Prevalence of headache and migraine in children and adolescents: a systematic review of population-based studies

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ABBREVIATIONS

IHS	International Headache Society
CI	Confidence Interval
ICHD-II	International Classification of Headache Disorders, second edition
OR	Odds Ratio

AIM The aim of this study was to review systematically the prevalence of headache and migraine in children and adolescents and to study the influence of sex, age, and region of residence on the epidemiology.

METHOD We systematically searched the literature in electronic databases to cover the period between 1 January 1990 and 31 December 2007. We assessed and included population-based studies on epidemiology of headache and migraine in children and adolescents if they fulfilled the following criteria: (1) reporting on unselected childhood population; (2) reliable methods of data collection using a questionnaire or face-to-face interviews; (3) using the International Headache Society's (IHS) criteria (1988 or 2004) for the diagnosis of migraine; and (4) provision of sufficient and explicit data for analysis. We used Excel, Stata, and Confidence Interval Analysis software.

RESULTS We identified and analysed 50 population-based studies reporting the prevalence of headache and/or migraine in children and adolescents (<20y). The estimated prevalence of headache over periods between 1 month and lifetime in children and adolescents is 58.4% (95% confidence interval [CI] 58.1–58.8). Females are more likely to have headache than males (odds ratio [OR] 1.53, 95% CI 1.48–1.6). The prevalence of migraine over periods between 6 months and lifetime is 7.7% (95% CI 7.6–7.8). Females are more likely than males to have migraine (OR 1.67, 95% CI 1.60–1.75). Regional differences in prevalence of migraine, though statistically significant, may not be of clinical significance. The change in the IHS's criteria for the diagnosis of migraine was not associated with any significant change in the prevalence of migraine.

INTERPRETATION This study confirms the global high prevalence of headache and migraine in children and adolescents. Sex, age, and regional differences are evident.

Childhood headache has an important adverse impact on the child and the family, as shown in many studies, including a recent review.[1] Therefore an accurate estimate of the true prevalence derived from all published world literature will help in assessing the magnitude of the problem, streamlining resources in improvement of diagnosis and treatment, and reducing its burden.

The prevalence of childhood headache and migraine has been reported from across the world with widely variable estimates of prevalence. Since the publication of the International Headache Society's (IHS) Classification and Diagnosis of Headache Disorders[2] in 1988 and the second edition of the International Classification of Headache Disorders[3] in 2004 (ICHD-II), there have been several published studies that share common methods and criteria for the diagnosis of migraine. These allow a systematic review of the world literature, despite some inevitable minor variations in methods such as the use of a questionnaire, face-to-face interviews, or both in collecting data, point-in-time prevalence, and reporting on different age groups within the childhood population. A degree of heterogeneity is, therefore, an inherent feature of such analysis and is addressed in this study by maintaining its focus on a few questions relating to prevalence. The large number of children and adolescents in the studies is likely to minimize the effects of such minor differences.

METHOD

A protocol for this study was developed by paediatricians with interest in headache epidemiology and supported by a statistician. A quantitative summary of published data as described by Blattner et al.[4] is considered an appropriate method for analysing the epidemiology of headache and migraine in children. We based our data collection, analysis, and reporting on the methods and style of Cochrane databases, and in keeping with the 'preferred reporting items for systemic reviews and meta-analysis: the PRISMA statement'.[5]

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Literature search

We searched the literature on the epidemiology of headache and migraine in children using PubMed. We used the search command (prevalence *or* epidemiology) *and* (headache *or* migraine) *and* (children *or* adolescents) for publications between 1 January 1990 and 31 December 2007. We also searched Cochrane databases, Embase, and Google Scholar, and cross-referenced recent review articles on childhood headache and migraine.

Quality assessment and inclusion criteria

We assessed each paper to eliminate any selection bias. A strict adherence to the inclusion criteria with the focus on the research methods, but not the results, was followed. The first three authors agreed after reading all the papers, independently, on their validity for inclusion. Studies were included if they fulfilled the following criteria. (1) Population-based studies of randomly selected participants published between 1

What this paper adds

- It allows better understanding of the epidemiology of headache and migraine in children and adolescents.
- It quantifies the effects of sex, age, and regional influences on the prevalence of headache in children over variable periods of time.
- It assesses the influence of different diagnostic criteria on the prevalence of migraine.
- To our knowledge, no similar study has been published.

Table I: Summary of population-based studies on the prevalence of headache in children and adolescents

Reference	Year of publication	Country	Age range (y)	Total	Headache *n* (%)	Total males	Males' headache *n* (%)	Total females	Females' headache *n* (%)	Method	Point reference
King and Sharpley[10]	1990	Australia	10–18	900	513 (57)					Q	
Mortimer et al.[11]	1992	UK	3–11	1083	409 (38)	549	307 (56)	534	294 (55)	I and E	12mo
Kristjánsdóttir and Wahlberg[12]	1993	Iceland	11–12	1016	533 (53)	512	256 (50)	498	272 (55)	Q	Lifetime
Kristjánsdóttir and Wahlberg[12]	1993	Iceland	15–16	1124	567 (50)	572	241 (42)	547	327 (60)	Q	Lifetime
Abu-Arafeh and Russell[13]	1994	UK	5–15	1754	1166 (67)					Q and I	12mo
Pothmann et al.[14]	1994	Germany	8–16	4835	4297 (89)	2418	2108 (87)	2417	2189 (91)	Q	Lifetime
Raieli et al.[15]	1995	Italy	11–14	1445	345 (24)	738	147 (20)	707	198 (28)	I	12mo
Barea et al.[16]	1996	Brazil	10–18	538	446 (83)	266	234 (88)	274	212 (77)	I and E	12mo
Carlsson[17]	1996	Sweden	7–16	1144	281 (25)	588	135 (23)	556	146 (26)	Q	Lifetime
Antoniuk et al.[18]	1998	Brazil	10–14	460	414 (90)						12mo
Aromaa et al.[19]	1998	Finland	6	968	204 (21)						
Bener et al.[20]	1998	United Arab Emirates	6–14	1159	428 (37)					Q and I	12mo
Metsahonkala et al.[21]	1998	Finland	8–9	3580	1306 (37)						
Anttila et al.[22]	1999	Finland	6–7	1290	725 (56)						
Krasnik[23]	1999	Poland	6–19	2353	1759 (75)					I and E	12mo
Bendell-Hockstra et al.[24]	2001	Holland	10–17	2358	2145 (91)	1077	934 (87)	1281	1222 (95)		12mo
Al Jumah et al.[25]	2002	Saudi Arabia	6–18	1181	588 (50)	573	272 (48)	608	316 (52)	Q	12
Fichtel and Larsson[26]	2002	Sweden	15–16	792	258 (33)	407	98 (24)	385	160 (42)	Q	Current
Ho and Ong[27]	2003	Singapore	10–19	205	174 (85)					Q	Lifetime
Shivpuri et al.[28]	2003	India	11–15	1305	255 (20)	750	135 (18)	555	117 (21)	Q	Lifetime
Laurell et al.[29]	2004	Sweden	7–15	1371	614 (45)	686	269 (39)	685	345 (50)	Q and I	12mo
Zwart et al.[30]	2004	Norway	13–18	5847	4535 (78)	2811	1940 (69)	3036	2586 (85)	Q and I	12mo
Bessisso et al.[31]	2005	Qatar	6–17	851	706 (83)	236	191 (81)	615	532 (87)	Q and I	12
Bugdayci et al.[32]	2005	Turkey	8–16	5562	2739 (49)	2985	1378 (46)	2577	1361 (53)	Q and I	Lifetime
Roth-Isigkeit et al.[33]	2005	Germany	4–18	749	453 (61)					Q	3mo
Alawneh and Bataineh[34]	2006	Jordan	6–14	1120	269 (24)						12mo
Ayotallahi and Khorsavi[35]	2006	Iran	6–13	2226	691 (31)						12mo
Karli et al.[36]	2006	Turkey	12–17	2387	1245 (52)	1244	561 (45)	1143	684 (60)	Q and I	12mo
Lundqvist et al.[37]	2006	Norway	7–12	2126	1225 (58)					Q	1mo
Siddiqui et al.[38]	2006	Pakistan	12–20	1211	1035 (86)	614	521 (85)	597	514 (86)	Q and I	Lifetime
van Dijk et al.[39]	2006	Canada	9–13	495	386 (78)						
Aykol et al.[40]	2007	Turkey	9–17	7721	6431 (83)	3875	3084 (80)	3846	3350 (87)		Lifetime
Brun Sundblad et al.[41]	2007	Sweden	9–15	1903	1122 (59)	975	486 (60)	928	636 (69)	Q	3mo
Kroner-Herwig et al.[42]	2007	Germany	7–14	5474	2927 (54)	2770	1440 (52)	2704	1487 (55)	Q	6mo
Isik et al.[43]	2007	Turkey	6–13	2228	700 (31)	1134	336 (30)	1094	364 (33)	Q	
Milovanovic[44]	2007	Serbia	7–12	1259	413 (33)					Q and I	
Unalp et al.[45]	2007	Turkey	14–18	2384	1090 (46)	1018	367 (36)	1366	723 (53)	Q	12mo
Ando et al.[46]	2007	Japan	12–15	6472	3872 (60)					Q	
Total				80 876	47 266 (58)	26 798	15 440 (58)	26 953	18 035 (67)		

Q, questionnaire; I, interview; E, examination.

January 1990 and 31 December 2007. The starting date was based on the fact that no population-based studies were published before this date that used the 1988 IHS's criteria for the diagnosis of migraine. The year 2007 was the last full year before the beginning of our work on this project. (2) Reporting on a population of children and adolescents. Studies reporting on populations under 20 years of age were included to maximize the inclusion of relevant studies. (3) Descriptive data were available or easily reproducible from the original article. (4) The diagnosis of migraine was based on the IHS criteria and classification of 1988 or 2004. (5) Clear description of the methods of data collection such as the use of a questionnaire, face-to-face interview, and examination were provided. (6) Appropriate statistical methods were used for analysis. Corresponding authors were contacted for clarifications if an ambiguity was detected but could not be resolved.

Collection of data

From each study we collected data on the year of publication, sample size, number of participants with effects and the prevalence of headache and/or migraine, the geographical origin of the study, the methods of assessment of headache and migraine, age range of the participants, and prevalence by sex. The data were tabulated for ease of comparison, analysis and

Table II: Summary of population-based studies on the prevalence of migraine in children and adolescents

Reference	Year of publication	Country	Age range (y)	Criteria	Total	Migraine *n* (%)	Total males	Males' migraine *n* (%)	Total females	Females' migraine *n* (%)	Method	Point reference
Mortimer et al.[11]	1992	UK	3–11	IHS-I	1083	40 (3.7)	549	16 (2.9)	534	24 (4.5)	I and E	12mo
Abu-Arafeh and Russell[13]	1994	UK	5–15	IHS-I	1754	159 (9.1)	888	74 (8.3)	866	85 (9.8)	Q and I	12mo
Pothmann et al.[14]	1994	German	8–16	IHS-I	4835	532 (11.0)	2418	196 (8.1)	2417	336 (13.9)	Q	Lifetime
Raieli et al.[15]	1995	Italy	11–14	IHS-I	1445	43 (3.0)	738	20 (2.7)	707	23 (3.3)	Q and I	12mo
Barea et al.[16]	1996	Brazil	10–18	IHS-I	538	53 (9.9)	266	26 (9.8)	272	27 (10.3)	I and E	12mo
Lee and Olness[47]	1997	USA	5–13	IHS-I	2572	222 (8.6)	1115	99 (8.9)	1111	120 (9.9)	Q and I	Lifetime
Bener et al.[20]	1998	United Arab Emirates	6–14	IHS-I	1159	44 (3.8)					Q and I	12mo
Krasnik[23]	1999	Poland	6–19	IHS-I	2353	198 (8.4)	1194	54 (4.5)	1159	144 (12.4)		
Mavromichalis et al.[48]	1999	Greece	4–15	IHS-I	3509	219 (6.2)	1759	92 (5.2)	1750	127 (7.3)	Q and I	12mo
Split and Neuman[49]	1999	Poland	15–19	IHS-I	2352	511 (21.7)	852	85 (10.0)	1500	426 (28.4)	Q and E	12mo
Lu et al.[50]	2000	Taiwan	13–15	IHS-I	4064	277 (6.8)	1983	114 (5.8)	2081	163 (7.8)	Q and I	Lifetime
Kong et al.[51]	2001	Hong Kong	6–13	IHS-I	2120	11 (0.5)					Q and I	12mo
Al Jumah et al.[25]	2002	Saudi Arabia	6–18	IHS-I	1181	84 (7.1)	573	37 (6.5)	608	47 (7.7)	Q	12mo
Ayatollahi et al.[52]	2002	Iran	11–18	IHS-I					1868	114 (6.1)	I	Lifetime
Shivpuri et al.[28]	2002	India	11–15	IHS-I	1305	145 (11.1)	750	67 (8.9)	555	78 (14.1)	Q	Lifetime
Fuh et al.[53]	2003	Taiwan	13–15	IHS-I	8359	526 (6.3)						Lifetime
Ho and Ong[27]	2003	Singapore	10–19	IHS-I	205	6 (2.9)	107	4 (3.7)	98	2 (2.0)	Q and I	
Ozge et al.[54]	2003	Turkey	8–16	IHS-IR	5562	576 (10.4)	2985	273 (9.2)	2577	303 (11.8)	Q and I	
Laurell et al.[29]	2004	Sweden	7–15	IHS-IR	1371	151 (11.0)	685	67 (9.8)	686	84 (12.2)	Q and I	12mo
Zencir et al.[55]	2004	Turkey	11–18	IHS-I	2490	220 (8.8)	1266	85 (6.7)	1224	135 (11.0)	Q	
Zwart et al.[30]	2004	Norway	13–18	Self-report	5847	410 (7.0)	2811	134 (4.8)	3036	273 (9.0)	Q and I	12mo
Bessisso et al.[31]	2005	Qatar	6–17	IHS-I	851	101 (11.9)					Q and I	12mo
Wang et al.[56] 1999	2005	Taiwan	12–14	IHS-I	7942	413 (5.2)	4161	187 (4.5)	3781	226 (6.0)	Q	12mo
Wang et al.[56] 2001	2005	Taiwan	12–14	IHS-I	7833	533 (6.8)	4152	204 (4.9)	3681	328 (8.9)		
Wang et al.[56] 2002	2005	Taiwan	12–14	IHS-I	7658	567 (7.4)	4077	241 (5.9)	3581	326 (9.1)		
Anttila et al.[57]	2006	Finland	7	ICHD-II	1066	114 (10.7)					I and E	6mo
Alawneh and Bataineh[34]	2006	Jordan	6–14	IHS-1	1120	32 (2.9)					Q and I	12mo
Ayatollahi and Khorsavi[35]	2006	Iran	6–13	IHS-I	2226	38 (1.7)	1171	16 (1.4)	1055	22 (2.1)	Q and I	12mo
Karli et al.[38]	2006	Turkey	12–17	ICHD-II	2387	341 (14.3)					Q and I	12mo
Isik et al.[43]	2007	Turkey	6–13	ICHD-II	2228	74 (3.3)	1134	34 (3.0)	1094	40 (3.7)	Q	
Akyol et al.[40]	2007	Turkey	9–17	ICHD-II	7721	752 (9.7)	3875	302 (7.8)	3846	450 (11.7)	Q and I	Life time
Bigal et al.[58]	2007	USA	12–19	ICHD-II	18714	1178 (6.3)	9624	481 (5.0)	9090	700 (7.7)	Q	12mo
Kroner-Herwig et al.[42]	2007	Germany	7–14	ICHD-II	5474	411 (7.5)					Q and I	6mo
Milovanovic et al.[44]	2007	Serbia	7–12	IHS-IR	1259	41 (3.3)	668	14 (2.1)	591	27 (4.6)	Q and I	
Unalp et al.[45]	2007	Turkey	14–18	ICHD-II	2384	510 (21.4)	1018	140 (13.8)	1366	370 (27.1)	Q	12mo
Visudtibhan et al.[59]	2007	Thailand	12–15	ICHD-II	1789	248 (13.9)	945	111 (11.8)	844	137 (16.2)	Q and I and E	Lifetime
Ando et al.[46]	2007	Japan	12–15	ICHD-II	6472	313 (4.8)	3346	110 (3.3)	3126	203 (6.5)	Q	
Total					131 228	10 093 (7.7)	55 110	3283 (6.0)	55 104	5340 (9.7)		

IHS-I, International Headache Society's Classification and Diagnosis of Headache Disorders (1988); IHS-IR, International Headache Society's Classification and Diagnosis of Headache Disorders – Revised; ICHD-II, International Classification of Headache Disorders (2004); Q, questionnaire; I, interview; E, examination.

to show similarities as well as differences (heterogeneity). Analysis of the prevalence of migraine with and without aura was not possible in these studies and is not presented here.

Publication bias

We tested for publication bias by using the informal funnel graph as recommended by Begg and Berlin.[6]

Assessment of heterogeneity and subgroup analysis

Differences between studies were explored to identify heterogeneity. These included the following areas. (1) The reported prevalence of headache and migraine over different periods of time, ranging from 1 month to lifetime, was investigated. It is feasible that these variables may constitute major differences and may provide heterogeneous data. Therefore we comparatively assessed the prevalence of headache and migraine in studies reporting over a short period (<6mo) with prevalence in those reporting over a long period (at least 6mo). (2) Differences in prevalence between age groups were explored. We assessed the prevalence of migraine in young children (<14y) compared with that in all children and adolescents up to the age of 20 years. (3) The role of the diagnostic criteria on the prevalence of migraine was also explored. We separately analysed the prevalence of migraine in studies using the IHS criteria for the diagnosis of migraine (1988) and in those using the ICHD-II. (4) We also investigated and compared the possible influences of racial or geographical origin.

Statistical analysis

We show the raw data in tables and our assessments in figures. Heterogeneity between studies for point-in-time prevalence, method of data collection, and age range of childhood populations are included. We used Confidence Interval Analysis software (published by the British Medical Journal Publishing Group[7]) and analysed the differences between the percentages by a χ^2 test. We also used Excel and Stata for the odds ratio (OR) with 95% confidence intervals (CIs) where appropriate. Analysis included graphic data summary and Forest Plot.[8,9]

RESULTS

The search of PubMed, Google Scholar, Cochrane databases, and Embase produced 258 articles. PubMed produced most of the papers except for five articles identified by Google Scholar. It was possible to exclude 213 articles: 40 were review articles, 21 clinic series, 28 prevalence studies on adult populations, 38 on headache diagnosis or the prevalence of headache among specific patients groups, 21 on headache treatment, nine on genetics of headache, nine on chronic daily headache, 12 on the prognosis of headache, one case report, and 34 on headache comorbidities. Only 50 articles were found to fulfil the search criteria for population-based studies of headache and/or migraine in childhood.

We summarize the findings of each study in Tables I and II, showing year of publication, country of origin, number of participants in the study population, number of cases, methods of data collection, diagnostic criteria of migraine, prevalence, and sex differences if applicable.

Publication bias

The informal funnel graph, as recommended by Begg and Berlin,[6] shows the typical pyramid-shaped graph with tapering for prevalence of headache (Fig. 1) and migraine (Fig. 2).

Prevalence of headache

Thirty-seven population-based studies (Table I) provided 38 sets of data and reported on the prevalence of headache in children under the age of 20 years.[10–12,14–59] All studies collected information from unselected childhood populations using a questionnaire with or without an interview and examination. Prevalence of headache was reported for children complaining of headache occurring over lifetime or the past 12, 6, 3, or 1 month; however, in nine studies no reference was made to the period of time. The reported prevalence of headache and the calculated 95% CIs in all studies are shown in Fig. 3 and demonstrate the variability in prevalence among studies. The overall calculated prevalence of headache (at any point in time) in a total population of 80 876 children is 58.4% with a narrower 95% CI (58.1–58.8%).

Twenty-two studies provided the sex-specific prevalence of headache. Meta-analysis of the sex differences in prevalence of headache using Stata to calculate OR and the 95% CI is shown in Fig. 4. The OR for prevalence of headache in females compared with males is 1.53 (1.48–1.60).

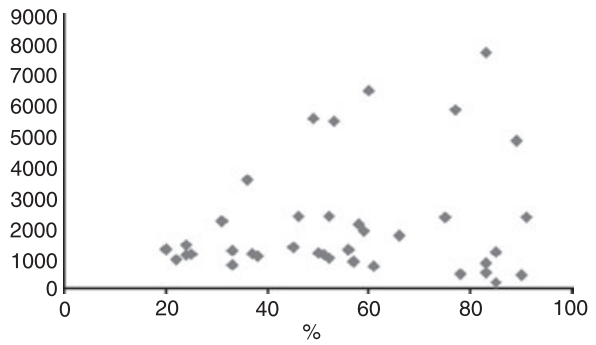

Figure 1: Publication bias test for the sample size (*y* axis) versus prevalence of headache in each study (*x* axis).

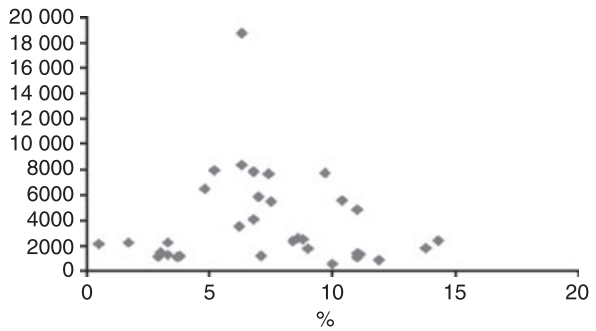

Figure 2: Publication bias test for the sample size (*y* axis) versus prevalence of migraine in each study (*x* axis).

Author	Total	Headache *n*	Headache %
King and Sharpley[10]	900	513	57
Mortimer et al.[11]	1083	409	38
Kristjánsdóttir and Wahlberg[12]	1016	533	53
Kristjánsdóttir and Wahlberg[12]	1124	567	50
Abu-Arafeh and Russell[13]	1754	1166	67
Pothmann et al.[14]	4835	4297	89
Raieli et al.[15]	1445	345	24
Barea et al.[16]	538	446	83
Carlsson[17]	1144	281	25
Antoniuk et al.[18]	460	414	90
Aaromaa et al.[19]	968	204	21
Bener et al.[20]	1159	428	37
Metsahonkala et al.[21]	3580	1306	37
Anttila et al.[22]	1290	725	56
Krasnik[23]	2353	1759	75
Bendell-Hockstra et al.[24]	2358	2145	91
Al Jumah et al.[25]	1181	588	50
Fichtel and Larsson[26]	792	258	33
Ho and Ong[27]	205	174	85
Shivpuri et al.[28]	1305	255	20
Laurell et al.[29]	1371	614	45
Zwart et al.[30]	5847	4535	78
Bessisso et al.[31]	851	706	83
Bugdayci et al.[32]	5562	2739	49
Roth-Isgkeit et al.[33]	749	453	61
Alawneh and Bataineh[34]	1120	269	24
Ayotallahi and Khorsavi[35]	2226	691	31
Karli et al.[36]	2387	1245	52
Lundqvist et al.[37]	2126	1225	58
Siddiqui et al.[38]	1211	1035	86
Van Dijk et al.[39]	495	386	78
Aykol et al.[40]	7721	6431	83
Brun Sundblad et al.[41]	1903	1122	59
Kroner-Herwig et al.[42]	5474	2927	54
Isik et al.[43]	2228	700	31
Milovanovic[44]	1259	413	33
Unalp et al.[45]	2384	1090	46
Ando et al.[46]	6472	3872	60
Total	80876	47266	58

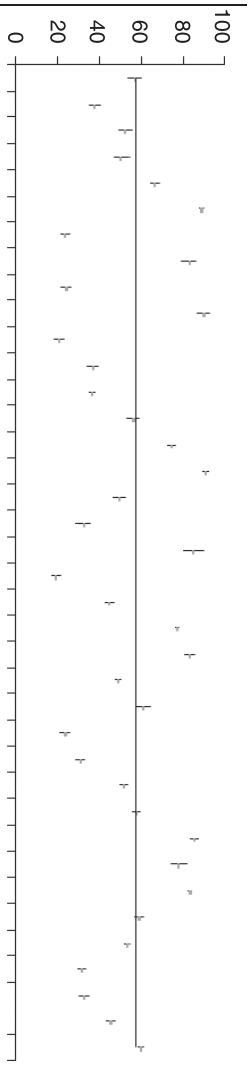

Figure 3: Prevalence and 95% confidence interval of headache in population-based studies. The trend in prevalence is shown by the vertical line.

Prevalence of migraine

Thirty-five studies (Table II) provided 37 sets of data of the prevalence of migraine in people under the age of 20 years. The diagnosis of migraine was made on the application of the IHS's criteria of 1988 or the ICHD-II.[2,3] Two studies used revised criteria. The reported prevalence figures of migraine over a minimum period of 3 months (and 95% CIs) are shown in Fig. 5. The cumulative analysis showed the overall prevalence of migraine in children and adolescents is 7.7% (95% CI 7.6–7.8).

Subgroup analysis

Role of sex on prevalence of migraine

Twenty-eight population-based studies provided data on the prevalence of migraine among males. Twenty-nine studies provided data on the prevalence of migraine in females (one study reported on females only). The overall prevalence of migraine in female children and adolescents is 9.7% (95% CI 9.4–9.9) and in males 6.0% (95% CI 5.8–6.2); the difference is 3.7% (95% CI 3.4–3.9, $p<0.001$). Meta-analysis of the OR for prevalence of migraine in females, as shown in Fig. 6, gives a value of 1.67 (95% CI 1.60–1.75).

Role of age on prevalence of migraine

Table III shows the population studies reporting prevalence of migraine in children (≤14y). The prevalence of migraine among females is 7.0% (95% CI 6.7–7.4), which is significantly lower than the prevalence of migraine in all females under the age of 20 years, which is 9.7%; the difference is 2.7% (95% CI for difference 2.5–2.9, $p<0.001$). Similarly the prevalence of migraine in males of 14 years of age or under is 4.7% compared with 6.0% in males of all ages under 20 years (95% CI 5.8–6.2); the difference is 2.3% ($p<0.01$).

Role of diagnostic criteria on the prevalence of migraine

Twenty-one studies used the 1988 IHS criteria, giving a total number of children of 68 954 and a prevalence of 7.5% (95% CI 7.3–7.7). Eleven studies used the ICHD-II of 2004, giving

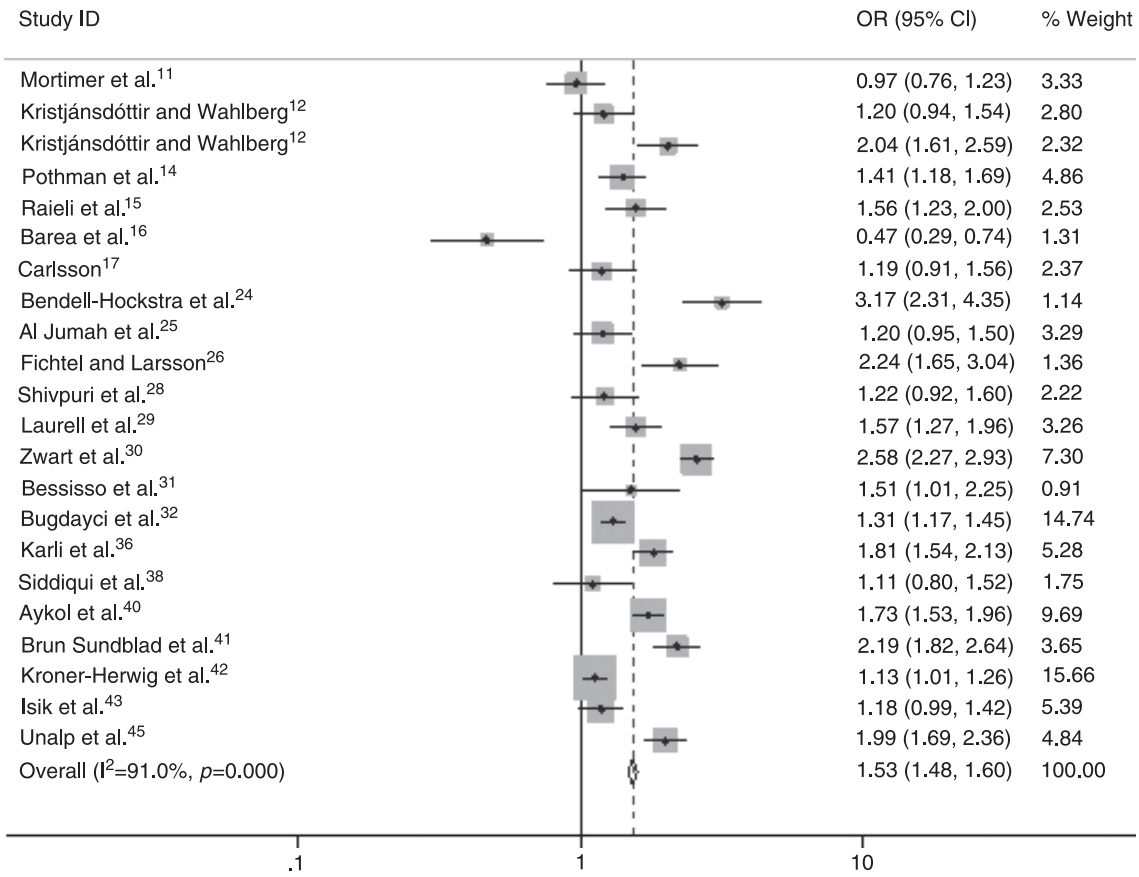

Figure 4: Odds ratio and 95% confidence interval for prevalence of headache in female children and adolescents.

a total number of children of 64 985 and a prevalence of 7.8% (95% CI 7.6–8.0). The difference in prevalence between the two sets of criteria is not statistically significant, although it may be of clinical value for individual patients.

Role of geographical background on prevalence of migraine

The prevalence of migraine by geographical region is illustrated in Table IV. There is evidence of a statistically significant difference (χ^2=173.12, degrees of freedom=3, p<0.001). It is not possible to assess the role of any possible racial influences on the prevalence of migraine from the information given in the studies.

Point-in-time prevalence of migraine

No evidence of a significant difference was noted between studies that reported on prevalence of migraine or headache over long periods of time (at least 6mo or no report on the time period) compared with the overall prevalence (Table V).

DISCUSSION

Study methods

The use of published literature is unlikely to carry any selection bias as most papers presented at meetings and conferences were subsequently published in full and are included. It is not possible to assess the quality of methods and data in studies that were neither published nor presented.

We realize the difficulties that are inherent with systemic reviews and meta-analyses of published literature, especially when some or all of the epidemiological studies are observational in nature and may have disparate results, as described by Greenland.[9] We therefore identified and managed the differences between studies as appropriate and performed subgroup analysis, capturing as much homogeneity among the subgroups as possible by assessing one variable at a time.

The prevalence figures in the pooled data, though, produced narrow 95% CIs that should be read with caution as they should not hide the differences in the individual studies. Despite these limitations of our data, it is still possible to make reasonable conclusions about the appropriateness of the methods we used, particularly the inclusion of the whole age spectrum of children and adolescents up to 20 years.

Also, the heterogeneity of the studies in reporting prevalence against different points in time may seem a significant difference. However, the high frequency of headache and migraine, as shown in several population-based studies, has minimized any such differences and proved of little consequence in the overall analysis.

Similarly, the use of the first or second editions of the IHS criteria for the diagnosis of migraine are shown in our analysis

Author	Total	Migraine *n*	%
Mortimer et al.[11]	1083	40	3.7
Abu-Arafeh and Russell[13]	1754	159	9.1
Pothman et al.[14]	4835	532	11.0
Raieli et al.[15]	1445	43	3.0
Barea et al.[16]	538	53	9.9
Lee and Olness[47]	2572	222	8.6
Bener et al.[20]	1159	44	3.8
Krasnik[23]	2353	198	8.4
Mavromichalis et al.[48]	3509	219	6.2
Split and Neuman[49]	2352	511	21.7
Lu et al.[50]	4064	277	6.8
Kong et al.[51]	2120	11	0.5
Al Jumah et al.[25]	1181	84	7.1
Ayatollahi et al.[52]	1868	114	6.1
Shivpuri et al.[28]	1305	145	11.1
Fuh et al.[53]	8359	526	6.3
Ho and Ong[27]	205	6	2.9
Ozge et al.[54]	5562	576	10.4
Laurell et al.[29]	1371	151	11.0
Zencir et al.[55]	2490	220	8.8
Zwart et al.[30]	5847	410	7.0
Bessisso et al.[31]	851	101	11.9
Wang et al.[56] 1999	7942	413	5.2
Wang et al.[56] 2001	7833	533	6.8
Wang et al.[56] 2002	7658	567	7.4
Anttila et al.[57]	1066	114	10.7
Alawneh and Bataineh[34]	1120	32	2.9
Ayatollahi and Khorsavi[35]	2226	38	1.7
Karli et al.[36]	2387	341	14.3
Isik et al.[43]	2228	74	3.3
Akyol et al.[40]	7721	752	9.7
Bigal et al.[58]	18714	1178	6.3
Kroner-Herwig et al.[42]	5474	411	7.5
Milovanovic et al.[44]	1259	41	3.3
Unalp et al.[45]	2384	510	21.4
Visudtibhan et al.[59]	1789	248	13.9
Ando et al.[46]	6472	313	4.8
Total	131228	10093	7.7%

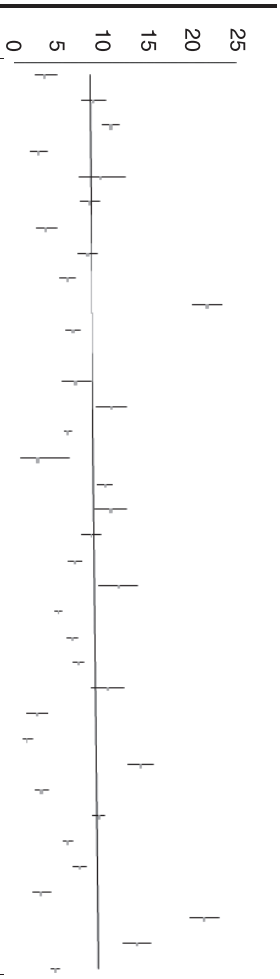

Figure 5: Prevalence and 95% confidence interval of migraine in population-based studies. The trend in prevalence is shown by the vertical line.

Table III: Prevalence by sex of migraine in children under the age of 14 years

Reference	Age (y)	Total males	Males' migraine *n* (%)	Total females	Females' migraine *n* (%)
Mortimer et al.[11]	3–11	549	16 (2.9)	534	24 (4.5)
Raieli et al.[15]	11–14	738	20 (2.7)	707	23 (3.3)
Ayatollahi and Khorsavi[35]	6–13	1171	16 (1.4)	1055	22 (2.1)
Isik et al.[43]	6–13	1134	34 (3.0)	1094	40 (3.7)
Milovanovic et al.[44]	7–12	668	14 (2.1)	591	27 (4.6)
Lee and Olness[47]	5–13	1115	99 (8.9)	1111	120 (9.9)
Wang et al.[56] 1999	12–14	4161	187 (4.5)	3781	226 (6.0)
Wang et al.[56] 2001	12–14	4152	204 (4.9)	3681	328 (8.9)
Wang et al.[56] 2002	12–14	4077	241 (5.9)	3581	326 (9.1)
Total		17 765	831 (4.7)	16 135	1136 (7.0)

to be of some effect, but probably of no clinical significance on the prevalence of migraine, for which subgroup analysis has proved a very useful tool.

Pooled grouping has also provided data on specific population characteristics. The validity of our study and the analysis of the data were assessed against the checklist of items as suggested by a recent publication on research methods and reporting.[5] Analysis for publication bias using the informal graphic method was reassuring and conforms to accepted recommendations.[6]

Prevalence of headache

Despite the wide differences in the reported prevalence of headache in different studies in children and adolescents, a

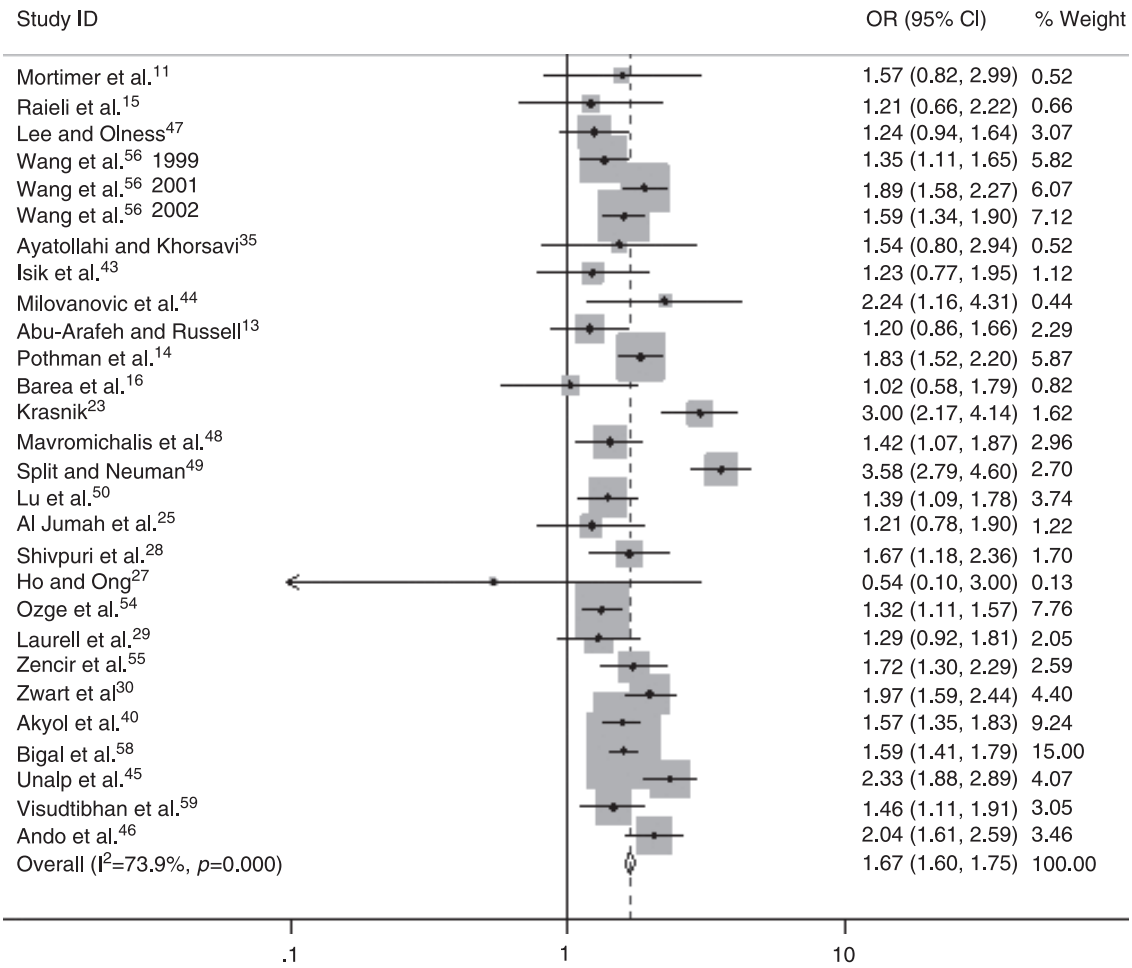

Figure 6: Odds ratio and 95% confidence interval for prevalence of migraine in female children and adolescents.

Table IV: Geographical prevalence rates of migraine

Region	Population studies	Total	Migraine	Prevalence (%)	95% confidence interval
Europe	Mortimer et al.[11], Abu-Arafeh and Russell[13], Pothmann et al.[14], Raieli et al.[15], Krasnik[23], Split and Neuman[49] Mavromichalis et al.[48], Laurell et al.[29], Zwart et al.[30], Anttila et al.[57], Kroner-Herwig et al.[42]	46 580	3888	8.35	8.10–8.60
Middle East	Bener et al.[20], Al Jumah et al.[25], Ayatollahi et al.[52], Ozge et al.[54], Zencir et al.[55], Bessisso et al.[31] Alawneh et al.[34], Ayatollahi and Khorsavi[35], Karli et al.[36], Isik et al.[43], Akyol et al.[40], Milovanovic et al.[44], Unalp et al.[45], Visudtibhan et al.[59], Ando et al.[46]	38 829	3374	8.69	8.41–8.97
Far East	Lu et al.[50], Kong et al.[51], Fuh et al.[53], Ho and Ong[27], Wang et al.[56], Shivpuri et al.[28]	39 486	2646	6.70	6.45–6.95
USA	Lee and Olness[47], Bigal et al.[58]	21 286	1400	6.58	6.24–6.91

clear and reliable estimate of the magnitude of the problem has emerged. This analysis shows that around 60% of children are prone to headache, over periods varying from 3 months to lifetime, and may have attacks of variable frequency. It does not mean that 60% of children have headache at any given point in time. Such a high prevalence may not surprise many researchers and clinicians, but it confirms the high prevalence of headache in children. This result will help public health

Table V: Influences of the different time periods on prevalence of migraine and headache

	Migraine		Headache	
Point prevalence	>6mo	Whole group	>6mo	Whole group
Total population	85 513	131 228	65 981	80 876
Migraine	6738	10 093	40 860	47 266
Prevalence (CI)	7.9% (7.7–8.1)	7.7% (7.6–7.8)	61.9% (61.6–62.3)	58.4% (58.1–58.8)
Total males	31 322	55 110	24 282	26 798
Migraine	1932	3283	14 520	15 440
Prevalence (CI)	6.2% (5.9–6.4)	7.0% (5.8–6.2)	59.8% (59.2–60.4)	57.6% (57.0–58.2)
Total females	33 177	55 104	24 546	26 953
Migraine	3337	5340	16 875	18 035
Prevalence (CI)	10.1% (9.7–10.4)	9.7% (9.4–9.9)	68.7% (68.2–69.3)	66.9% (66.4–67.5)

CI, confidence interval.

planners and doctors treating children to understand better the extent of the condition. Our review also shows that headache is significantly more common in females (67%) than in males (58%), and that headache is common across the age range and across the world.

Prevalence of migraine

Similarly, we confirm that migraine is a common disorder: approximately 8% of children and adolescents are prone to it over at least a 3-month period. We have also shown that migraine is more common in older children over the age of 14 years. The prevalence of migraine in our systematic review should be viewed as a minimum estimate as it was not possible to adjust for non-responders to questionnaires in some studies and those who did not attend interviews. Experience from one study that adjusted for these variables showed an increase from the actual to the estimated prevalence by a factor of 1.17 (Abu-Arafeh and Russell[13]).

The only difference between the IHS's diagnostic criteria of migraine of 1988 and those of ICHD-II of 2004 is the reduction in the duration of migraine attacks from a minimum of 2 to 1 hour. This change is clinically important in making the diagnosis of migraine in individual patients, but it does not seem to have made a significant difference in the calculation of migraine prevalence in children and adolescents.

This review shows clear and statistically significant differences in the prevalence of migraine between Europe and the Middle East on the one hand and the USA and the Far East on the other. The differences are probably a combination of genetic predisposition as well as environmental factors. Despite the clear differences in migraine prevalence in different regions of the world, it is not possible to assume that the differences are due to racial background as most studies did not provide data on the racial makeup of their populations.

CONCLUSION

Headache is common across the world, with about 60% of children and adolescents being prone to it over at least a 3-month period. Migraine is also common, and despite small variations in reporting across the world it is safe to state that around 8% of children and adolescents suffer from it over periods ranging from 3 months to lifetime. This analysis confirms the frequently reported observation of a significantly lower prevalence of migraine in children under the age of 14 years than in the general childhood population. Small regional and possibly interracial differences in its prevalence are also evident. Migraine affects males and females equally at a young age (<14y), and more females than males in adolescence and young adulthood.

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