</sup> · Mohamed Elsayed Ahmed Allawy<sup>ID</sup> · Mohammed Salfeeq H. Alshammari<sup>ID</sup> · Ali Malik Tiryag<sup>ID</sup> · Samaa Ahmad Akram Al Tabbah<sup>ID</sup> · Nabih Mohammad Lawand<sup>ID</sup> · Moath Abu Ejheisheh<sup>ID</sup> · Anter Mothenna Abdullah Nasser<sup>ID</sup> · Aussan Al-Athwari · Fatima Adnan Hallaj<sup>ID</sup> · Tajeldinn Helal · Wael Alwahchi<sup>ID</sup> · Sarra Chouaib · Ahmed Allioueche · Mohamed Marouf<sup>ID</sup> · Walaa Mansour Ahmed<sup>ID</sup> · Sameh El Rayes<sup>ID</sup> · Zeyad Yassin<sup>ID</sup> · Mona A. F. Nada · Hesham Eissa<sup>ID</sup> · Ahmed Ahmed Mohamed Kamal Ebied

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## Abstract

**Background** Cluster headache is one of the most severely disabling primary headache disorders and is frequently associated with diagnostic delay, inappropriate treatment, disability, and substantial psychosocial burden. Because primary healthcare (PHC) physicians are commonly the first point of contact for patients with new headache presentations, their ability to recognize the disorder and initiate evidence-based management is clinically important. However, data on PHC-level cluster headache competency across the Middle East and North Africa (MENA) and Türkiye are limited. We assessed knowledge, attitudes, practice patterns, perceived barriers, and educational needs among PHC physicians across this region.

**Methods** We conducted a cross-sectional study of 3,045 PHC physicians in 14 countries from May to July 2026 using non-probability, network-based recruitment. A pilot-tested, study-specific questionnaire aligned with the International Classification of Headache Disorders, third edition, and contemporary treatment guidance assessed knowledge, attitudes, practice, resources, barriers, and educational needs. Prespecified pragmatic thresholds defined adequate performance. Multivariable logistic regression estimated adjusted odds ratios, and modified Poisson regression with robust standard errors provided sensitivity estimates as adjusted prevalence ratios.

**Results** Adequate knowledge was observed in 42.2% of participants, positive attitudes in 53.4%, adequate practice in 23.9%, and adequate composite performance in 34.4%. Only 13.3% correctly recognized the complete

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constellation of cranial autonomic features. High-flow oxygen was routinely available in 36.0% of facilities. Previous formal headache training was associated with a higher prevalence of adequate knowledge (adjusted prevalence ratio 2.80, 95% confidence interval 2.46–3.18), adequate practice (1.57, 1.32–1.86), and adequate composite performance (3.53, 2.97–4.19). Limited neurology referral access was associated with lower prevalence of adequate knowledge (0.60, 0.52–0.70) and adequate composite performance (0.63, 0.53–0.75).

**Conclusions** This large multinational study documents substantial, actionable gaps in cluster headache competency among PHC physicians. The findings support targeted headache-specific continuing medical education, reliable facility-level oxygen access, and structured referral pathways as priorities for improving care.

**Clinical trial number** Not applicable.

**Keywords** Cluster headache · Trigeminal autonomic cephalalgias · Knowledge · Attitudes · Practice · Primary healthcare · Middle East and North Africa · Türkiye

## Abbreviations

|          |                                                                       |
|----------|-----------------------------------------------------------------------|
| AHS      | American Headache Society                                             |
| aOR      | adjusted odds ratio                                                   |
| aPR      | adjusted prevalence ratio                                             |
| AUC      | Area under the receiver operating characteristic curve                |
| CH       | Cluster headache                                                      |
| CHERRIES | Checklist for Reporting Results of Internet E-Surveys                 |
| CI       | Confidence interval                                                   |
| CME      | Continuing medical education                                          |
| ECG      | Electrocardiography / electrocardiogram                               |
| EAN      | European Academy of Neurology                                         |
| GP       | General practitioner                                                  |
| HC3      | Heteroskedasticity-consistent robust standard error estimator, type 3 |
| ICHD-3   | International Classification of Headache Disorders, third edition     |
| IQR      | Interquartile range                                                   |
| KAP      | Knowledge, attitudes, and practice                                    |
| MBBS     | Bachelor of Medicine, Bachelor of Surgery                             |
| MBChB    | Bachelor of Medicine and Bachelor of Surgery                          |
| MENA     | Middle East and North Africa                                          |
| OR       | Odds ratio                                                            |
| PHC      | Primary healthcare                                                    |
| SD       | Standard deviation                                                    |
| STROBE   | Strengthening the Reporting of Observational Studies in Epidemiology  |
| TACs     | Trigeminal autonomic cephalalgias                                     |
| UAE      | United Arab Emirates                                                  |

## Background

Headache disorders affected an estimated 2.9 billion people worldwide in 2023 and accounted for an age-standardized rate of 541.9 years lived with disability per 100,000 population [1]. Within this broad neurological burden, cluster headache (CH) represents a comparatively uncommon but exceptionally disabling primary headache disorder. The International Classification of Headache Disorders, third edition (ICHD-3), classifies CH among the trigeminal autonomic cephalalgias and defines it by recurrent attacks of severe or very severe, strictly unilateral

orbital, supraorbital, and/or temporal pain lasting 15–180 min, accompanied by ipsilateral cranial autonomic manifestations and/or marked restlessness or agitation [2]. CH affects approximately 0.1% of the population, with reported prevalence estimates varying substantially across settings [3, 4]. Its clinical importance, however, extends beyond prevalence. Recurrent attacks disrupt sleep, employment, family functioning, and social participation, while fear of subsequent attacks can produce substantial interictal psychological distress [5]. CH also generates considerable direct healthcare expenditure and indirect costs through work absence and reduced productivity [6]. A recent meta-analysis estimated suicidal ideation in 8.0% of patients overall, with markedly higher estimates in specialist clinical samples, although substantial between-study heterogeneity requires cautious interpretation [7]. These findings establish CH as a neurological disorder whose individual and societal burden is disproportionate to its epidemiological frequency.

Despite its recognizable clinical phenotype and the availability of effective acute and preventive treatments, CH remains frequently unrecognized or incorrectly managed. A 2025 systematic review and meta-analysis estimated a mean diagnostic delay of 10.43 years [8]. Patients commonly receive initial diagnoses of migraine, sinusitis, dental disease, trigeminal neuralgia, or ocular disorders, leading to ineffective treatments, unnecessary procedures, repeated consultations, and delayed access to appropriate headache care [9]. Several features may contribute to this delay, including the relative rarity of CH, episodic presentation, incomplete cranial autonomic manifestations, overlap with migraine symptoms, and limited clinician familiarity with formal diagnostic criteria, particularly at primary healthcare level. Inadequate treatment readiness can compound diagnostic deficiencies because evidence-aligned care requires rapid access to high-flow oxygen or non-oral triptans for acute attacks and structured pathways for preventive treatment, monitoring, and specialist referral [3, 4].

Primary healthcare (PHC) physicians commonly provide the first clinical assessment for patients with new or recurrent severe headache. Their ability to recognize the characteristic temporal pattern of CH, identify associated autonomic manifestations, distinguish primary CH from secondary headache syndromes, initiate appropriate acute measures, and arrange timely referral can substantially influence the subsequent care pathway. Available evidence nevertheless suggests that frontline clinicians remain insufficiently prepared. A qualitative study involving general practitioners and neurologists identified persistent diagnostic uncertainty, misdiagnosis, treatment difficulties, and disagreement regarding the respective responsibilities of primary and specialist care [10]. More recently, a 2025 survey of 120 family medicine physicians and 98 emergency physicians in Türkiye found that only 15% considered their CH knowledge sufficient, while 70% reported concern about misdiagnosing the disorder [11]. These studies identify an important frontline-care problem but do not provide a multinational evaluation of objective knowledge, clinical attitudes, evidence-aligned practices, treatment resources, and referral capacity.

This evidence gap is particularly relevant across the Middle East and North Africa (MENA) and Türkiye, where health systems differ substantially in primary-care organization, neurology workforce capacity, medication availability, continuing medical education, and access to specialist referral. Regional headache research has concentrated predominantly on migraine, leaving cluster headache epidemiology, physician preparedness, and service readiness comparatively underexamined [12]. Emerging studies from Egypt have documented prolonged diagnostic delay among patients with cluster headache and incomplete awareness of its clinical presentation and management among physicians [13, 14]. However, the available studies used patient-based or single-city samples, included heterogeneous medical specialties, and did not focus specifically on physicians delivering first-contact primary care. They also did not examine physician preparedness alongside practical determinants of implementation, including high-flow oxygen availability, confidence in preventive prescribing, neurology referral access, perceived barriers, and educational preferences. Consequently, regional policymakers lack comparative evidence to determine whether deficiencies primarily reflect limited knowledge, unfavorable attitudes, inadequate clinical routines, constrained resources, or combinations of these factors.

We therefore conducted this multinational cross-sectional study of PHC physicians practicing across 14 countries in the MENA region, including Türkiye. The primary objective was to evaluate CH-related knowledge, attitudes, self-reported evidence-aligned practices, clinical resource availability, perceived barriers, and educational needs. The secondary objectives were to identify demographic, professional, educational, and health-system

factors independently associated with adequate performance; examine variation across countries and subregions; and determine whether favorable attitudes translated into appropriate clinical practice. By integrating a knowledge-attitudes-practice framework with measures of treatment and referral readiness, this study aimed to generate actionable evidence for PHC continuing medical education, clinical decision support, facility preparedness, and regional headache-care pathways.

## Methods

### Study design

We conducted a multinational, cross-sectional study to evaluate CH-related knowledge, attitudes, self-reported clinical practices, care readiness, perceived barriers, and educational needs among primary healthcare (PHC) physicians. The study covered 14 countries in the MENA region, including Türkiye. We designed and reported the study in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement for cross-sectional studies and the Checklist for Reporting Results of Internet E-Surveys (CHERRIES) [15, 16]. Because exposure and outcome variables were measured at one time point, all associations should be interpreted as non-causal.

### Setting and participating countries

Data collection occurred from May to July 2026. Country collaborators distributed the study questionnaire through professional medical networks, institutional communication channels, PHC and family-medicine groups, and professional social media platforms. For prespecified descriptive comparisons, countries were grouped into North Africa (Algeria, Egypt, Libya, Morocco, and Sudan), the Levant and Türkiye (Lebanon, Palestine, the Syrian Arab Republic, and Türkiye), and the Gulf-adjacent region (Iraq, Oman, Saudi Arabia, the United Arab Emirates, and Yemen). Country-level analyses retained each country as a separate category.

Table 1 shows the countries participating and the number of participants from each country.

**Table 1** Participating countries, subregional grouping, and number of participants

| Region/ country      | Participants, <i>n</i> | % of total sample |
|----------------------|------------------------|-------------------|
| North Africa         | 1002                   | 32.9%             |
| Egypt                | 575                    | 18.9%             |
| Morocco              | 114                    | 3.7%              |
| Algeria              | 109                    | 3.6%              |
| Libya                | 103                    | 3.4%              |
| Sudan                | 101                    | 3.3%              |
| Levant and Türkiye   | <b>1321</b>            | <b>43.4%</b>      |
| Palestine            | 423                    | 13.9%             |
| Lebanon              | 392                    | 12.9%             |
| Syrian Arab Republic | 270                    | 8.9%              |
| Türkiye              | 236                    | 7.8%              |
| Gulf-adjacent region | <b>722</b>             | <b>23.7%</b>      |
| Iraq                 | 244                    | 8.0%              |
| United Arab Emirates | 122                    | 4.0%              |
| Oman                 | 120                    | 3.9%              |
| Yemen                | 119                    | 3.9%              |
| Saudi Arabia         | 117                    | 3.8%              |
| <b>Total</b>         | <b>3,045</b>           | <b>100.0%</b>     |

## Participants, eligibility criteria and recruitment

Eligible participants were licensed physicians delivering first-contact, comprehensive outpatient care in community or primary-care settings. General practitioners, family physicians, family-medicine residents assigned to primary care, medical officers, and community-clinic physicians were eligible. Neurologists, headache specialists, physicians practicing exclusively in secondary or tertiary services, interns, students, non-physician professionals, persons who did not give consent, and submissions failing eligibility requirements were excluded.

Recruitment was non-probability, network-based, voluntary, and uncompensated. The term country collaborators referred to author-affiliated investigators who supported dissemination in their countries; affiliation-based country coverage is listed in Supplementary Table S1. Collaborators documented 7,224 initial invitations. The survey link was distributed through a country-specific mix of institutional e-mail lists, closed professional messaging groups, primary-care and family-medicine groups, and professional social media pages. Platforms and reach were not standardized across countries.

A total of 4,050 questionnaires were submitted, corresponding to 56.1% of the documented initial invitations. Before data locking, we excluded 317 submissions because they were ineligible or identified as duplicates and 688 because they were substantially incomplete. We defined “substantially incomplete” a priori as failure to complete one or more entire scored sections after passing the mandatory eligibility and consent screen. Submissions with isolated missing responses confined to non-core descriptive items were retained. The four primary outcomes and all covariates included in the regression analyses were complete; therefore, no imputation was performed.

The final analytic sample comprised 3,045 complete, eligible, consented, non-duplicate responses (75.2% of submissions). The screening log retained ineligible and duplicate submissions as a combined category, so these 317 records could not be subdivided reliably. The recruitment funnel is shown in Fig. 1. Because country participation depended on voluntary network-based recruitment, country-level estimates were considered exploratory descriptive estimates rather than nationally representative measures. Differences between countries may reflect true variation in competency, differential exposure to headache education, recruitment characteristics, or combinations of these factors.

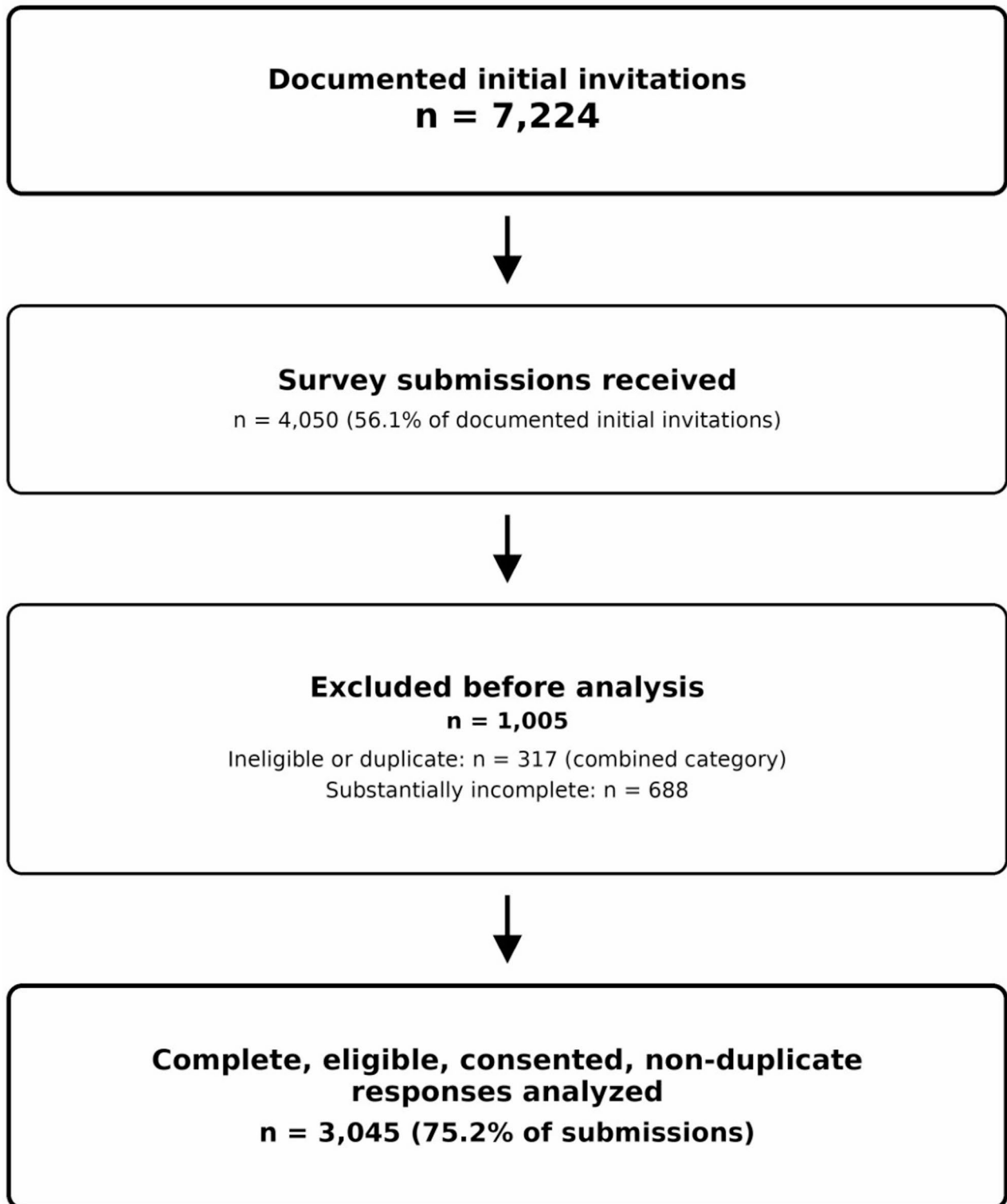
Because recipients could forward the link through overlapping closed groups and open electronic channels, the total number of unique physicians exposed to the survey and the number who viewed the landing page could not be determined. Accordingly, a landing-page view rate could not be calculated. The 56.1% figure is therefore reported as a submission proportion based on documented initial invitations, not as a unique-recipient response rate. Eligibility was assessed at the beginning of the form using qualifying medical degree, current practice in an eligible first-contact setting, participating country, survey language, and electronic-consent criteria.

## Sample size calculation

We calculated the minimum sample size for estimating a single population proportion using  $n = Z^2 p(1-p)/d^2$ . With a two-sided 95% confidence level ( $Z = 1.96$ ), an expected proportion of 0.50, and absolute precision of 0.05, the minimum required sample was 385 physicians. The final analytic sample comprised 3,045 respondents. The least frequent primary outcome, adequate practice, occurred in 729 participants; this provided more than 30 outcome events per parameter in the largest prespecified regression model. The calculation supported the overall analysis but was not intended to generate nationally representative country estimates.

## Questionnaire development

The study investigators developed a structured, self-administered questionnaire specially designed for this study after reviewing the International Classification of Headache Disorders, third edition (ICHD-3), contemporary international cluster headache treatment guidance, clinical reviews, regional headache literature, and published



**Fig. 1** Recruitment and analysis flow

physician-awareness surveys [2, 3, 11, 13, 17, 18]. Neurology and primary-care experts co-investigators reviewed the draft for clinical relevance, content coverage, clarity, and suitability for first-contact practice.

The questionnaire comprised 44 numbered questions organized into seven sections; several numbered questions contained multiple subitems, response matrices, or multi-select options. The first section contained mandatory eligibility and electronic-consent items. The second collected sociodemographic and professional information, including age, sex, country, years of practice, highest qualification, practice type and location, previous headache-related education, sources of training, and access to neurology referral services. The knowledge section contained 20 objectively scored questions across four clinically defined domains: epidemiology and clinical features (seven questions), ICHD-3 classification and differential diagnosis (five questions), acute pharmacological and non-pharmacological treatment (four questions), and preventive treatment (four questions). Nineteen questions used a single-best-answer format, and one question assessed recognition of cranial autonomic features using a multi-select format. This section included a clinical vignette to assess applied diagnostic reasoning rather than factual recall alone [19]. Item content reflected ICHD-3 diagnostic criteria, the 2023 European Academy of Neurology guideline, American Headache Society evidence-based recommendations, and contemporary clinical reviews [2, 3, 17, 18]. The attitude and confidence section contained ten statements rated on a five-point Likert scale from 1 (strongly disagree) to 5 (strongly agree). The statements assessed the perceived importance of CH competency in PHC, diagnostic confidence, willingness to initiate acute treatment, views regarding high-flow oxygen availability, attribution of diagnostic delay, confidence in preventive prescribing, and perceived adequacy and value of continuing medical education (CME). Two negatively framed items were reverse-coded to reduce acquiescence bias [20]. The practice section assessed headache caseload, previous diagnostic exposure to CH, differential diagnoses considered for unilateral headache with autonomic manifestations, diagnostic approach, acute and preventive treatment selection, availability of high-flow oxygen, referral thresholds, and routine clinical behaviors. Ten practice-habit statements used a three-level response scale: always, sometimes, and never or rarely. Separate multi-select questions assessed six perceived diagnostic barriers and five treatment barriers. The final section assessed interest in additional CH education and preferred CME formats, including live workshops, online courses, educational videos or webinars, pocket algorithms, mobile applications, and guideline-based materials [21, 22]. The full study questionnaire is available as supplementary file.

### Pilot testing and survey administration

The complete questionnaire was piloted with a convenience sample of 90 PHC physicians from four participating countries who were not included in the final study. The pilot assessed face validity and usability, including comprehension, ambiguity, response-option fit, sequencing, technical display, and completion burden. Mean completion time was 11.4 min (range, 8–16 min). Feedback led to clarification of ambiguous wording, harmonization of response anchors and multi-select instructions, and formatting adjustments for electronic administration; the construct map, scoring framework, and intended content domains remained unchanged.

We administered the final questionnaire using Google Forms (Google LLC, Mountain View, CA, USA). The landing page described the purpose of the study, eligibility requirements, voluntary nature of participation, anonymity, estimated completion time, data use, and investigators' contact details. Respondents could proceed only after confirming eligibility and providing electronic consent. Mandatory response settings were used for core survey fields. During data harmonization, the four primary outcomes and all covariates entered in the regression models were checked for completeness and were complete. The survey did not request names, contact details, or other direct personal identifiers.

### Scoring procedures and outcome definitions

Each knowledge response received 1 point when correct and 0 when incorrect. The multi-select cranial-autonomic-feature question received 1 point only when the respondent selected all correct options and no incorrect

option. The total knowledge score ranged from 0 to 20. We classified scores as poor ( $<8$ ), below average (8–11), borderline or fair (12–13), adequate (14–16), and good or excellent (17–20). For the primary binary outcome, adequate knowledge was defined a priori as at least 14 of 20 points (70% of the maximum) [23].

Attitude responses received 1–5 points, with higher values representing a more favorable orientation after reverse-coding the two negatively framed items using the transformation 6 minus the original response. The total attitude score ranged from 10 to 50. We classified scores as negative ( $<25$ ), neutral or mixed (25–34), positive (35–42), and highly positive (43–50). The binary outcome positive attitude included scores of at least 35 of 50.

The practice score combined three evidence-aligned clinical-decision questions with ten practice-habit items. Correct or guideline-concordant responses to diagnostic approach, acute treatment, and preventive treatment questions received 1 point; other responses received 0. High-flow oxygen and subcutaneous or intranasal triptan therapy were both accepted as evidence-aligned acute treatments. Practice-habit responses received 2 points for always, 1 point for sometimes, and 0 for never or rarely. The total practice score ranged from 0 to 23 and was categorized as inadequate ( $<8$ ), below adequate (8–13), borderline (14–16), adequate (17–19), and good or excellent (20–23). Adequate practice was defined as at least 17 of 23 points.

We created a composite KAP score after standardizing domain contributions to reduce the influence of their different raw ranges. The knowledge score was multiplied by 2 to contribute a maximum of 40 points; the attitude score was multiplied by 30/50 to contribute a maximum of 30 points; and the practice score was multiplied by 28/23 to contribute a maximum of 28 points. The composite score therefore ranged from 0 to 98. We defined adequate composite KAP as at least 69 points. The 70% thresholds were prespecified pragmatic interpretive cut points rather than validated clinical thresholds; continuous domain scores were retained for correlation analyses.

We assessed internal consistency in the final analytic sample because the study-specific instrument had no previously established reliability estimates. The Kuder-Richardson 20 coefficient was 0.868 for the dichotomously scored knowledge scale. Cronbach's alpha coefficients were 0.891 for the attitude scale and 0.748 for the practice scale. These coefficients indicate acceptable to good internal consistency but do not establish construct validity or cross-cultural measurement equivalence across participating countries.

## Ethical considerations

The Institutional Review Board of the Faculty of Medicine, Alexandria University approved the study (approval no. 0307950; May 2026). The study complied with the principles of the 2013 revision of the Declaration of Helsinki. It involved an anonymous physician survey and did not include patient contact, clinical intervention, medical-record access, biological specimens, or collection of direct personal identifiers. All participants provided electronic informed consent before opening the questionnaire and could decline participation without penalty. The research team stored the dataset in password-protected electronic files and restricted access to authorized investigators. We analyzed and reported data only in aggregate form. No participant received compensation, and the survey collected no patient-level data.

## Statistical analysis

Data were analyzed using IBM SPSS Statistics for Windows, version 27.0 (IBM Corp., Armonk, NY, USA). Sensitivity analyses and reproducibility checks were conducted in Python 3.13 using pandas 2.2.3 and statsmodels 0.14.6. Before analysis, we checked allowable ranges, coding consistency, duplicate records, and the prespecified ranges of all derived scores. No data were missing for the four primary outcomes or for covariates entered in the regression models. Categorical variables are reported as frequencies and percentages. Because the knowledge, attitude, practice, and composite KAP scores were bounded and non-normally distributed on graphical inspection, we report both means with standard deviations and medians with interquartile ranges.

Spearman rank correlation coefficients quantified associations among continuous knowledge, attitude, and practice scores. Country- and subregion-specific adequacy estimates were treated as descriptive because recruitment

used non-probability network sampling and country samples were not population-weighted. Multiple-response barrier and educational-format items were summarized as the proportion of the full sample endorsing each option; their percentages were therefore not expected to sum to 100%.

We fitted four multivariable binary logistic regression models to identify factors independently associated with: (1) adequate knowledge, (2) positive attitude, (3) adequate practice, and (4) adequate composite KAP. Candidate covariates were selected a priori on clinical and health-system grounds and entered simultaneously rather than selected by automated stepwise procedures. Core covariates were age group, sex, years of clinical experience, highest professional qualification, practice location, previous formal headache training, neurology referral access, and subregion. The attitude model additionally included knowledge adequacy, and the practice model additionally included knowledge adequacy and positive attitude. The composite KAP model excluded the individual KAP domains because they were components of the dependent variable.

Categorical predictors were dummy-coded using the following reference groups: age 20–30 years, female sex, 6–10 years of clinical experience, MBBS/MChB or equivalent qualification, rural practice, no previous formal headache training, neurology referral within two weeks, and the Levant and Türkiye subregion. We assessed multicollinearity using variance inflation factors, verified model convergence, and inspected outcome-predictor combinations for sparsity. Adjusted odds ratios (aORs), 95% confidence intervals (CIs), and two-sided Wald  $p$  values are reported. Model performance was summarized using the likelihood-ratio chi-square statistic, Nagelkerke  $R^2$ , and the area under the receiver operating characteristic curve (AUC). Because all four outcomes were common, modified Poisson regression with heteroskedasticity-consistent (HC3) robust standard errors provided sensitivity estimates as adjusted prevalence ratios (aPRs). Statistical significance was defined as  $p < 0.05$ ; interpretation emphasized effect magnitude and 95% CIs. Because exploratory analysis identified extreme between-country variation in knowledge-adequacy estimates (Table 5), a post hoc sensitivity analysis re-estimated knowledge adequacy and the corresponding multivariable model after excluding the countries with the most extreme estimates, to assess whether this finding was driven disproportionately by a small number of national samples (Supplementary Table S2).

## Results

### Participant characteristics

The analysis included 3,045 eligible, consented, non-duplicate responses. Physicians aged 31–40 years constituted the largest age group (37.7%), and 53.5% were female. The Levant and Türkiye contributed 43.4% of the sample, North Africa 32.9%, and the Gulf-adjacent region 23.7%. Most participants practiced in urban settings (74.6%); 64.6% had received a prior formal headache education or training, and 47.0% reported access to neurology referral within two weeks (Table 2).

### Knowledge, attitudes, practice, and composite performance

The mean knowledge score was 12.01 (SD, 5.11) of 20, and 1,285 physicians (42.2%) met the prespecified adequacy threshold. Classification and diagnosis had the highest mean domain percentage score (67.2%), followed by acute treatment (63.5%), preventive treatment (61.4%), and epidemiology and clinical features (52.2%). Recognition of the complete constellation of cranial autonomic features was the weakest item (13.3% correct), whereas 73.9% correctly identified the clinical vignette as cluster headache.

The reverse-coded attitude score averaged 32.17 (SD, 9.13) of 50; 1,625 participants (53.4%) demonstrated a positive or highly positive attitude. Agreement was strongest for the value of dedicated continuing medical education (mean, 3.57; SD, 1.39) and the need to make high-flow oxygen available in primary care (mean, 3.54; SD, 1.34). Confidence in initiating verapamil was lowest (mean, 2.85; SD, 1.19).

**Table 2** Study participants' demographic and professional characteristics (*n* = 3,045)

| Characteristic                                     | <i>n</i> | %    |
|----------------------------------------------------|----------|------|
| <b>Age group</b>                                   |          |      |
| 20–30 years                                        | 771      | 25.3 |
| 31–40 years                                        | 1147     | 37.7 |
| 41–50 years                                        | 691      | 22.7 |
| 51–60 years                                        | 325      | 10.7 |
| > 60 years                                         | 111      | 3.6  |
| <b>Sex</b>                                         |          |      |
| Male                                               | 1415     | 46.5 |
| Female                                             | 1630     | 53.5 |
| <b>Subregion</b>                                   |          |      |
| Gulf-adjacent region                               | 722      | 23.7 |
| Levant and Türkiye                                 | 1321     | 43.4 |
| North Africa                                       | 1002     | 32.9 |
| <b>Years of clinical practice</b>                  |          |      |
| Less than 2 years                                  | 417      | 13.7 |
| 2–5 years                                          | 669      | 22.0 |
| 6–10 years                                         | 862      | 28.3 |
| 11–20 years                                        | 765      | 25.1 |
| > 20 years                                         | 332      | 10.9 |
| <b>Highest professional qualification</b>          |          |      |
| MBBS/MBChB or equivalent                           | 809      | 26.6 |
| Diploma in family medicine/general practice        | 686      | 22.5 |
| Board-certified specialist/fellowship              | 803      | 26.4 |
| Master's degree                                    | 323      | 10.6 |
| Other postgraduate qualification                   | 424      | 13.9 |
| <b>Practice location</b>                           |          |      |
| Urban                                              | 2272     | 74.6 |
| Rural                                              | 773      | 25.4 |
| <b>Previous formal headache education/training</b> |          |      |
| Yes                                                | 1966     | 64.6 |
| No                                                 | 1079     | 35.4 |
| <b>Neurology referral access</b>                   |          |      |
| Within 2 weeks                                     | 1432     | 47.0 |
| Significant delay (> 4 weeks)                      | 782      | 25.7 |
| Limited access                                     | 509      | 16.7 |
| No neurology referral service                      | 322      | 10.6 |

Practice represented the weakest performance domain. The mean practice score was 13.87 (SD, 4.10) of 23, and 729 physicians (23.9%) met the adequacy threshold. The mean composite KAP score was 60.22 (SD, 15.74) of 98; 1,046 physicians (34.4%) achieved adequate composite performance (Table 3).

### Clinical exposure, diagnostic approach, and service readiness

Most physicians (69.9%) evaluated no more than 15 patients with headache per month. Although 71.7% had diagnosed at least one patient with cluster headache during their career, only 7.4% had diagnosed more than 10 cases. Cluster headache (65.5%) and migraine with autonomic features (56.0%) were the most frequently selected initial differential diagnoses for severe unilateral headache with ocular autonomic manifestations.

Only 1,095 physicians (36.0%) reported routine access to high-flow oxygen; 24.3% could obtain oxygen only through a special request, 26.8% reported that it was unavailable, and 12.9% did not know whether it was available. Red flags suggesting a secondary headache disorder were the most frequently selected referral indication (54.9%), followed by diagnostic uncertainty (49.9%) and failure of first-line treatment (44.9%) (Table 4).

**Table 3** Knowledge, attitude, practice, and composite KAP scores ( $n=3,045$ )

| Domain (range)       | Mean $\pm$ SD     | Median | IQR         | Adequate $n$ (%) | Adequacy criterion |
|----------------------|-------------------|--------|-------------|------------------|--------------------|
| Knowledge (0–20)     | 12.01 $\pm$ 5.11  | 12.00  | 8.00–17.00  | 1285 (42.2)      | $\geq 14/20$       |
| Attitude (10–50)     | 32.17 $\pm$ 9.13  | 35.00  | 27.00–39.00 | 1625 (53.4)      | $\geq 35/50$       |
| Practice (0–23)      | 13.87 $\pm$ 4.10  | 14.00  | 11.00–16.00 | 729 (23.9)       | $\geq 17/23$       |
| Composite KAP (0–98) | 60.22 $\pm$ 15.74 | 61.70  | 46.76–73.24 | 1046 (34.4)      | $\geq 69/98$       |

KAP, knowledge-attitudes-practice; IQR, interquartile range

**Table 4** Clinical exposure, oxygen availability, and referral practices ( $n=3,045$ )

| Variable                                 | $n$  | %    |
|------------------------------------------|------|------|
| <b>Monthly headache patient volume</b>   |      |      |
| Less than 5 patients/month               | 1084 | 35.6 |
| 6–15 patients/month                      | 1044 | 34.3 |
| 16–30 patients/month                     | 627  | 20.6 |
| More than 30 patients/month              | 290  | 9.5  |
| <b>Career cluster headache diagnoses</b> |      |      |
| None                                     | 861  | 28.3 |
| 1–3 patients                             | 1181 | 38.8 |
| 4–10 patients                            | 777  | 25.5 |
| More than 10 patients                    | 226  | 7.4  |
| <b>Initial differential diagnosis*</b>   |      |      |
| Cluster headache                         | 1993 | 65.5 |
| Migraine with autonomic features         | 1704 | 56.0 |
| Acute angle-closure glaucoma             | 1449 | 47.6 |
| Sinusitis                                | 1174 | 38.6 |
| Cavernous sinus thrombosis               | 1114 | 36.6 |
| Trigeminal neuralgia                     | 566  | 18.6 |
| <b>High-flow oxygen availability</b>     |      |      |
| Routinely available                      | 1095 | 36.0 |
| Available after special request          | 740  | 24.3 |
| Not available                            | 817  | 26.8 |
| Unknown                                  | 393  | 12.9 |
| <b>Neurology referral threshold*</b>     |      |      |
| Secondary-headache red flags             | 1671 | 54.9 |
| Diagnostic uncertainty after assessment  | 1519 | 49.9 |
| Failure of first-line treatment          | 1366 | 44.9 |
| Confirmed or suspected cluster headache  | 1001 | 32.9 |
| Any headache disorder                    | 596  | 19.6 |

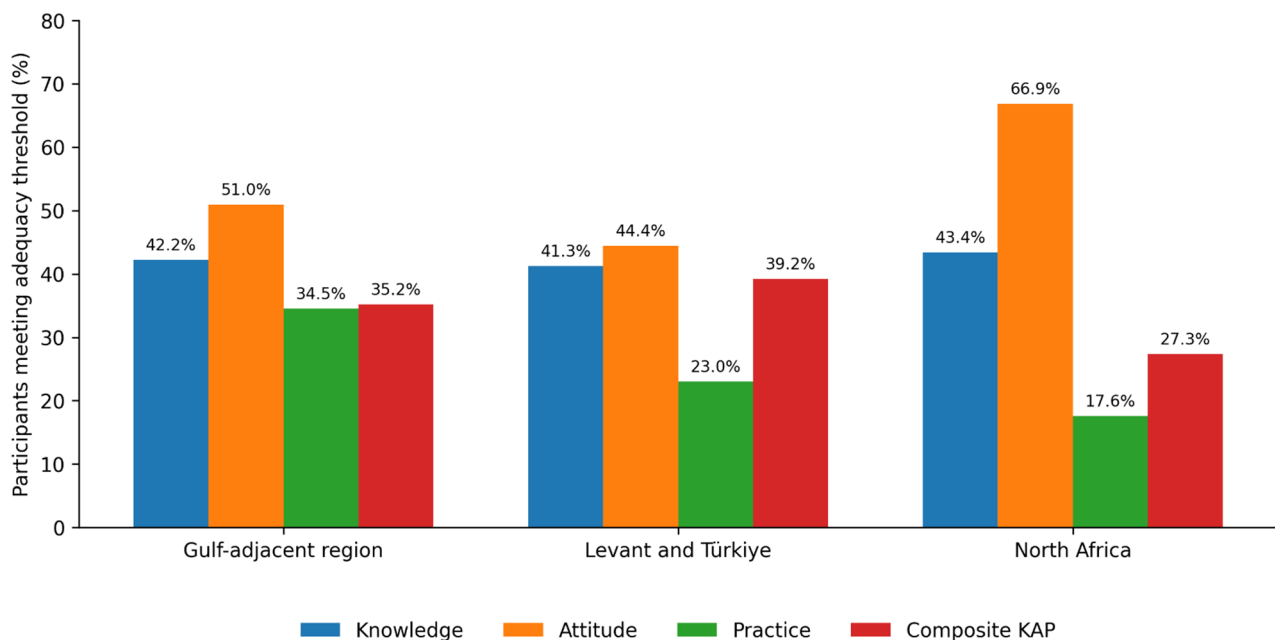
\*Multiple responses were permitted; percentages therefore do not sum to 100%

## Subregional and country variation

Performance varied across subregions. Knowledge adequacy was similar across the three groups (41.3%–43.4%), whereas attitude and practice did not move in parallel. North Africa had the highest proportion with positive attitudes (66.9%) and the lowest proportion with adequate practice (17.6%). The Gulf-adjacent region had the highest practice adequacy (34.5%), whereas the Levant and Türkiye had the highest composite adequacy (39.2%) (Fig. 2).

Country-level estimates showed pronounced heterogeneity (Table 5). Because recruitment used non-probability professional networks, country sample sizes differed, and estimates were not population-weighted, these results describe only the participating samples and should not be interpreted as national prevalence estimates or as rankings of health-system performance.

Given the magnitude of the between-country variation in knowledge adequacy observed in Table 5, a sensitivity analysis was performed excluding the two countries with the lowest estimates (Palestine, Iraq) and, separately,



**Fig. 2** Subregional proportions meeting prespecified adequacy thresholds

**Table 5** Descriptive adequacy estimates by participating-country sample\*

| Country              | <i>n</i> | Knowledge <i>n</i> (%) | Attitude <i>n</i> (%) | Practice <i>n</i> (%) | Composite KAP <i>n</i> (%) |
|----------------------|----------|------------------------|-----------------------|-----------------------|----------------------------|
| Egypt                | 575      | 217 (37.7)             | 430 (74.8)            | 42 (7.3)              | 117 (20.3)                 |
| Saudi Arabia         | 117      | 99 (84.6)              | 97 (82.9)             | 98 (83.8)             | 99 (84.6)                  |
| Palestine            | 423      | 0 (0.0)                | 27 (6.4)              | 65 (15.4)             | 1 (0.2)                    |
| United Arab Emirates | 122      | 73 (59.8)              | 68 (55.7)             | 69 (56.6)             | 52 (42.6)                  |
| Sudan                | 101      | 57 (56.4)              | 63 (62.4)             | 30 (29.7)             | 34 (33.7)                  |
| Yemen                | 119      | 61 (51.3)              | 56 (47.1)             | 38 (31.9)             | 41 (34.5)                  |
| Iraq                 | 244      | 2 (0.8)                | 89 (36.5)             | 5 (2.0)               | 1 (0.4)                    |
| Oman                 | 120      | 70 (58.3)              | 58 (48.3)             | 39 (32.5)             | 61 (50.8)                  |
| Libya                | 103      | 63 (61.2)              | 53 (51.5)             | 24 (23.3)             | 42 (40.8)                  |
| Algeria              | 109      | 49 (45.0)              | 60 (55.0)             | 50 (45.9)             | 41 (37.6)                  |
| Morocco              | 114      | 49 (43.0)              | 64 (56.1)             | 30 (26.3)             | 40 (35.1)                  |
| Lebanon              | 392      | 378 (96.4)             | 332 (84.7)            | 98 (25.0)             | 377 (96.2)                 |
| Syrian Arab Republic | 270      | 102 (37.8)             | 106 (39.3)            | 75 (27.8)             | 82 (30.4)                  |
| Türkiye              | 236      | 65 (27.5)              | 122 (51.7)            | 66 (28.0)             | 58 (24.6)                  |

\* Adequacy thresholds: knowledge  $\geq 14/20$ ; attitude  $\geq 35/50$  after reverse coding; practice  $\geq 17/23$ ; composite KAP  $\geq 69/98$ . Country estimates are descriptive and are not population-weighted

all four countries with the most extreme estimates in either direction (Palestine, Iraq, Lebanon, Saudi Arabia) (Supplementary Table S2). Knowledge adequacy was 42.2% in the full sample, 43.1% after excluding the four most extreme countries, and 54.0% after excluding only the two lowest-performing countries; the asymmetry between these two exclusions reflects that the low- and high-performing outlier countries partially offset one another in the pooled estimate. The adjusted association between prior headache training and adequate knowledge remained statistically significant in every sensitivity sample (full sample: adjusted odds ratio [aOR] 5.66, 95% confidence interval [CI] 4.66–6.88; excluding four flagged countries: aOR 2.91, 95% CI 2.34–3.63; excluding Palestine and Iraq: aOR 3.85, 95% CI 3.11–4.76; all  $p < 0.001$ ), although its magnitude was smaller once the flagged countries were removed, indicating that these countries contributed disproportionately, but not exclusively, to the strength of this association. The adjusted association between restricted neurology referral access and lower knowledge adequacy was stable in direction, magnitude, and significance across all sensitivity samples (aOR range 0.31–0.54 across models, all  $p < 0.001$ ).

## Associations among KAP domains

Knowledge correlated moderately with attitude (Spearman  $r=0.483$ ,  $p<0.001$ ) and weakly with practice ( $r=0.296$ ,  $p<0.001$ ). Attitude showed a very weak positive correlation with practice ( $r=0.113$ ,  $p<0.001$ ). These associations indicate that more favorable knowledge and attitude scores did not consistently translate into reported clinical behavior.

## Independent correlates of adequate performance

All four multivariable logistic models were statistically significant (likelihood-ratio  $p<0.001$ ) (Table 6).

Previous formal headache education was the strongest modifiable correlate of adequate knowledge (aOR 5.66, 95% CI 4.66–6.88) and adequate composite KAP (aOR 6.07, 95% CI 4.88–7.54). Compared with referral within two weeks, limited referral access was associated with lower odds of adequate knowledge (aOR 0.37, 95% CI 0.29–0.48) and adequate composite KAP (aOR 0.45, 95% CI 0.35–0.58). All models converged, and no problematic multicollinearity was detected (maximum variance inflation factor, 3.16).

Adequate knowledge was associated with positive attitude (aOR 4.28, 95% CI 3.57–5.12). In the practice model, both adequate knowledge (aOR 1.44, 95% CI 1.18–1.75) and positive attitude (aOR 1.63, 95% CI 1.34–1.98) were independently associated with adequate practice. The practice model had lower explanatory performance than the other models (Nagelkerke  $R^2 = 0.124$ ; AUC=0.688), indicating that important organizational or resource determinants were not captured by the measured covariates.

Age was retained in the prespecified five-category model rather than collapsed post hoc at 40 years. Compared with physicians aged 20–30 years, those aged 31–40 years did not differ significantly in adjusted odds of adequate knowledge, positive attitude, adequate practice, or adequate composite KAP. Lower adjusted odds were concentrated in older categories: physicians aged 41–50 years had lower odds of adequate knowledge (aOR 0.62, 95% CI 0.43–0.88); those aged 51–60 years had lower odds of adequate knowledge (0.58, 0.38–0.89), adequate practice (0.61, 0.38–0.99), and adequate composite KAP (0.62, 0.40–0.96); and those aged > 60 years had lower odds of adequate knowledge (0.19, 0.10–0.36), positive attitude (0.28, 0.15–0.50), and adequate composite KAP (0.18, 0.09–0.37). These estimates are adjusted for years of practice and the other prespecified covariates and should not be interpreted causally.

## Sensitivity analysis

Modified Poisson models produced attenuated but directionally concordant estimates. Previous formal headache training remained associated with adequate knowledge (aPR 2.80, 95% CI 2.46–3.18), adequate practice (aPR 1.57, 95% CI 1.32–1.86), and adequate composite KAP (aPR 3.53, 95% CI 2.97–4.19). Limited neurology referral access remained associated with lower prevalence of adequate knowledge (aPR 0.60, 95% CI 0.52–0.70) and adequate composite KAP (aPR 0.63, 95% CI 0.53–0.75). Adequate knowledge and positive attitude remained associated with adequate practice (aPR 1.30, 95% CI 1.12–1.50 and aPR 1.42, 95% CI 1.23–1.64, respectively).

## Perceived barriers and educational needs

The leading perceived diagnostic barriers were confusion with migraine or sinusitis because of overlapping symptoms (63.8%), low clinical exposure to a rare disorder (58.9%), and limited familiarity with ICHD-3 criteria (57.6%). Treatment barriers centered on inadequate access to high-flow oxygen (49.8%), limited experience with preventive prescribing (47.3%), delayed or limited neurology consultation (44.7%), and restricted availability or affordability of triptans (42.7%). Most respondents expressed demand for further education: 72.2% answered yes and 20.6% answered maybe. The preferred formats were self-paced online courses (54.3%), short clinical

**Table 6** Adjusted logistic regression models for adequate KAP outcomes ( $n = 3,045$ )

| Predictor                                                         | Adequate knowledge            | Positive attitude             | Adequate practice             | Adequate composite KAP        |
|-------------------------------------------------------------------|-------------------------------|-------------------------------|-------------------------------|-------------------------------|
| <b>Age group (reference: 20–30 years)</b>                         | —                             | —                             | —                             | —                             |
| 31–40 years                                                       | 1.06 (0.79–1.41); $p = 0.706$ | 0.91 (0.69–1.20); $p = 0.500$ | 1.13 (0.83–1.54); $p = 0.448$ | 1.11 (0.82–1.50); $p = 0.489$ |
| 41–50 years                                                       | 0.62 (0.43–0.88); $p = 0.008$ | 0.94 (0.67–1.32); $p = 0.728$ | 0.89 (0.60–1.31); $p = 0.552$ | 0.75 (0.52–1.08); $p = 0.120$ |
| 51–60 years                                                       | 0.58 (0.38–0.89); $p = 0.013$ | 0.73 (0.48–1.09); $p = 0.124$ | 0.61 (0.38–0.99); $p = 0.046$ | 0.62 (0.40–0.96); $p = 0.033$ |
| >60 years                                                         | 0.19 (0.10–0.36); $p < 0.001$ | 0.28 (0.15–0.50); $p < 0.001$ | 0.60 (0.31–1.16); $p = 0.128$ | 0.18 (0.09–0.37); $p < 0.001$ |
| <b>Sex (reference: Female)</b>                                    | —                             | —                             | —                             | —                             |
| Male                                                              | 1.15 (0.97–1.35); $p = 0.101$ | 0.96 (0.82–1.13); $p = 0.609$ | 0.96 (0.81–1.15); $p = 0.660$ | 1.09 (0.92–1.30); $p = 0.297$ |
| <b>Years of clinical practice (reference: 6–10 years)</b>         | —                             | —                             | —                             | —                             |
| Less than 2 years                                                 | 1.52 (1.13–2.06); $p = 0.006$ | 0.89 (0.66–1.19); $p = 0.427$ | 1.65 (1.20–2.26); $p = 0.002$ | 1.23 (0.90–1.69); $p = 0.199$ |
| 2–5 years                                                         | 1.65 (1.26–2.17); $p < 0.001$ | 1.34 (1.03–1.73); $p = 0.027$ | 0.84 (0.63–1.13); $p = 0.257$ | 1.64 (1.24–2.18); $p < 0.001$ |
| 11–20 years                                                       | 2.60 (1.92–3.54); $p < 0.001$ | 1.84 (1.37–2.46); $p < 0.001$ | 1.03 (0.74–1.43); $p = 0.867$ | 2.28 (1.66–3.14); $p < 0.001$ |
| >20 years                                                         | 2.92 (1.96–4.37); $p < 0.001$ | 2.18 (1.48–3.20); $p < 0.001$ | 2.07 (1.35–3.16); $p < 0.001$ | 3.02 (2.00–4.57); $p < 0.001$ |
| <b>Highest professional qualification (reference: MBBS/MBChB)</b> | —                             | —                             | —                             | —                             |
| Diploma in family medicine/general practice                       | 0.64 (0.51–0.82); $p < 0.001$ | 1.02 (0.81–1.29); $p = 0.844$ | 0.90 (0.70–1.17); $p = 0.429$ | 0.64 (0.50–0.82); $p < 0.001$ |
| Board-certified specialist/fellowship                             | 0.91 (0.72–1.14); $p = 0.405$ | 1.00 (0.79–1.26); $p = 0.996$ | 0.72 (0.56–0.93); $p = 0.012$ | 0.85 (0.66–1.08); $p = 0.171$ |
| Master's degree                                                   | 0.83 (0.61–1.12); $p = 0.224$ | 0.86 (0.64–1.16); $p = 0.331$ | 1.05 (0.77–1.45); $p = 0.749$ | 0.72 (0.52–0.99); $p = 0.040$ |
| Other postgraduate qualification                                  | 1.35 (1.03–1.77); $p = 0.028$ | 0.98 (0.75–1.28); $p = 0.864$ | 0.95 (0.72–1.26); $p = 0.727$ | 1.40 (1.07–1.83); $p = 0.015$ |
| <b>Practice location (reference: Rural)</b>                       | —                             | —                             | —                             | —                             |
| Urban                                                             | 1.45 (1.19–1.76); $p < 0.001$ | 1.64 (1.35–1.98); $p < 0.001$ | 1.15 (0.92–1.43); $p = 0.212$ | 1.50 (1.22–1.84); $p < 0.001$ |
| <b>Previous formal headache training (reference: No)</b>          | —                             | —                             | —                             | —                             |
| Yes                                                               | 5.66 (4.66–6.88); $p < 0.001$ | 1.23 (1.02–1.48); $p = 0.027$ | 1.81 (1.46–2.25); $p < 0.001$ | 6.07 (4.88–7.54); $p < 0.001$ |
| <b>Neurology referral access (reference: Within 2 weeks)</b>      | —                             | —                             | —                             | —                             |
| Significant delay (>4 weeks)                                      | 0.49 (0.40–0.60); $p < 0.001$ | 0.92 (0.75–1.14); $p = 0.448$ | 0.90 (0.72–1.12); $p = 0.350$ | 0.52 (0.43–0.65); $p < 0.001$ |
| Limited access                                                    | 0.37 (0.29–0.48); $p < 0.001$ | 0.79 (0.62–1.00); $p = 0.053$ | 0.95 (0.72–1.25); $p = 0.721$ | 0.45 (0.35–0.58); $p < 0.001$ |
| No neurology referral service                                     | 0.52 (0.39–0.70); $p < 0.001$ | 0.92 (0.69–1.23); $p = 0.581$ | 0.92 (0.66–1.29); $p = 0.643$ | 0.39 (0.28–0.55); $p < 0.001$ |
| <b>Subregion (reference: Levant and Türkiye)</b>                  | —                             | —                             | —                             | —                             |
| Gulf-adjacent region                                              | 1.05 (0.85–1.30); $p = 0.660$ | 1.19 (0.96–1.46); $p = 0.108$ | 1.85 (1.49–2.30); $p < 0.001$ | 0.80 (0.64–0.99); $p = 0.042$ |
| North Africa                                                      | 1.82 (1.48–2.24); $p < 0.001$ | 2.83 (2.30–3.47); $p < 0.001$ | 0.66 (0.52–0.83); $p < 0.001$ | 0.83 (0.67–1.03); $p = 0.092$ |
| <b>Knowledge adequacy (reference: Not adequate)</b>               | —                             | —                             | —                             | —                             |
| Adequate knowledge                                                | —                             | 4.28 (3.57–5.12); $p < 0.001$ | 1.44 (1.18–1.75); $p < 0.001$ | —                             |
| <b>Attitude status (reference: Negative/neutral)</b>              | —                             | —                             | —                             | —                             |
| Positive attitude                                                 | —                             | —                             | —                             | —                             |
| <b>Likelihood-ratio <math>\chi^2</math> (df)</b>                  | 692.8 (20); $p < 0.001$       | 649.4 (21); $p < 0.001$       | 262.9 (22); $p < 0.001$       | 682.5 (20); $p < 0.001$       |
| <b>Nagelkerke R<sup>2</sup></b>                                   | 0.274                         | 0.256                         | 0.124                         | 0.277                         |
| <b>AUC</b>                                                        | 0.765                         | 0.760                         | 0.688                         | 0.777                         |

Values are adjusted odds ratios (95% confidence intervals); Wald  $p$  values. Reference categories are shown within the predictor column. Knowledge adequacy and positive attitude were included only in the models specified in the Methods. AUC, area under the receiver operating characteristic curve

**Table 7** Perceived barriers and preferred educational responses ( $n=3,045$ )

| Item                                                | <i>n</i> | %    |
|-----------------------------------------------------|----------|------|
| <b>Diagnostic barriers*</b>                         |          |      |
| Confusion with sinusitis or migraine                | 1943     | 63.8 |
| Rare condition/low clinical exposure                | 1793     | 58.9 |
| Limited familiarity with ICHD-3 criteria            | 1753     | 57.6 |
| Lack of formal headache training                    | 1293     | 42.5 |
| Limited consultation time                           | 1269     | 41.7 |
| Lack of practical PHC diagnostic guidance           | 856      | 28.1 |
| <b>Treatment barriers*</b>                          |          |      |
| Lack of access to high-flow oxygen                  | 1516     | 49.8 |
| Limited experience prescribing preventive treatment | 1441     | 47.3 |
| Limited or delayed neurology consultation           | 1362     | 44.7 |
| Limited availability or affordability of triptans   | 1300     | 42.7 |
| Formulary restrictions or referral bottlenecks      | 1252     | 41.1 |
| <b>Interest in additional education</b>             |          |      |
| Yes                                                 | 2199     | 72.2 |
| Maybe                                               | 628      | 20.6 |
| No                                                  | 218      | 7.2  |
| <b>Preferred educational formats*</b>               |          |      |
| Online self-paced courses                           | 1652     | 54.3 |
| Short clinical algorithms or pocket cards           | 1619     | 53.2 |
| Printed or digital clinical guidelines              | 1608     | 52.8 |
| Live CME workshops or conferences                   | 1430     | 47.0 |
| Educational videos or webinars                      | 1427     | 46.9 |
| Mobile diagnostic application                       | 1225     | 40.2 |

\* Multiple responses were permitted; percentages therefore do not sum to 100%. CME, continuing medical education; ICHD-3, International Classification of Headache Disorders, third edition; PHC, primary healthcare

algorithms or pocket cards (53.2%), and printed or digital guidelines (52.8%). Table 7 presents the complete barrier and education profile.

## Discussion

This multinational study identified a substantial gap between cluster headache recognition and readiness to deliver evidence-aligned care in primary healthcare. Although 42.2% of participants achieved adequate knowledge and 53.4% had positive attitudes, only 23.9% achieved adequate practice and 34.4% achieved adequate composite KAP. Practice correlated only weakly with knowledge and attitude, and the practice model had modest discrimination. Together, these findings indicate that clinical behavior reflects not only factual knowledge or professional willingness but also treatment resources, prescribing confidence, referral access, and organizational support. Modified Poisson sensitivity analyses attenuated the effect estimates but confirmed the direction of the principal associations.

This pattern extends the limited evidence from frontline physicians. In the Turkish survey cited earlier, few family and emergency physicians considered their cluster headache knowledge sufficient, and most reported concern about misdiagnosis [11]. The present study adds objective item-level assessment, self-reported practice, and service-readiness measures across 14 countries. It also offers a plausible first-contact-care context for the persistent diagnostic delay reported internationally [8, 9]. These cross-sectional data cannot establish that primary-care deficiencies cause diagnostic delay, but they identify modifiable points at which delay may arise or persist.

## Diagnostic recognition and clinical reasoning

The largest knowledge deficit concerned recognition of the complete constellation of cranial autonomic features, which only 13.3% of physicians identified correctly. In contrast, 73.9% recognized a classic clinical vignette. This discrepancy suggests that many physicians can identify an archetypal presentation but may not apply the full ICHD-3 phenotype systematically. Such pattern recognition may perform adequately when laterality, orbital pain, attack duration, autonomic manifestations, and agitation occur together, but it is less reliable when presentations are incomplete, early in the disease course, or complicated by migrainous symptoms. This distinction matters because cluster headache is commonly confused with migraine, sinusitis, dental disorders, trigeminal neuralgia, and ocular disease [9].

The barrier profile supports this interpretation. Confusion with migraine or sinusitis, low clinical exposure, and limited familiarity with ICHD-3 criteria were the three most frequently endorsed diagnostic barriers. Primary-care interventions should therefore focus on structured diagnostic reasoning rather than isolated factual recall. A concise consultation aid could prompt physicians to document laterality, pain location and severity, attack duration and frequency, restlessness, ipsilateral autonomic signs, circadian or circannual periodicity, remission pattern, and treatment response. It should also distinguish features supporting cluster headache from red flags requiring urgent investigation. Such tools may strengthen clinical recognition while reducing unnecessary investigations and delayed specialist referral.

An important observation deserving emphasis is that physicians aged 40 years or younger constituted 63.0% of the sample. Internet-based professional-network recruitment may have facilitated participation by younger and more digitally connected clinicians, while the absence of harmonized country-specific PHC workforce denominators prevents formal standardization of the age distribution. The observed age profile may therefore reflect regional workforce composition, recruitment pathways, or both. Importantly, the broad digital recruitment network enabled rapid inclusion of 3,045 eligible PHC physicians across 14 countries—nearly eight times the minimum required sample—and provided sufficient outcome events for the prespecified multivariable analyses. In adjusted models, physicians aged 31–40 years did not differ from the 20–30-year reference group; lower performance was concentrated in several older categories, providing an actionable signal for age-sensitive CME design. These findings are interpreted as patterns within the participating sample rather than estimates of the underlying regional workforce. Future probability-based studies can build on this regional baseline by using country-specific sampling frames and workforce weighting.

## Treatment readiness and the attitude-practice gap

Practice represented the weakest domain despite generally favorable attitudes toward primary-care responsibility and continuing education. North Africa showed the clearest subregional discordance: 66.9% met the positive-attitude threshold, but only 17.6% achieved adequate practice, indicating that positive attitudes did not ensure evidence-aligned behavior. This pattern is compatible with behavioral models in which intention translates into action only when clinicians have sufficient perceived and actual control over the clinical environment [24]. In the present study, relevant forms of control likely included access to oxygen, rapid-acting medications, electrocardiographic monitoring, decision support, consultation time, and specialist advice.

The limited availability of high-flow oxygen provides the clearest service-readiness signal. Only 36.0% of physicians reported routine availability, although current European guidance recommends oxygen and non-oral triptans as principal acute treatments [17], and randomized evidence supports high-flow oxygen for aborting attacks [25]. A physician who recognizes cluster headache but cannot access oxygen, a non-rebreather mask, or an appropriate triptan cannot deliver guideline-concordant acute care. The survey measured facility-level oxygen access and perceived triptan availability rather than national regulatory or formulary status; therefore, country differences should not be interpreted as market-access comparisons. Low practice performance should not be interpreted as an educational deficit alone; facility preparedness and medication access also warrant attention.

Preventive-treatment confidence showed a similar implementation challenge. Physicians reported the lowest agreement for confidence in initiating verapamil. This finding is clinically plausible because verapamil use requires attention to contraindications, dose escalation, drug interactions, and electrocardiographic monitoring. Primary care pathways should not encourage unsupervised prescribing; instead, they should define when a trained physician may initiate treatment, specify baseline and interval ECG requirements, establish titration and stopping rules, and provide rapid specialist support. Clear shared-care protocols would reduce both therapeutic delay and inappropriate prescribing.

### Training, experience, and referral access

Previous formal headache education emerged as the strongest modifiable correlate of performance. The modified Poisson models estimated substantially higher prevalence of adequate knowledge, practice, and composite KAP among trained physicians. This finding agrees with evidence that structured headache education can improve general practitioners' knowledge and management [26] and with regional migraine studies linking prior education to better primary-care preparedness [21, 22]. The results support incorporating cluster headache into family-medicine curricula and continuing medical education rather than limiting headache teaching to migraine.

Education should nevertheless move beyond a single didactic session. The weak translation of knowledge and attitude into practice suggests that effective programs should combine brief evidence-based teaching with case simulation, diagnostic checklists, prescribing algorithms, facility resource review, and feedback from confirmed referrals. The preferred learning formats reported by participants—self-paced online courses, pocket algorithms, and digital or printed guidelines—provide a feasible delivery platform. Programs should include periodic reassessment because guideline knowledge, medication availability, and referral arrangements change over time.

Restricted neurology access independently reduced the odds of adequate knowledge and composite KAP. Referral systems may therefore function not only as routes to specialist care but also as learning networks. Diagnostic confirmation, management advice, and feedback expose primary care physicians to verified cases and reinforce future recognition. Where neurology access is delayed or absent, this feedback loop weakens. Global inequities in neurological workforce distribution make this problem especially relevant [27]. Tele-neurology consultations, rapid advice lines, regional headache networks, and standardized referral templates could strengthen both patient access and continuing professional learning.

### Geographic heterogeneity and interpretation of country-level findings

The substantial subregional and country-level variation underscores the heterogeneity of the participating health systems. Differences in primary-care organization, workforce capacity, postgraduate training, medicine availability, and referral infrastructure across the Eastern Mediterranean region are well recognized [28]. Regional analyses likewise describe disparities in headache care across North Africa [29] and the Arabic Gulf [30]. The observed subregional patterns are compatible with differences in service readiness, but the present design cannot identify the mechanisms responsible.

Country estimates require particular caution. Recruitment relied on non-probability professional networks, sample sizes differed, and respondent composition may have varied by qualification, training exposure, and facility type. Some contrasts were very large and may reflect selection, differences in respondent composition, or contextual variation that cannot be separated in this dataset. The estimates should therefore be treated as descriptive signals for confirmatory research, not as national rankings. Evidence from primary care outside the region also shows that limited headache knowledge can coexist with favorable attitudes and strong demand for training [31], indicating that the knowledge-implementation gap is not unique to the MENA region. A sensitivity analysis directly testing this concern for the knowledge domain (Supplementary Table S2) confirmed that the direction and statistical significance of the two principal predictors of knowledge adequacy — prior headache training and restricted neurology referral access — were unaffected by the exclusion of the countries with the most extreme

estimates. However, the magnitude of the training association was approximately halved once these countries were removed, indicating that Palestine, Iraq, Lebanon, and Saudi Arabia contributed disproportionately to the magnitude of this association, although not to its direction. We interpret this as evidence that the qualitative conclusion — that prior training is associated with better knowledge performance — is robust, while the precise effect size should be regarded as sensitive to a small number of national samples and interpreted with appropriate caution.

## Implications for clinical practice and policy

The findings support an integrated education-and-readiness strategy. A minimum primary-care package should include: an ICHD-3-aligned diagnostic checklist; a one-page acute-treatment algorithm; reliable access to oxygen delivery equipment and non-rebreather masks; guidance on subcutaneous or intranasal triptans where available; an ECG-supported pathway for verapamil initiation and titration; explicit red-flag criteria for urgent imaging or referral; and a rapid specialist-advice route for uncertain or refractory cases. Each component addresses a specific failure point identified in the survey.

Implementation should be adapted to local capacity. Better-resourced systems may prioritize integrating cluster headache into established neurology and emergency pathways and auditing appropriate use of available therapies. Systems with positive physician attitudes but weak practice should prioritize oxygen readiness, medication access, and point-of-care protocols. Resource-constrained settings may obtain greater value from multilingual digital modules, mobile decision aids, regional teleconsultation, and referral triage. Across all settings, performance indicators should include more than course completion: suspected-case recognition, time to specialist confirmation, delivery of appropriate acute treatment, preventive-treatment initiation and monitoring, and patient-reported outcomes should be measured.

## Strengths and limitations

This study has several important strengths. It provides a large multinational assessment of cluster-headache competency among PHC physicians and integrates objective knowledge, attitudes, self-reported practice, treatment readiness, referral access, perceived barriers, and educational preferences across 14 countries in the MENA region and Türkiye. The sample substantially exceeded the prespecified minimum and provided ample outcome events for the planned multivariable models. The instrument was explicitly anchored to ICHD-3 and contemporary treatment guidance, underwent multidisciplinary review, and pilot testing, and demonstrated acceptable-to-good internal consistency. However, formal psychometric validation of the instrument — including exploratory or confirmatory factor analysis, cognitive interviewing, and differential item functioning across participating countries or relevant respondent subgroups — was not performed. Internal consistency coefficients (Kuder-Richardson 20 and Cronbach's alpha) confirm that items within each domain covaried as expected within this sample, but they do not establish that the instrument measures the same underlying construct with equal precision across different cultural, educational, or health-system contexts. Country- and subregion-level score comparisons should therefore be interpreted with this caveat: observed between-country differences may partly reflect unmeasured differences in item functioning rather than true differences in underlying competency. Analytically, the study used prespecified covariates, transparent score definitions and reference groups, model-performance diagnostics, continuous-score correlations, and modified Poisson sensitivity analyses rather than relying solely on odds ratios for common outcomes. The convergence of item-level, domain-level, service-readiness, and adjusted-association findings strengthens the clinical coherence and actionability of the results. A further sensitivity analysis confirmed that the principal predictors of adequate knowledge remained robust in direction and statistical significance after exclusion of countries with extreme knowledge-adequacy estimates, although the magnitude of the training association was attenuated.

The principal interpretive boundaries follow from the study design. Network-based recruitment does not permit national prevalence estimates or a conventional response rate; accordingly, country findings were explicitly treated as descriptive signals, and inferential conclusions were based on the pooled prespecified analyses. The marked country-level heterogeneity requires cautious interpretation. Extreme values observed in some countries may partly reflect differences in recruitment pathways, respondent characteristics, local educational exposure, or sampling variability. Therefore, country comparisons should be interpreted as hypothesis-generating and should not be considered direct estimates of national physician competency. Self-reported practice may not fully reproduce observed clinical behavior, although the instrument combined objective knowledge items, case-based decisions, routine-practice measures, and service-readiness indicators rather than relying on confidence alone. In particular, self-reported adherence to guideline-concordant acute and preventive treatment decisions is susceptible to social desirability bias, whereby respondents may report the response they perceive as clinically correct rather than their actual practice. Because this bias would be expected to inflate rather than deflate reported adequacy, the true gap between knowledge, attitude, and practice may be larger than the present estimates suggest, and practice-adequacy findings should be interpreted as an upper-bound estimates of actual clinical behavior. Cross-sectional associations cannot establish causality but prespecified adjustment and concordant modified Poisson sensitivity analyses support the robustness of the principal correlates. The study-specific performance thresholds are pragmatic rather than validated clinical cut points; continuous scores and domain-specific results were therefore also reported. Patient-level diagnostic accuracy and longitudinal outcomes were outside the study objectives. Within these defined boundaries, the study provides a uniquely broad and clinically actionable regional baseline for targeted CME, oxygen readiness, and referral-pathway improvement. Finally, the questionnaire was administered in English only. Because individual first-language background and English proficiency were not reported, the extent of any comprehension variability cannot be quantified. This limitation, together with the absence of formal cross-cultural measurement-equivalence testing, further constrains direct comparison of country-level scores.

Future work should validate the instrument across languages and health systems using cognitive interviewing, factor analysis, differential item functioning, and external criterion measures. Multilevel studies should distinguish physician-, facility-, and country-level determinants using appropriately specified random effects. Facility audits should verify oxygen equipment, non-rebreather masks, triptan access, electrocardiography capacity, and referral times. Prospective studies should examine whether physician knowledge and service readiness predict diagnostic accuracy, time to treatment, and patient outcomes. The most important next step is implementation research. Cluster-randomized or stepped-wedge trials could test an intervention bundle combining case-based CME, an ICHD-3 checklist, acute and preventive treatment algorithms, resource-readiness assessment, and rapid neurology support. Outcomes should include objectively observed management, diagnostic delay, inappropriate investigations or treatments, attack relief, disability, quality of life, and healthcare use. Regional cluster headache registries would further clarify epidemiology, care pathways, and treatment access in countries where population-level data remain sparse.

## Conclusion

Primary-care preparedness for cluster headache was limited by both physician-level knowledge gaps and implementation constraints. Fewer than one-quarter of participants achieved adequate practice despite more favorable knowledge and attitude profiles. Previous headache education was strongly associated with better performance, while limited oxygen availability, low confidence in preventive prescribing, and restricted referral access indicated important readiness deficits. Health systems should combine cluster headache-specific education with point-of-care diagnostic support, acute-treatment readiness, electrocardiography-supported preventive-treatment pathways, and timely neurology referral.

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**Author contributions** Author 1 conceptualized the study, developed the study design, drafted the questionnaire, supervised the project, coordinated data harmonization, performed and verified the statistical analyses, interpreted the findings, prepared the figures and tables, and drafted the original manuscript. Authors 2–7 contributed to study methodology, questionnaire development, expert content review, regional coordination, interpretation of findings, and critical revision of the manuscript for important intellectual content. Authors 8–28 contributed to country-level coordination, participant recruitment, data collection, contextual interpretation, and critical review of the manuscript. Author 15 served as corresponding author and contributed to manuscript coordination, administrative communication, and final submission preparation. All authors reviewed and approved the final manuscript and agreed to be accountable for all aspects of the work.

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**Data availability** The de-identified dataset and analysis code supporting the findings of this study are available from the corresponding author on reasonable request, subject to institutional approval and applicable data-protection requirements.

## Declarations

**Human ethics and consent to participate** The Institutional Review Board of the Faculty of Medicine, Alexandria University approved the study (approval no. 0307950; May 2026). The study complied with the Declaration of Helsinki, 2013. All participants provided electronic informed consent for participation before accessing the questionnaire.

**Consent for publication** Not applicable.

**Competing interests** The authors declare no competing interests.

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## References

1. GBD 2023 Headache Collaborators (2025) Global, regional, and national burden of headache disorders, 1990–2023: a systematic analysis for the Global Burden of Disease Study 2023. *Lancet Neurol* 24(12):1005–1015. [https://doi.org/10.1016/S1474-4422\(25\)00402-8](https://doi.org/10.1016/S1474-4422(25)00402-8)
2. Headache Classification Committee of the International Headache Society (2018) The International Classification of Headache Disorders, 3rd edition. *Cephalalgia* 38(1):1–211. <https://doi.org/10.1177/0333102417738202>
3. San-Juan D, Velez-Jimenez K, Hoffmann J, Martinez-Mayorga AP, Melo-Carrillo A, Rodriguez-Leyva I et al (2024) Cluster headache: an update on clinical features, epidemiology, pathophysiology, diagnosis, and treatment. *Front Pain Res* 5:1373528. <https://doi.org/10.3389/fpain.2024.1373528>
4. Coppola G, Arruda MA, Ashina M et al (2025) Hallmarks of primary headache: part 3 — cluster headache. *J Headache Pain* 26(1):196. <https://doi.org/10.1186/s10194-025-02145-6>
5. Freeman E, Adair M, Beeler D, Casper R, Herman MP, Reeves D et al (2022) Patient-identified burden and unmet needs in patients with cluster headache: an evidence-based qualitative literature review. *Cephalalgia Rep* 5:25158163221096866. <https://doi.org/10.1177/25158163221096866>

6. Petersen AS, Lund N, Snoer A, Jensen RH, Barloese M (2022) The economic and personal burden of cluster headache: a controlled cross-sectional study. *J Headache Pain* 23:58. <https://doi.org/10.1186/s10194-022-01427-7>
7. Van Obberghen EK, Fabre R, Lanteri-Minet M (2025) Cluster headache suicidality: a systematic review with a meta-analysis. *J Headache Pain* 26(1):281. <https://doi.org/10.1186/s10194-025-02140-x>
8. Van Obberghen EK, Fabre R, Lanteri-Minet M (2025) Cluster headache diagnostic delay and its predictors: a systematic review with a meta-analysis. *J Headache Pain* 26(1):71. <https://doi.org/10.1186/s10194-025-02001-7>
9. Buture A, Ahmed F, Dikomitil L, Boland JW (2019) Systematic literature review on the delays in the diagnosis and misdiagnosis of cluster headache. *Neurol Sci* 40(1):25–39. <https://doi.org/10.1007/s10072-018-3598-5>
10. Buture A, Ahmed F, Mehta Y, Paemeleire K, Goadsby PJ, Dikomitil L (2020) Perceptions, experiences and understandings of cluster headache among GPs and neurologists: a qualitative study. *Br J Gen Pract* 70(696):e514–e522. <https://doi.org/10.3399/bjgp20X710417>
11. Hasirci Bayir BR, Nazli E, Ulutas C (2025) Cluster headache management: evaluating diagnostic and treatment approaches among family and emergency medicine physicians. *Med (Kaunas)* 61(3):437. <https://doi.org/10.3390/medicina61030437>
12. Alsaadi T, Al Madani A, Alhatou M, Nada M, Albilali A, Al-Qassabi A et al (2025) Prevalence, treatment, and unmet needs of migraine in the Middle East: a systematic review. *Pain Ther* 14(1):145–183. <https://doi.org/10.1007/s40122-024-00686-3>
13. Hamdy MM, Nasr N, Hamdy E (2025) Awareness of cluster headache clinical presentations and management among different healthcare specialties in Egypt: a cross-sectional survey. *Egypt J Neurol Psychiatry Neurosurg* 61:32. <https://doi.org/10.1186/s41983-025-00954-9>
14. Nada MA, Al-Azayem SA, Moawad MK (2024) Clinical characteristics and diagnostic delay in cluster headache in Egypt. *Neurol Res* 46(10):925–932. <https://doi.org/10.1080/01616412.2024.2367936>
15. von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP (2007) The Strengthening of Reporting of Observational Studies in Epidemiology (STROBE) statement: guidelines for reporting observational studies. *PLoS Med* 4(10):e296. <https://doi.org/10.1371/journal.pmed.0040296>
16. Eysenbach G (2004) Improving the quality of Web surveys: the Checklist for Reporting Results of Internet E-Surveys (CHERRIES). *J Med Internet Res* 6(3):e34. <https://doi.org/10.2196/jmir.6.3.e34>
17. May A, Evers S, Goadsby PJ, Leone M, Manzoni GC, Pascual J et al (2023) European Academy of Neurology guidelines on the treatment of cluster headache. *Eur J Neurol* 30(10):2955–2979. <https://doi.org/10.1111/ene.15956>
18. Robbins MS, Starling AJ, Pringsheim TM, Becker WJ, Schwedt TJ (2016) Treatment of cluster headache: the American Headache Society evidence-based guidelines. *Headache* 56(7):1093–1106. <https://doi.org/10.1111/head.12866>
19. Epstein RM, Hundert EM (2002) Defining and assessing professional competence. *JAMA* 287(2):226–235. <https://doi.org/10.1001/jama.287.2.226>
20. Paulhus DL (1991) Measurement and control of response bias. In: Robinson JP, Shaver PR, Wrightsman LS (eds) Measures of personality and social psychological attitudes. Academic, San Diego, pp 17–59. doi:<https://doi.org/10.1016/B978-0-12-590241-0.50006-X>.
21. Aljunaid MA, Jamal HH, Mubarak AA, Bardisi W (2020) Levels and determinants of knowledge about chronic migraine diagnosis and management among primary health-care physicians in Ministry of Health, Jeddah 2019. *J Family Med Prim Care* 9(5):2324–2331. [https://doi.org/10.4103/jfmpe.jfmpe\\_266\\_20](https://doi.org/10.4103/jfmpe.jfmpe_266_20)
22. Al-Quliti KW, Alraddadi AN, Alnoaman AW, Alahmadi MA, Khawaji ZY, Alquliti WK, Aljohani SA (2024) Knowledge, attitudes, and practices of migraine management among primary health care physicians in Al-Madinah Al-Munawarah. *J Med Life* 17(11):1012–1019. <https://doi.org/10.25122/jml-2024-0350>
23. World Health Organization (2008) Advocacy, communication and social mobilization for TB control: a guide to developing knowledge, attitude and practice surveys. World Health Organization, Geneva
24. Ajzen I (1991) The theory of planned behavior. *Organ Behav Hum Decis Process* 50(2):179–211. [https://doi.org/10.1016/0749-5978\(91\)90020-T](https://doi.org/10.1016/0749-5978(91)90020-T)
25. Cohen AS, Burns B, Goadsby PJ (2009) High-flow oxygen for treatment of cluster headache: a randomized trial. *JAMA* 302(22):2451–2457. <https://doi.org/10.1001/jama.2009.1855>
26. Kowacs PA, Twardowsky CA, Piovesan EJ, Dal-Pra Ducci R, Cirino RH, Hamdar F et al (2009) General practice physician knowledge about headache: evaluation of the municipal continual medical education program. *Arq Neuropsiquiatr* 67(3A):595–599. <https://doi.org/10.1590/S0004-282X2009000400004>
27. Budhu JA, Mejia NI, Saadi A (2025) Health disparities in neurology. *Nat Rev Neurol* 21(11):593–605. <https://doi.org/10.1038/s41582-025-01134-2>
28. Balkhy H (2024) Increasing access to healthcare in the Eastern Mediterranean Region. *East Mediterr Health J* 30(2):91–92. <https://doi.org/10.26719/2024.30.2.91>
29. Nada M (2025) Migraine care in the MENA region, a focus on North Africa. *Cephalalgia Rep* 8:25158163251403011. <https://doi.org/10.1177/25158163251403011>
30. Al-Hashel J, Ahmed SF (2025) Migraine care in Kuwait and the Arabic Gulf region. *Cephalalgia Rep* 8:25158163251374141. <https://doi.org/10.1177/25158163251374141>

31. Kouassi LK, Adou FAK, Abbé SA, Yeo SN, Broh CYN, Beuseize RMA et al (2025) Knowledge and attitudes of general practitioners towards migraine in primary health centres in Abidjan, Côte d'Ivoire. *Egypt J Neurol Psychiatry Neurosurg* 61:87. <https://doi.org/10.1186/s41983-025-01012-0>

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## Authors and Affiliations

Ahmed Dahshan<sup>1,2</sup>  · Marwa Ibrahim Mahfouz Khalil<sup>3</sup>  · Merve Ceren Akgor<sup>4,5</sup>  ·  
Derya Uludüz<sup>6</sup>  · Mahmood Khalifa Al Hinai<sup>7</sup> · Ahmed Abdelfattah Nassar<sup>7</sup> ·  
Mahmoud Ali Khazbak<sup>8</sup>  · Kamal Khaled Hamad<sup>9</sup>  ·  
Mohamed Elsayed Ahmed Allawy<sup>10,11</sup>  · Mohammed Salfeeq H. Alshammari<sup>12,13</sup>  ·  
Ali Malik Tiryag<sup>14</sup>  · Samaa Ahmad Akram Al Tabbah<sup>15</sup>  ·  
Nabih Mohammad Lawand<sup>16</sup>  · Moath Abu Ejheisheh<sup>17</sup>  ·  
Anter Mothenna Abdullah Nasser<sup>18</sup>  · Aussan Al-Athwari<sup>19</sup> · Fatima Adnan Hallaj<sup>20</sup>  ·  
Tajeldinn Helal<sup>21</sup> · Wael Alwahchi<sup>22</sup>  · Sarra Chouaib<sup>23</sup> · Ahmed Allioueche<sup>24</sup> ·  
Mohamed Marouf<sup>25</sup>  · Walaa Mansour Ahmed<sup>26</sup>  · Sameh El Rayes<sup>25</sup>  · Zeyad Yassin<sup>27</sup>  ·  
Mona A. F. Nada<sup>1</sup> · Hesham Eissa<sup>28</sup>  · Ahmed Ahmed Mohamed Kamal Ebied<sup>29,30</sup>

✉ Anter Mothenna Abdullah Nasser  
aljlanyanter@gmail.com

Ahmed Dahshan  
drdahshanneuro@kasralainy.edu.eg

Marwa Ibrahim Mahfouz Khalil  
marwa-mahfouz@alexu.edu.eg

Merve Ceren Akgor  
cerenmervee@gmail.com

Derya Uludüz  
deryaulu@yahoo.com

Mahmood Khalifa Al Hinai  
mkkalhinai86@gmail.com

Ahmed Abdelfattah Nassar  
Ahmed.abdelfattah.nassar@gmail.com

Mahmoud Ali Khazbak  
Mahmoud.khazbak@gmail.com

Kamal Khaled Hamad  
kamalhamad029@gmail.com

Mohamed Elsayed Ahmed Allawy  
mohamedelsayed@nursing.suez.edu.eg

Mohammed Salfeeq H. Alshammari  
msh772@gmail.com

Ali Malik Tiryag  
Altaj76@gmail.com

Samaa Ahmad Akram Al Tabbah  
Samaa.tab@hotmail.com

Nabih Mohammad Lawand  
Nabihlawand@hotmail.com

Moath Abu Ejheisheh  
moath@paluniv.edu.ps

Aussan Al-Athwari  
alathwariaussan2@gmail.com

Fatima Adnan Hallaj  
fatimahallaj@latakia-univ.edu.sy

Tajeldinn Helal  
Altaj76@gmail.com

Wael Alwahchi  
Waelwahchi@yahoo.com

Sarra Chouaib  
Chouaib.sarra@hotmail.fr

Ahmed Allioueche  
ahmedallioueche63@gmail.com

Mohamed Marouf  
mohamedmaroufmd@gmail.com

Wala Mansour Ahmed  
Walaamansour@residents.kasralainy.edu.eg

Sameh El Rayes  
elrayessameh@outlook.com

Zeyad Yassin  
Zeyadyassin760@gmail.com

Mona A. F. Nada  
Dr.monanada@gmail.com

Hesham Eissa  
Hesham\_mrneuro21@yahoo.com

Ahmed Ahmed Mohamed Kamal Ebied  
Ahmedebied296@gmail.com

<sup>1</sup> Department of Neurology, Faculty of Medicine, Cairo University, Cairo, Egypt

<sup>2</sup> Neurology Unit, Nizwa Hospital, Ministry of Health, Nizwa, Oman

<sup>3</sup> Department of Gerontological Nursing, Faculty of Nursing, Alexandria University, Alexandria, Egypt

<sup>4</sup> Department of Neurology, Ankara Atatürk Sanatorium Training and Research Hospital, Ankara, Türkiye

<sup>5</sup> Neuroscience and Neurotechnology Center of Excellence (NÖROM), Ankara, Turkey

<sup>6</sup> Istanbul Atlas University, Brain360 Headache Center, Istanbul, Turkey

<sup>7</sup> Department of Neurology, Khoulia Hospital, Ministry of Health, Muscat, Oman

<sup>8</sup> Ministry of Health, Muscat, Oman

<sup>9</sup> Department of Neurology, Medical City of Military and Security Services, Muscat, Oman

<sup>10</sup> Department of Nursing Sciences, College of Applied Medical Sciences, Prince Sattam bin Abdulaziz University, Al Kharj, Saudi Arabia

<sup>11</sup> Department of Medical-Surgical Nursing, Faculty of Nursing, Suez Canal University, Ismailia, Egypt

- <sup>12</sup> Nursing Administration Department, Rafha General Hospital, Northern Borders Health Cluster, Rafha, Saudi Arabia
- <sup>13</sup> Nursing Sciences (Nurse Educator Track), King Faisal University, Al-Ahsa, Saudi Arabia
- <sup>14</sup> College of Nursing, University of Basrah, Basrah, Iraq
- <sup>15</sup> School of Pharmacy, Lebanese American University, Beirut, Lebanon
- <sup>16</sup> Faculty of Medicine, Beirut Arab University, Beirut, Lebanon
- <sup>17</sup> Nursing and Medical Laboratory Science Department, Faculty of Allied Medical Sciences, Palestine Ahliya University, Bethlehem, Palestine
- <sup>18</sup> Faculty of Medicine, Thamar University, Dhamar, Yemen
- <sup>19</sup> Department of Neurology, Aden University, Aden, Yemen
- <sup>20</sup> Department of Community and Family Medicine, Faculty of Medicine, Latakia University, Lattakia, Syria
- <sup>21</sup> Division of Neurology, Department of Internal Medicine, Faculty of Medicine, Alfashir University, Alfashir, Sudan
- <sup>22</sup> Department of Neurology, Ali Omar Askar Hospital, Tripoli, Libya
- <sup>23</sup> Independent Researcher, Meknès, Morocco
- <sup>24</sup> Independent Researcher, Constantine, Algeria
- <sup>25</sup> Faculty of Medicine, Mansoura University, Mansoura, Egypt
- <sup>26</sup> Department of Family Medicine, Faculty of Medicine, Cairo University, Cairo, Egypt
- <sup>27</sup> Faculty of Medicine, Al-Azhar University, Damietta, Egypt
- <sup>28</sup> Department of Neurology, Sheikh Sultan Bin Zayed Hospital, Batayeh, United Arab Emirates
- <sup>29</sup> Department of Neurology, Faculty of Medicine, Zagazig University, Zagazig, Egypt
- <sup>30</sup> Department of Neurology, NMC Royal Hospital, Sharjah, United Arab Emirates