Journal of the Neurological Sciences 342 (2014) 1–15

Contents lists available at ScienceDirect

Journal of the Neurological Sciences

journal homepage: www.elsevier.com/locate/jns

Review article

Prevalence of migraine headache and its weight on neurological burden in Africa: A 43-year systematic review and meta-analysis of community-based studies

Yohannes W. Woldeamanuel [a,*], Anna P. Andreou [b], Robert P. Cowan [a]

[a] Stanford Headache Program, Department of Neurology and Neurological Sciences, Room H3160, Stanford University School of Medicine, 300 Pasteur Drive, Stanford, CA 94305–5235, USA
[b] Headache Research Laboratory, Section of Anaesthetics, Pain Medicine and Intensive Care, Faculty of Medicine, Chelsea and Westminster Hospital, Imperial College London, 369 Fulham Road, London SW10 9NH, UK

ARTICLE INFO

Article history:
Received 12 November 2013
Received in revised form 22 March 2014
Accepted 14 April 2014
Available online 24 April 2014

Keywords:
Migraine
Prevalence
Burden of Headache in Africa
Neurological disorders
Systematic review and meta-analysis
Community-based studies

ABSTRACT

Background: Headache burden is not adequately explored in Africa. Here, we measured weighted migraine prevalence from community-based studies in Africa.
Methods: PubMed search was employed using terms 'headache in Africa' AND/OR 'migraine in Africa' for published literature from 1970 until January 31, 2014. PRISMA was applied for systematic review. Forest-plot meta-analysis, inter-study heterogeneity, and odds ratio were used to measure weighted prevalence, inter-gender, and urban–rural differences. Disability adjusted life years (DALYs) for migraine and other neurologic disorders in Africa were extracted from Global Burden of Diseases (GBD) 2000–2030.
Results: Among 21 community-based studies included ($n = 137{,}277$), pooled migraine prevalence was 5.61% (95% CI 4.61, 6.70; random effects) among general population; while 14.89% (14.06, 15.74; fixed effects) among student cohorts. Female students had weighted OR of 2.13 (1.34, 3.37; $p = 0.0013$). Prevalence of migraine was higher among urban population compared to rural settings. Migraine burden is bound to increase by more than 10% DALYs within the next decade.
Conclusion: Africa has a crude estimate of 56 million people suffering from migraine. By virtue of mainly afflicting the younger working-age group, migraine disability has wider socioeconomic implications. Improving early headache management access points at community-level, training and research at facility-level, and healthy lifestyle modification among urban residents can help reduce this costly and disabling chronic progressive health problem.

Contents

* Corresponding author. Tel.: +1 650 933 3560.
E-mail addresses: yohannes.woldeamanuel@gmail.com, ywoldeam@stanford.edu (Y.W. Woldeamanuel).

http://dx.doi.org/10.1016/j.jns.2014.04.019
0022-510X/

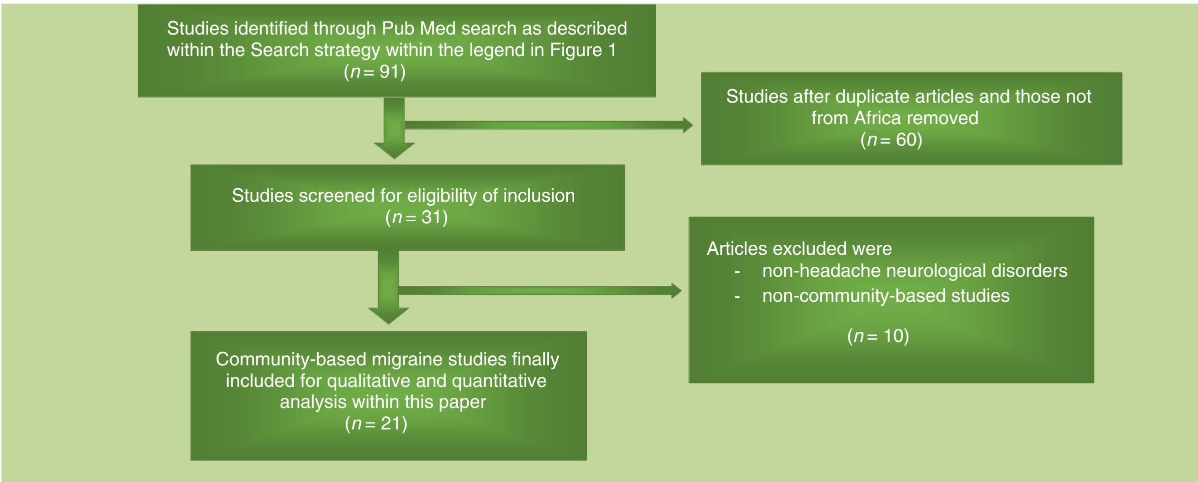


Fig. 1. PRISMA[12] flowchart used for selection of studies reviewed. Search strategy: A MEDLINE/PubMed search was employed using the following terms, both in keywords and MeSH headings: 'headache in Africa' AND/OR 'migraine in Africa'. Additional papers were included through reference search relevant to migraine headache in African countries. We limited to search from 1970 until January 31, 2013 inclusive. Relevant data on migraine and neurological disorders was extracted from the WHO GBD health statistics and health information systems for the years 2000, 2002, 2004, 2008, 2015, and 2030 (projections for 2015 and 2030)[14] to trace the trend line for migraine burden throughout the 43-year period.

1. Introduction

Primary headache disorders are disabling neurological disorders characterized, beyond the head pain, by a number of sensory disturbances [1–3]. Headache disorders are among the most common neurological disorders worldwide [4]. The 2010 Global Burden of Disease (GBD) Study revealed that global years lived with disability (YLD) for migraine and tension types of headache have increased by 40% since 1990, making primary headache disorders the leading causes of sequelae[1] of up to 35.5% prevalence in both sexes (10.7% in males, 18.8% in females for migraine; 18.9% in males, 22.7% in females for tension type headache) [4].

In Africa, migraine ranked as the 13th leading cause of YLDs in 2010 [4]. In 2004, migraine on its own accounted for 15% of the continent's DALYs[2] (Disability Adjusted Life Years) due to neurological disorders [5]. African health metrics are largely constructed from facility-based reports; only a handful of community-based studies are available [6,7]. In 2011, societal impact of headache information existed only in 6% of African countries, while economic burden has not been effectively measured to date [8]. Headaches in Africa are mostly self-treated [8] due to limited availability of primary care, neurologic consultations, imaging facilities, and related investigative modalities [8]. The burden of medication overuse headache (MOH) in Africa has yet to be determined. Health professionals do not get adequate training to manage headache disorders effectively, while headache specialists are extremely rare [8]. Besides common primary headaches like migraine, African headache epidemiology is heavy-laden with secondary-type headaches, mostly due to tropical neuroinfections. Sociodemographic characteristics of African settings comprise of rapidly growing, younger working-age population. By 2040, Africa will contribute nearly half a billion young people to the global labor force; this will make the continent to have the highest number of productive age-group toppling that of China and India [9]. Rapid population growth coupled with unfavorable lifestyle changes and rise of chronic progressive disorders, in particular primary headaches, can lead to significant reduction of regional productivity due to accrued disability, and

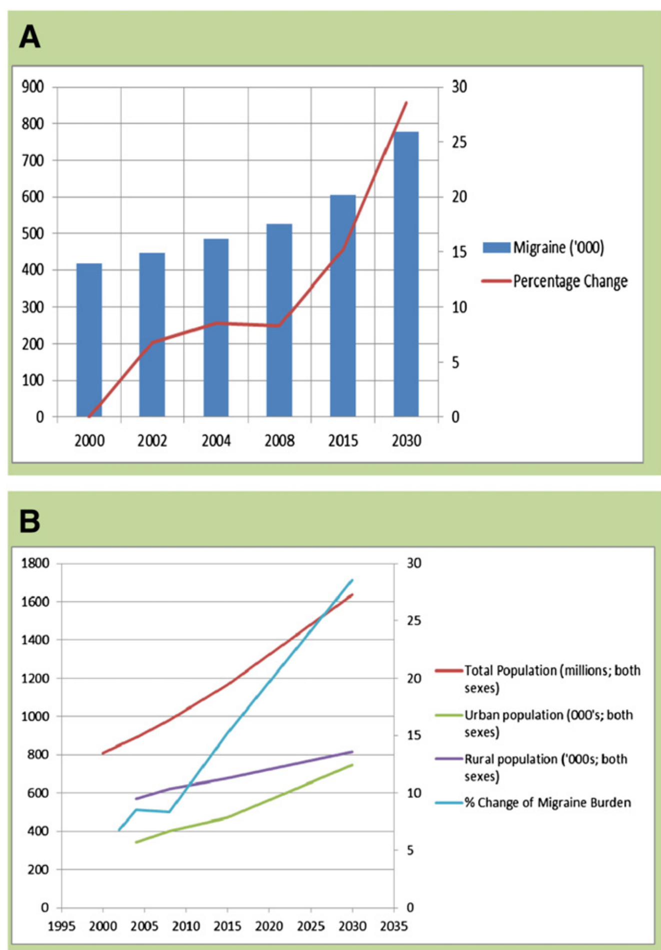


Fig. 2. A: Disability-adjusted life years (DALYs) caused by migraine in the WHO African Region. Data includes migraine burden and projected estimates beginning from the year 2000 up to 2030. Data extracted employed standard DALYs (3% discounting, age weights, and baseline scenario)[14]. B: Migraine burden increase rate is higher than that of population growth rate. Note that urban population growth rate i.e. urbanization is higher than that of rural[16].

[1] GBD 2010 has a list of 291 diseases and injuries, of which 289 cause disability. 1160 sequelae of these diseases and injuries have been identified. For example, diabetic neuropathy is one sequela of diabetes mellitus.

[2] DALYs: Disability Adjusted Life Years – a health biometric adopted by the World Health Organization (WHO) to measure the burden of a disease by adding the sum of years of potential life lost due to premature mortality and the years of productive life lost due to disability.

Table 1
Description of community-based studies of migraine prevalence in African settings - included in this systematic review and meta-analysis.

	Study [First authors and year]	Country of origin	Sample size	Total number of participants with migraine	Male to female ratio of total participants	Prevalence and 95% CI of migraine among Females (%age)	Prevalence and 95% CI of migraine among Males (%age)	Overall prevalence and 95% CI of Migraine (%age, in both sexes)	Weights% (fixed, random)	Study setting	Time period of prevalence study	Method of headache diagnosis
1	Osuntokun BO, 1982 [17]	Nigeria	903	62	0.91	8.89 (6.32, 11.46)	4.64 (2.65, 6.63)	6.86 (5.30, 8.71)	0.95, 6.29	Rural	Lifetime	AHC
2	Levy LM, 1983 [18]	Zimbabwe	5028	210	2.63	5.99 (4.74, 7.24)	3.51 (2.91,4.11)	4.18 (3.64, 4.77)	5.26, 7.03	Rural	1-year	AHC
3	Ogunyemi A, 1984 [19]	Nigeria	1756	294	2.92	19.87(16.18, 23.56)	15.67 (13.7, 17.64)	16.74 (15.02, 18.57)	25.54, 14.62	University Students	Lifetime	AHC
4	Longe AC, 1989 [20]	Nigeria	2925	185	0.99	N/A	N/A	6.32 (5.47, 7.27)	3.06, 6.90	Rural	N/A	AHC
5	Osuntokun, 1992 [7]	Nigeria	18594	985	0.99	5.64 (5.18, 6.10)	5.03 (4.59, 5.47)	5.29 (4.98, 5.63)	18.16, 4.73	Rural	Lifetime	AHC
6 i	Attia Romdhane, 1993 [21]	Tunisia	25139	626	N/A	N/A	N/A	2.49 (2.30, 2.69)	26.31, 7.18	Urban	N/A	AHC
6 ii	Attia Romdhane, 1993 [21]	Tunisia	9735	398	N/A	N/A	N/A	4.08 (3.70, 4.50)	10.19, 7.12	Rural	N/A	AHC
6 iii	Attia Romdhane, 1993 [21]	Tunisia	34874	1024	1.06	3.85 (3.56, 4.14)	2.08 (1.87, 2.29)	2.94 (2.77, 3.12)	N/A	72% Urban	N/A	AHC
7	Tekle Haimanot, 1995 [6]	Ethiopia	15500	465	0.875	4.16 (3.72, 4.6)	1.73 (1.42, 2.04)	3 (2.74, 3.28)	15.14, 4.73	Rural	1-year	ICHD-I
8	Matuja, 1995 [22]	Tanzania	1540	113	3.74	11.69 (8.2, 15.18)	5.93 (4.60, 7.26)	7.34 (6.09, 8.76)	1.61, 6.64	Urban	2-year	AHC
9	Amayo, 1996 [23]	Kenya	711	240	1:1.3 Male: Female ratio of migraine	N/A	N/A	33.75 (30.28, 37.36)	10.35, 14.33	Medical School	6-month	ICHD-I
10	Jelsma, 2002 [24]	Zimbabwe	805	96	N/A	N/A	N/A	11.93 (9.76, 14.37)	0.84, 6.19	Urban	N/A	AHC
11	Dent, 2004 [25]	Tanzania	3351	168	0.78	6.93 (5.78, 8.08)	2.51 (1.71, 3.31)	5.01 (4.29, 5.81)	3.51, 6.94	Rural	1-year	ICHD-I
12	Takele, 2008 [26]	Ethiopia	1105	68	1.61	10.21 (7.94, 12.48)	3.67 (1.88, 5.46)	6.15 (4.81, 7.74)	1.16, 6.44	Urban	1-year	ICHD-II
13	Adoukouonu, 2009 [27]	Benin	336	38	1.56	18.32 (13.02, 23.62)	6.83 (2.51, 11.15)	11.31 (8.13, 15.19)	4.89, 13.80	University	Lifetime	ICHD-II
14	Wahab 2009 [28]	Nigeria	1513	145	0.99	10.29 (8.13, 12.45)	8.87 (6.84, 10.9)	9.58 (8.15, 11.18)	22.01, 14.59	University	Lifetime	ICHD-II
15	Ojini, 2009 [29]	Nigeria	376	24	1.41	27.56 (20.55, 34.57)	5.90 (2.79, 9.01)	6.38 (4.13, 9.35)	5.48, 13.90	Medical Students	1-year	ICHD-II
16	Houinato, 2010 [30]	Benin	1113	37	0.57	3.97 (2.53, 5.41)	2.21 (0.78, 3.64)	3.32 (2.35, 4.55)	1.16, 6.44	Rural	Lifetime	ICHD-I
17	Winkler, 2010 [31]	Tanzania	7412	316	0.98	6.32 (5.54, 7.10)	2.17 (1.70, 2.64)	4.26 (3.81, 4.75)	7.76, 7.09	Rural	1-year	ICHD-I
18	Ofovwe, 2010 [32]	Nigeria	1679	226	1.07	18.17 (15.51, 20.83)	9.19 (7.27, 11.11)	13.46 (11.83, 15.09)	24.42, 14.61	Secondary School	1-year	ICHD-II
19	Ezeala-Adikaibe AB 2012 [33]	Nigeria	500	90	N/A	N/A	N/A	18 (14.63, 21.37)	7.28, 14.12	Medical Students	1-year	ICHD-II
20	Gelaye, 2013 [34]	Ethiopia	2151	212	1.52	14.29 (11.94, 16.64)	6.94 (5.56, 8.32)	9.86 (8.60, 11.12)	2.25, 6.79	Urban	Lifetime	ICHD-II
21	Mengistu, 2013 [35]	Ethiopia	231	23	1.06	10.71 (4.98, 16.44)	9.24 (4.04, 14.44)	9.96 (6.10, 13.82)	0.24, 4.57	Urban	1-year	ICHD-II

Extracted data presented in this table include first authors, year of study, country of origin, total number of participants, total number of participants with migraine, male-to-female ratio of total sample, prevalence and 95% CI of migraine among females, among males, and in both sexes, weighted-effect (fixed, random), study setting, period of prevalence, and method of headache diagnosis. *Light blue shades* represent the student cohort studies included in meta-analysis. *Light red shades* represent rural studies included in meta-analysis. *White shades* represent urban studies included in meta-analysis. The study by Attia Romdhane et al. [21], reported data from both urban and rural populations and these are reported separately in the current meta-analysis study. AHC: Ad-Hoc Criteria. ICHD: International Classification of Headache Disorders. NA: not available.

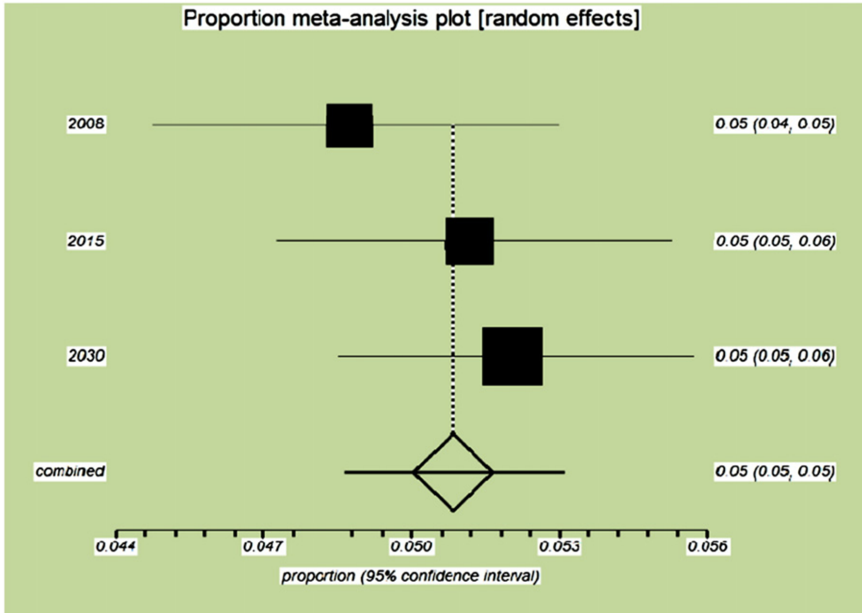


Fig. 3. Proportion and uncertainty intervals of DALYs caused by migraine among neurological disorders in Africa. Regional data extracted include migraine and neurological disorders burden and projected estimates beginning from the year 2008 up to 2030[14]. Data extracted employed standard DALYs (3% discounting, age weights, and baseline scenario)[14]. Random-effects (DerSimonian-Laird[13]) meta-analysis forest plot for proportion of migraine as of neurological disorders in the African setting.

higher levels of absenteeism and presenteeism in the workplace and/or school. Clinical and societal burden of migraine is worsened by high healthcare costs alike [10,11].

2. Methods

In this study, the authors conducted a systematic review of community-based studies from January 1, 1970 to January 31, 2014 inclusive, followed by meta-analysis to give accurate overview of pooled prevalence of migraine in the African setting. A stratified analysis was performed to study potential confounders and effect modification for reduction of multicausality within the outcome of our primary interest i.e. migraine prevalence; this allowed data comparison along gender-stratification, rural versus urban study setting, student cohort versus general population, and lifetime versus one-year prevalence strata. This study has given more focus to migraine due to paucity of studies on other types of headaches. The authors also made careful measurement of the weight of headache disorders on neurological burden in Africa. Available data from this region included DALYs and YLDs of migraine headache from GBD 2000, 2002, 2004, 2008, 2015, and 2030. Feasible intervention plans for lifting the increasing burden of headache in the African setting are further discussed. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [12] guidelines were followed (Fig. 1).

3. Inclusion and exclusion criteria

Community-based studies which reported overall prevalence rates of migraine were included within the meta-analysis, so that prevalence and 95% confidence intervals [CI] can be computed. Studies that reported migraine burden among specific cohorts of high school and university students were further included and separately analyzed to study the weighted prevalence of migraine among these students. Studies that reported migraine prevalence from countries outside Africa were excluded. Twenty-one studies were included for meta-analysis – seven of which were from student cohorts [Fig. 1]. Studies on non-migrainous headaches were excluded from systematic analysis.

4. Data extraction

Relevant data extracted from each selected paper were compiled as shown in Table 1. Detailed extracted information includes the following: first author, year of publication, country of origin, sample size, total number of participants with migraine, male to female ratio of total participants, prevalence of migraine among females, prevalence of migraine among males, overall prevalence of migraine in both sexes, study setting, study period, study design, total number of participants in the study, overall prevalence of migraine, overall prevalence of other types of headache, and method of headache diagnosis.

5. Statistical analysis

StatsDirect v2.7.9 was used to analyze the results, develop pooled prevalence rates and prepare forest plots, in an effort to provide population-based burden-of-migraine results. Combined pooled prevalence rates and 95% CIs were generated using both fixed- (inverse variance weighting) and random-effects (DerSimonian-Laird [13]) meta-analysis models. Heterogeneity comparisons were made among rural–urban, intra-urban, and intra-rural study settings.

DALYs were used to extract population-based burden measure for migraine and other neurologic disorders. Regional WHO African data and projected estimations of standard DALYs (3% discounting, age weights, and baseline scenario) from GBD 2000, 2002, 2004, 2008, 2015, and 2030 [14] were extracted from the WHO dataset. Available data for DALYs of all neurological disorders included those caused by migraine and the following seven neurological disorders – namely epilepsy, Alzheimer and other dementias, Parkinson disease, multiple sclerosis, primary insomnia, mental retardation, and cerebrovascular disease. Proportion and 95% CI (uncertainty interval) of DALYs being caused by migraine in each year was computed as: [(DALYs of migraine) ÷ (DALYs of non-migraine neurological disorders + DALYs of migraine)]. Proportion and CIs were selected as they offer burden measurement with precision level metric to study the results from the different study time-points; overall pooled proportion and 95% CIs were similarly developed using both fixed- (inverse variance weighting [15]) and random-effects (DerSimonian-Laird [13]) meta-analysis model. Inter-year homogeneity was computed to study for consistency of measurement during the

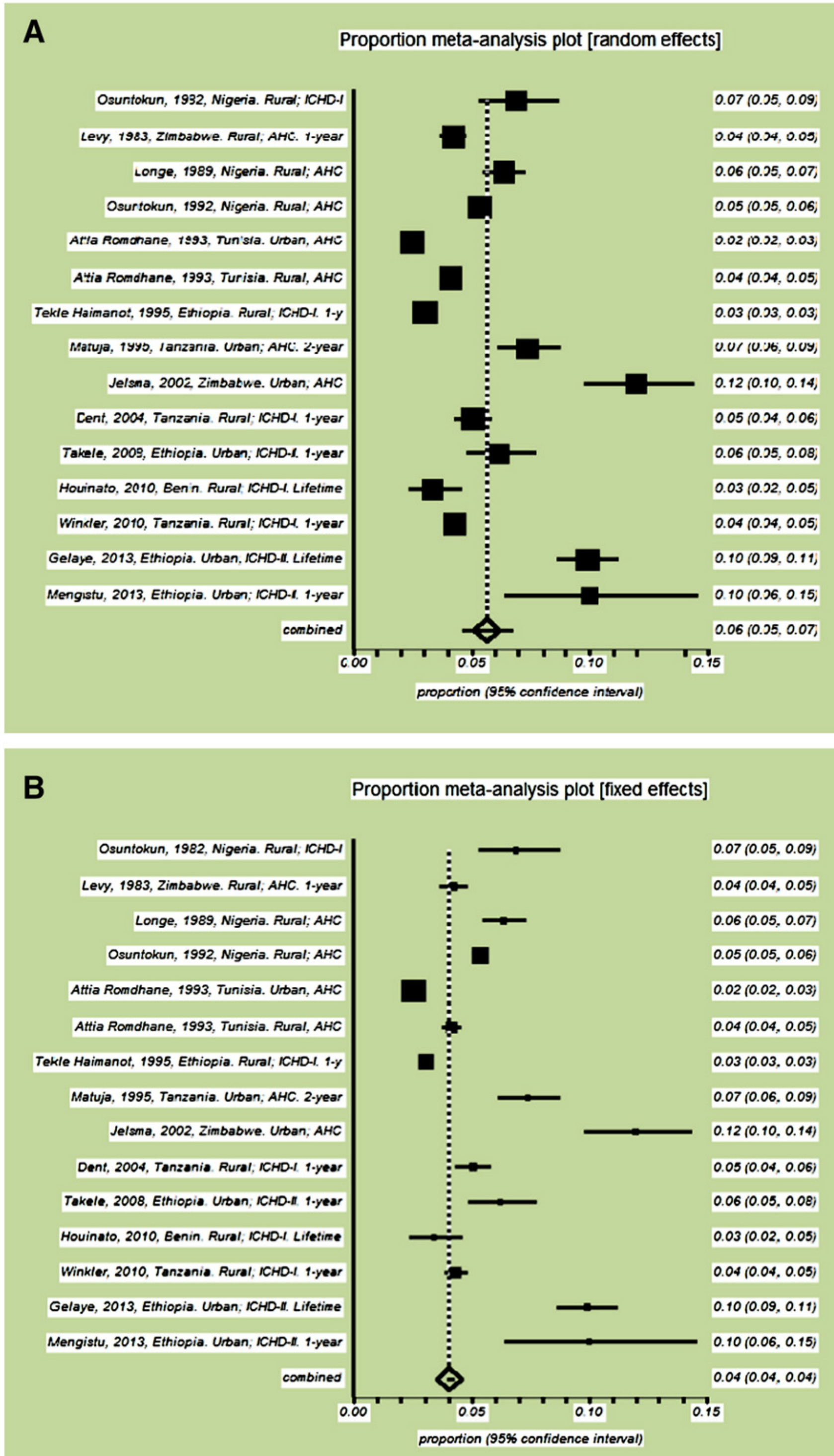


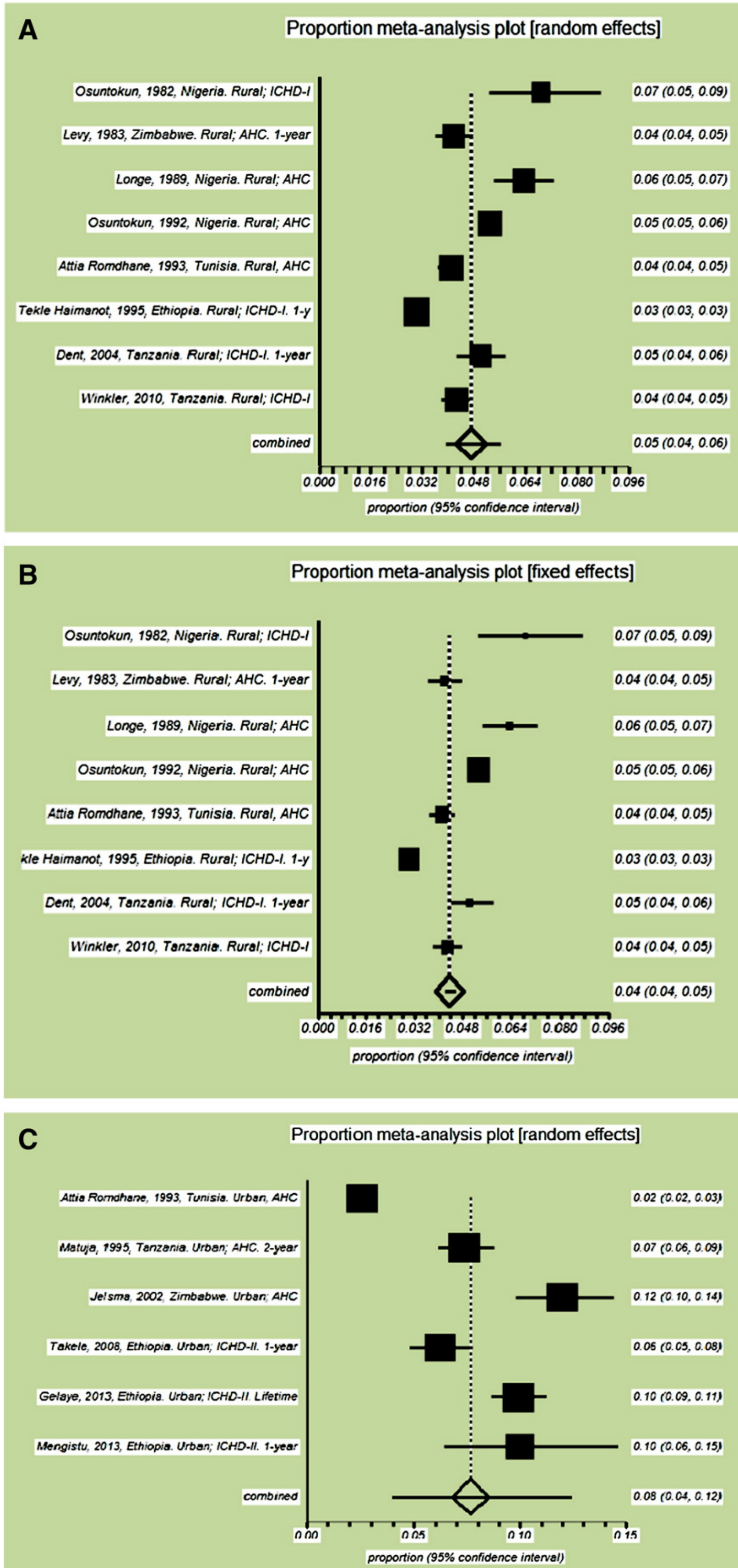
Fig. 4. Migraine prevalence in general population (excluding students). A. Random-effects forest plot meta-analysis (DerSimonian-Laird[13]) revealed general migraine prevalence to be 5.61% (95% CI 4.61, 6.70). The *dark squares* on all forest plots indicate precision of the specific study prevalence; larger dark squares showing higher precision with less uncertainty (narrower confidence) intervals (shown by the *horizontal bar lines*). B. Fixed-effect forest plot meta-analysis (inverse-variance weighted[15]) revealed general migraine prevalence of 4.01% (95% CI 3.89, 4.13). The study by Attia Romdhane et al., 1993[22], reported data from both urban and rural populations and these are reported separately in the current meta-analysis study.

different time points throughout the forty-three year period. Results were analyzed employing statistical software StatsDirect v2.7.9.

6. Results

Table 1 gives detailed description of extracted data that is relevant from the 21 community-based migraine prevalence studies i.e. presented as first author, year of study, country of origin, total number of participants, total number of participants with migraine, male to female ratio of total participants, migraine prevalence and 95% CI among males, females, and in both sexes, weighted effect-size (fixed-, random-effects), study setting, method of headache diagnosis, and study period for prevalence.

Migraine burden is progressively increasing in Africa (Fig. 2A); the highest rise is projected to happen within the next decade to come; this is supported by the 15–29% increase rate in migraine DALYs from


A
Proportion meta-analysis plot [random effects]
Osuntokun, 1982, Nigeria. Rural; ICHD-I
Levy, 1983, Zimbabwe. Rural; AHC. 1-year
Longe, 1989, Nigeria. Rural; AHC
Osuntokun, 1992, Nigeria. Rural; AHC
Attia Romdhane, 1993, Tunisia. Rural, AHC
Tekle Haimanot, 1995, Ethiopia. Rural; ICHD-I. 1-y
Dent, 2004, Tanzania. Rural; ICHD-I. 1-year
Winkler, 2010, Tanzania. Rural; ICHD-I
combined
0.07 (0.05, 0.09)
0.04 (0.04, 0.05)
0.06 (0.05, 0.07)
0.05 (0.05, 0.06)
0.04 (0.04, 0.05)
0.03 (0.03, 0.03)
0.05 (0.04, 0.06)
0.04 (0.04, 0.05)
0.05 (0.04, 0.06)
0.000 0.016 0.032 0.048 0.064 0.080 0.096
proportion (95% confidence interval)
B
Proportion meta-analysis plot [fixed effects]
Osuntokun, 1982, Nigeria. Rural; ICHD-I
Levy, 1983, Zimbabwe. Rural; AHC. 1-year
Longe, 1989, Nigeria. Rural; AHC
Osuntokun, 1992, Nigeria. Rural; AHC
Attia Romdhane, 1993, Tunisia. Rural, AHC
kle Haimanot, 1995, Ethiopia. Rural; ICHD-I. 1-y
Dent, 2004, Tanzania. Rural; ICHD-I. 1-year
Winkler, 2010, Tanzania. Rural; ICHD-I
combined
0.07 (0.05, 0.09)
0.04 (0.04, 0.05)
0.06 (0.05, 0.07)
0.05 (0.05, 0.06)
0.04 (0.04, 0.05)
0.03 (0.03, 0.03)
0.05 (0.04, 0.06)
0.04 (0.04, 0.05)
0.04 (0.04, 0.05)
0.000 0.016 0.032 0.048 0.064 0.080 0.096
proportion (95% confidence interval)
C
Proportion meta-analysis plot [random effects]
Attia Romdhane, 1993, Tunisia. Urban, AHC
Matuja, 1995, Tanzania. Urban; AHC. 2-year
Jelsma, 2002, Zimbabwe. Urban; AHC
Takele, 2008, Ethiopia. Urban; ICHD-II. 1-year
Gelaye, 2013, Ethiopia. Urban; ICHD-II. Lifetime
Mengistu, 2013, Ethiopia. Urban; ICHD-II. 1-year
combined
0.02 (0.02, 0.03)
0.07 (0.06, 0.09)
0.12 (0.10, 0.14)
0.06 (0.05, 0.08)
0.10 (0.09, 0.11)
0.10 (0.06, 0.15)
0.08 (0.04, 0.12)
0.00 0.05 0.10 0.15
proportion (95% confidence interval)

2008–2030. The weight of migraine burden on neurological DALYs is similarly projected to increase from 4.87% in 2008 to 5.20% in 2030 (Fig. 3). Pooled migraine burden as of neurological disorders was found to be 5.08% (95% CI 4.86%, 5.31%) using both random effects (DerSimonian-Laird [13]) and fixed effects (inverse-variance [15]) meta-analysis models (Fig. 3). In Africa, population-based migraine burden increase rate is projected to be higher than the trend in regional population growth rate. Urban population growth rate, i.e. urbanization, is expected to happen at faster rate than that of rural population growth rate [16] (Fig. 2B).

Among 14 rural and urban community-based studies included (n = 130,406), random-effect meta-analysis revealed pooled migraine crude prevalence in the general population to be 5.61% (95% CI 4.61, 6.70) (Fig. 4). Migraine was more prevalent in females than in males within both the general population and student cohorts combined, with a weighted odds ratio of 2.06 (95% CI 1.69, 2.50; $p < 0.0001$; random-effects forest plot meta-analysis (Der-Simonian Laird [13]) (Fig. 9). Between the rural and urban studies, the urban population of both sexes had higher prevalence [7.60 (3.91, 12.37)] (Fig. 5) compared to that of the rural [4.75 (3.95, 5.61)] (Fig. 5). Females of both urban and rural residency had a higher prevalence for migraine compared to males of both urban and rural residency (Figs. 5 and 6), however migraine was more prevalent in urban females (Fig. 7) compared to rural females (Fig. 6). Comparison of prevalence between lifetime versus one-year time period (Fig. 10A–G) revealed closely comparable prevalence.

Community-based studies which were conducted in urban and rural environment revealed lower migraine prevalence compared to studies performed in the student population; hence, the latter (n = 6871) were analyzed separately. Among student cohorts, pooled migraine prevalence employing random-effect meta-analysis (Der-Simonian Laird [13]) was found to be 14.95% (95% CI 9.99, 20.67) (Fig. 8). Female students showed the highest migraine burden with weighted prevalence (random-effects, Der-Simonian Laird [13]) of 18.29% (95% CI 13.13, 24.11) (Fig. 5a). Similarly, female-to-male random-effects weighted OR showed that female students carried highest risk of having migraine [2.13 (1.34, 3.37; $p = 0.0013$)].

Table 2 summarizes important results displayed on the forest plots from Figs. 3–8. Migraine burden sequentially increased in the following manner:

- rural males [3.03 (1.95, 4.35); Fig. 6A]
- rural population of both sexes [4.75 (3.95, 5.61); Fig. 5A and B]
- urban males [5.14 (2.62, 8.44); Fig. 7A]
- all males of rural, urban, and student cohorts [5.15 (3.81, 6.67); Fig. 9a and b]
- rural females [5.81 (4.87, 6.83); Fig. 6B]
- urban population of both sexes [7.60 (3.91, 12.37); Fig. 5C and D]
- male students [9.40 (6.24, 13.13); Fig. 8C]
- urban females [9.83 (4.56, 16.82); Fig. 7B]
- all females of rural, urban, and student cohorts [9.83 (8.00, 11.82); Fig. 9c and d]
- students of both sexes [14.95 (10.00, 20.69); Fig. 8A and B]
- female students [18.29 (13.13, 24.11); Fig. 8D]

7. Discussion

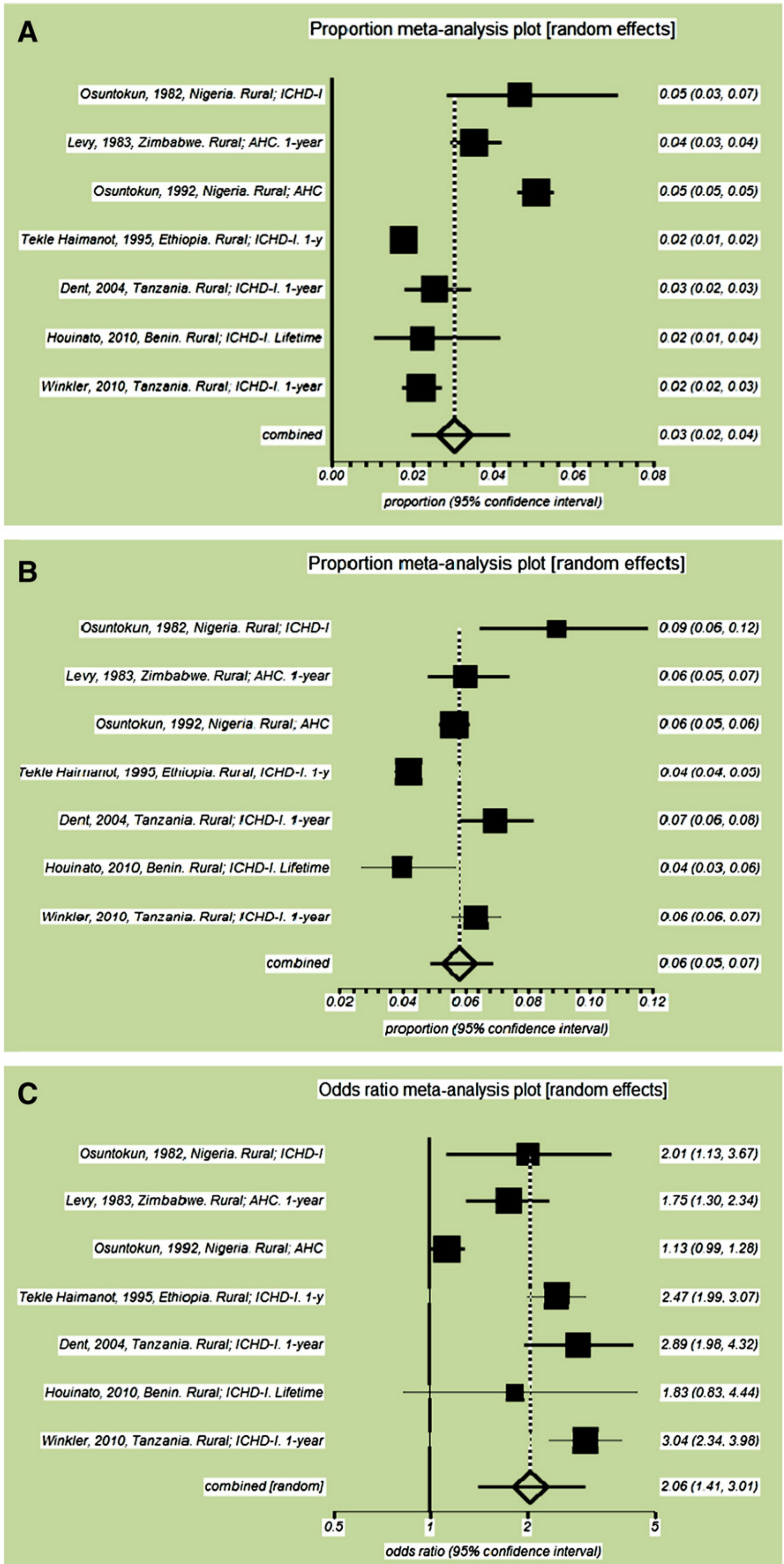
The current study demonstrated for the first time, that migraine burden in Africa is projected to increase by more than 10% within the next decade, with persistent weight on neurological burden. By virtue of its chronification, increased morbidity and accrued disability, migraine results in higher amount of YLDs and DALYs. In 2010, migraine alone ranked as 8th most common cause of YLDs [4]. Considering Africa's current rapidly growing total population to be over 1 billion [16], a crude pooled migraine prevalence of 5.61% can roughly estimate 56 million active migraine sufferers in the region; this needs to be stratum-adjusted to known demographic predictors of specific age-groups, gender, study setting, and variability of diagnostic method – as elucidated by the modest combinability among the different studies. During the last 50 years, urbanization rate in Africa has nearly tripled, from 14.4% in 1950 to 39.2% in 2010 [16]; this coupled with the region's higher adolescent and youth demographics makes migraine an important public health problem. Among the studies included within this meta-analysis, urban–rural heterogeneity manifested more evidently than intra-urban and intra-rural heterogeneity – reflected by higher burden among urban inhabitants. However, it remains difficult to rule out the possibility of lower self-report recall rates, differing cultural pain presentation, lower headache awareness, and other more pressing public health problems than headache which make headache burden measurement more difficult.

Some community-based studies in North America have shown higher migraine prevalence among Caucasians as compared to African- and Asian-Americans [36,37]; similar to ethnicity prevalence differences in England, UK [38]. Gender-specific prevalence follows what has been previously reported by various studies – reminding that females are at increased risk. Of all comparisons made within this meta-analysis, the highest risk for migraine prevalence was found among high school and university female students. This variance is likely to reflect hormonal changes that occur in adolescent females and different level of coping with stress e.g. to academic performance – since stress is a known migraine trigger. Female brains have lower threshold for cortical spreading depression (CSD) which accompanies migraine attacks [39]. Migraine prevalence has been found to be consistently high among female students in other studies from non-African regions [40–42]. Unhealthy lifestyle changes [43,44], inadequate sleep hygiene [45,46], physical inactivity [47], and circadian fluctuations [45] are known predictors. Putative causalities for such gender-difference have been suggested to be multifactorial, ranging from genetic to hormonal and environmental factors. Upon juxtaposition of cohorts in the current epidemiological community-based meta-analysis, urban residence, studentship (particularly female students), recent urban community-based studies, and female-gender are found to be to be important determinants in our study. The two ends of migraine prevalence in Africa revealed rural males to have the lowest burden on one end, while on the other end female students had the highest burden. Addressing migraine among students can help improve academic performance. Recent studies from migraine-burdened settings in western countries report similar gender-differences; results from the American Migraine Prevalence and Prevention Studies showed migraine to be present in 17.3% of females and 5.7% of males [48]. Lack of exercise, being overweight, and smoking were found to be independently associated with recurrent headache among adolescent females [49]. Meta-ethnographic analysis of longitudinal cohort studies among female adolescent students can provide qualitative descriptions specific to unfavorable behavioral and lifestyle changes. Based on the trend of the included studies within this meta-analysis, migraine prevalence among African urban residents has been progressively rising over the past decade; this needs to be followed closely and befitting interventions planned accordingly e.g. urban well-being programs and healthy lifestyle modifications.

By 2030, Africa will have a projected 10% increase in migraine burden; this indicates the urgent need for better clinical measurements, understanding, improved education, and management of migraine in Africa. Peculiarities of the African socio-demography setting include a

Fig. 5. Migraine prevalence in urban and rural population. A. Random-effects forest plot meta-analysis (Der-Simonian Laird[13]) revealed migraine prevalence among rural inhabitants of both sexes to be 4.74% (95% CI 3.95, 5.61). B. Fixed-effects forest plot meta-analysis (inverse-variance weighted[15]) revealed migraine prevalence among rural inhabitants of both sexes to be 4.34% (95% CI 4.19, 4.50). C. Random-effects forest plot meta-analysis (Der-Simonian Laird[13]) revealed migraine prevalence among urban inhabitants of both sexes to be 7.60% (95% CI 3.91, 12.37).

rapidly growing population – mainly among the younger working age group. In 2010, 34% of Africans were aged between 25 and 59. By 2050, this number is expected to reach 892 million people – representing 45% of African population [9]. This will create a dramatic shift within the global workforce, with Africa likely to replace China and India as principal contributor to global labor market. Disabling



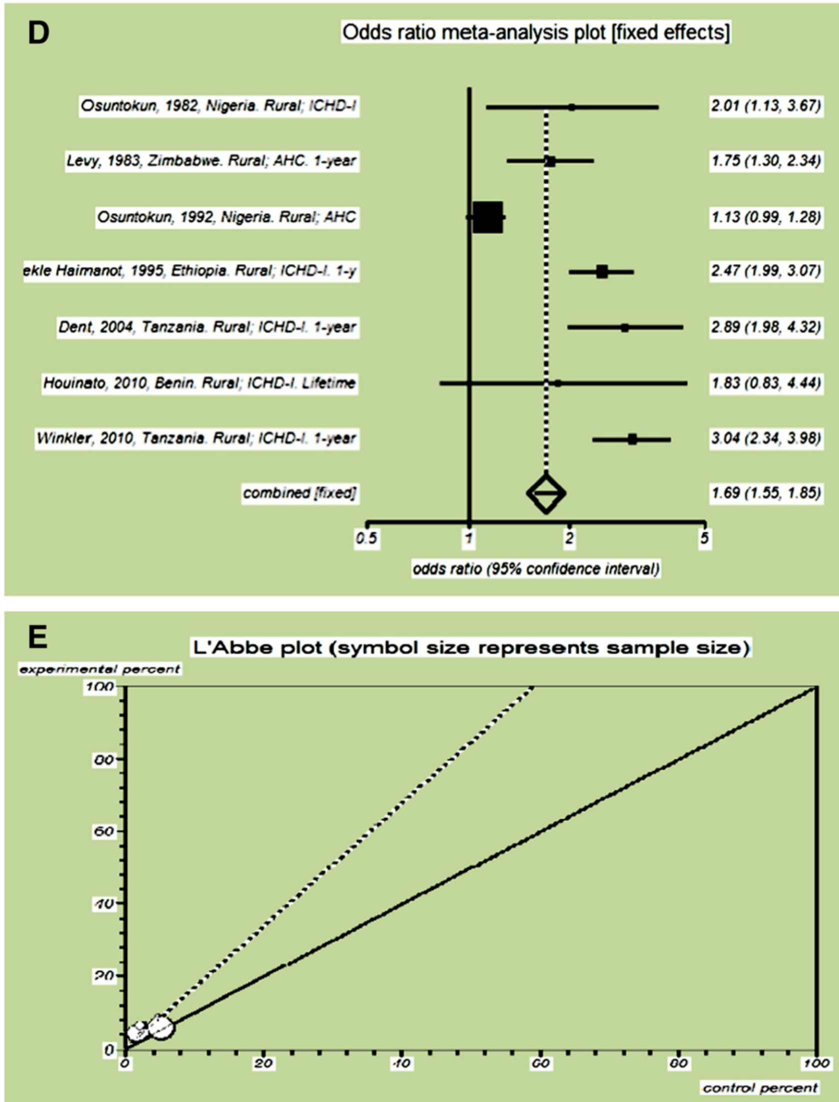
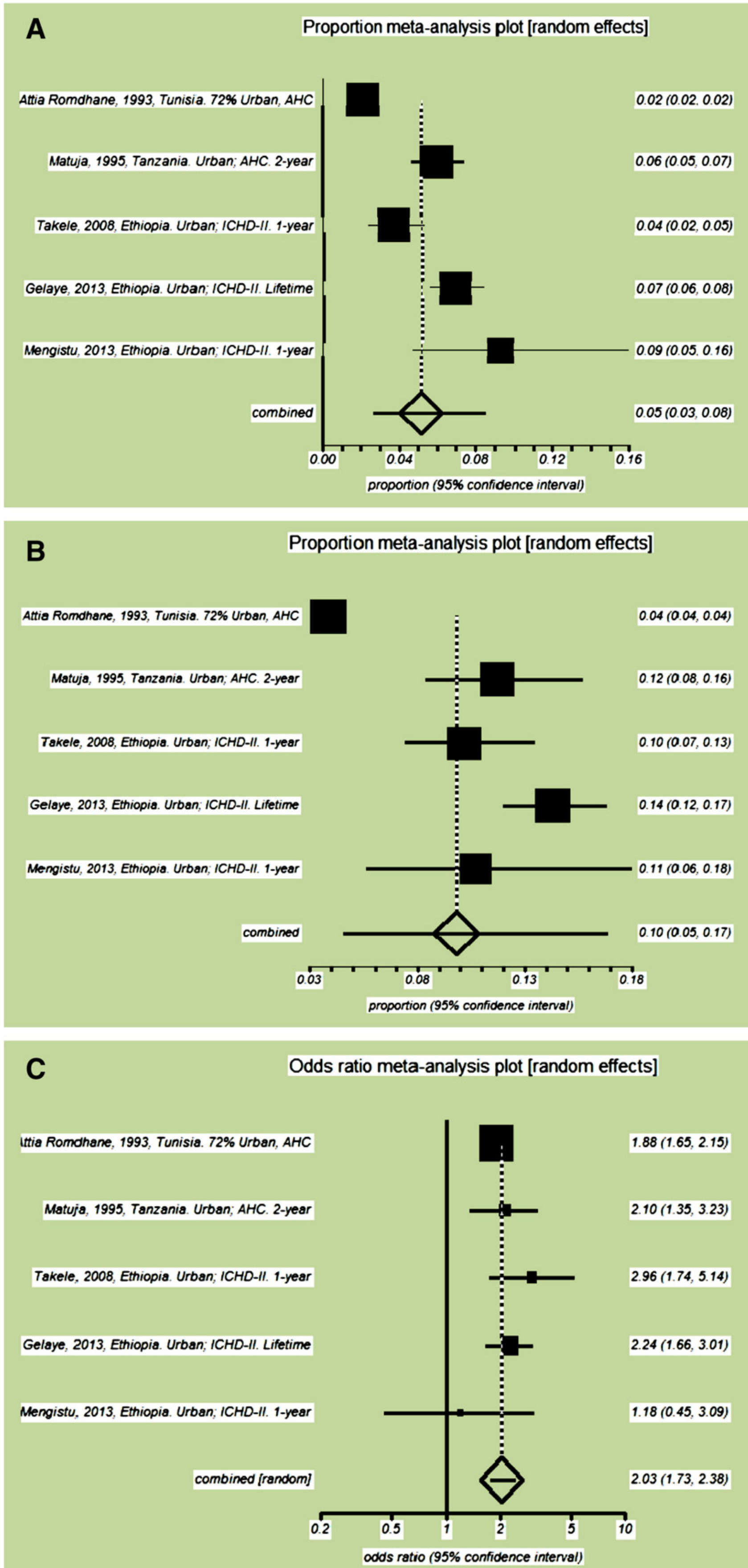


Fig. 6. Migraine prevalence in male and female rural population. A. Random-effects forest plot meta-analysis (Der-Simonian Laird[13]) revealed migraine prevalence among rural males to be 3.03% (95% CI 1.95, 4.35). B. Random-effects forest plot meta-analysis (Der-Simonian Laird[13]) revealed migraine prevalence among rural females to be 5.81% (95% CI 4.87, 6.83). C. Random-effects forest plot meta-analysis (Der-Simonian Laird[13]) revealed OR for migraine prevalence among rural females to be 2.06 (95% CI 1.41, 3.01; $p < 0.0002$) as compared to rural males. D. Fixed-effects forest plot meta-analysis (inverse-variance weighted[15]) revealed migraine prevalence among rural females to have OR of 1.69 (95% CI 1.55, 1.85; $p < 0.0001$) compared to rural males. E. L'Abbe´ plot. Event rate (%) of migraine prevalence among rural females (y-axis) plotted against that among all rural males (x-axis) to help explore heterogeneity of effect estimates. Each circle represents an individual study with bigger circles representing larger sample sizes. Solid diagonal line indicates that the prevalence of migraine in rural females is identical to that in males. The *dotted line* can be referred to as *'the overall pooled OR line'*. Female gender represented a higher risk for migraine, i.e., *dotted line* shifting above the *solid line.*

chronic disorders such as migraine which mainly afflict the younger age group and people at their peak productive years need to be given due attention so as to couple this population growth with parallel economic productivity. In the US, migraine alone has been estimated to cost American employers about $13 billion annually because of missed workdays and impaired work function [50]. Migraine, by virtue of attacking and disabling the younger, working, and productive population, tends to cause significant public health burden with far-reaching economic consequences. Two recent studies among Ethiopian urban dwellers showed higher migraine prevalence of 10% [34,35]; one study further revealed increased risk of migraine in people with stress and unipolar psychiatric symptoms [34]. Another study has shown that depression and anxiety disorders were found to be more associated to the frequency of both migrainous and non-migrainous headaches than exclusively to the presence of migraine or other types of headache [51]. It is important to note that the migraine burden weight meta-analyzed in this study represents computation for migraine alone, as there is paucity of community-based studies conducted on the prevalence of other headache disorders in Africa. If other forms of primary and secondary headaches were included, it would have resulted in a greater magnitude. Common secondary headaches seen in African clinics include neuroinfections of malaria and meningitis, where early and accurate diagnosis is lifesaving.

Fixed-effects model assumes resemblance of factors that can influence proportions among the different studies and timepoints; this allows generalizability of the pooled results. Random-effects permits factoring of timepoint setting covariates from one study to another. Although both approaches were used in our study, we reported results from the latter to allow factoring of study variations within the meta-analysis. Despite the fact that the selected studies operated independently at different periods, similarity of African study settings which is characterized by ongoing limited health access, inadequate public awareness, poor basic infrastructures, and related facilities can generate comparable factors affecting central measures of migraine prevalence burden employed within this in-depth meta-analysis. Regional representativeness is found to be adequate within the included community-based studies.


A
Proportion meta-analysis plot [random effects]
Attia Romdhane, 1993, Tunisia. 72% Urban, AHC
0.02 (0.02, 0.02)
Matuja, 1995, Tanzania. Urban; AHC. 2-year
0.06 (0.05, 0.07)
Takele, 2008, Ethiopia. Urban; ICHD-II. 1-year
0.04 (0.02, 0.05)
Gelaye, 2013, Ethiopia. Urban; ICHD-II. Lifetime
0.07 (0.06, 0.08)
Mengistu, 2013, Ethiopia. Urban; ICHD-II. 1-year
0.09 (0.05, 0.16)
combined
0.05 (0.03, 0.08)
0.00 0.04 0.08 0.12 0.16
proportion (95% confidence interval)
B
Proportion meta-analysis plot [random effects]
Attia Romdhane, 1993, Tunisia. 72% Urban, AHC
0.04 (0.04, 0.04)
Matuja, 1995, Tanzania. Urban; AHC. 2-year
0.12 (0.08, 0.16)
Takele, 2008, Ethiopia. Urban; ICHD-II. 1-year
0.10 (0.07, 0.13)
Gelaye, 2013, Ethiopia. Urban; ICHD-II. Lifetime
0.14 (0.12, 0.17)
Mengistu, 2013, Ethiopia. Urban; ICHD-II. 1-year
0.11 (0.06, 0.18)
combined
0.10 (0.05, 0.17)
0.03 0.08 0.13 0.18
proportion (95% confidence interval)
C
Odds ratio meta-analysis plot [random effects]
Attia Romdhane, 1993, Tunisia. 72% Urban, AHC
1.88 (1.65, 2.15)
Matuja, 1995, Tanzania. Urban; AHC. 2-year
2.10 (1.35, 3.23)
Takele, 2008, Ethiopia. Urban; ICHD-II. 1-year
2.96 (1.74, 5.14)
Gelaye, 2013, Ethiopia. Urban; ICHD-II. Lifetime
2.24 (1.66, 3.01)
Mengistu, 2013, Ethiopia. Urban; ICHD-II. 1-year
1.18 (0.45, 3.09)
combined [random]
2.03 (1.73, 2.38)
0.2 0.5 1 2 5 10
odds ratio (95% confidence interval)

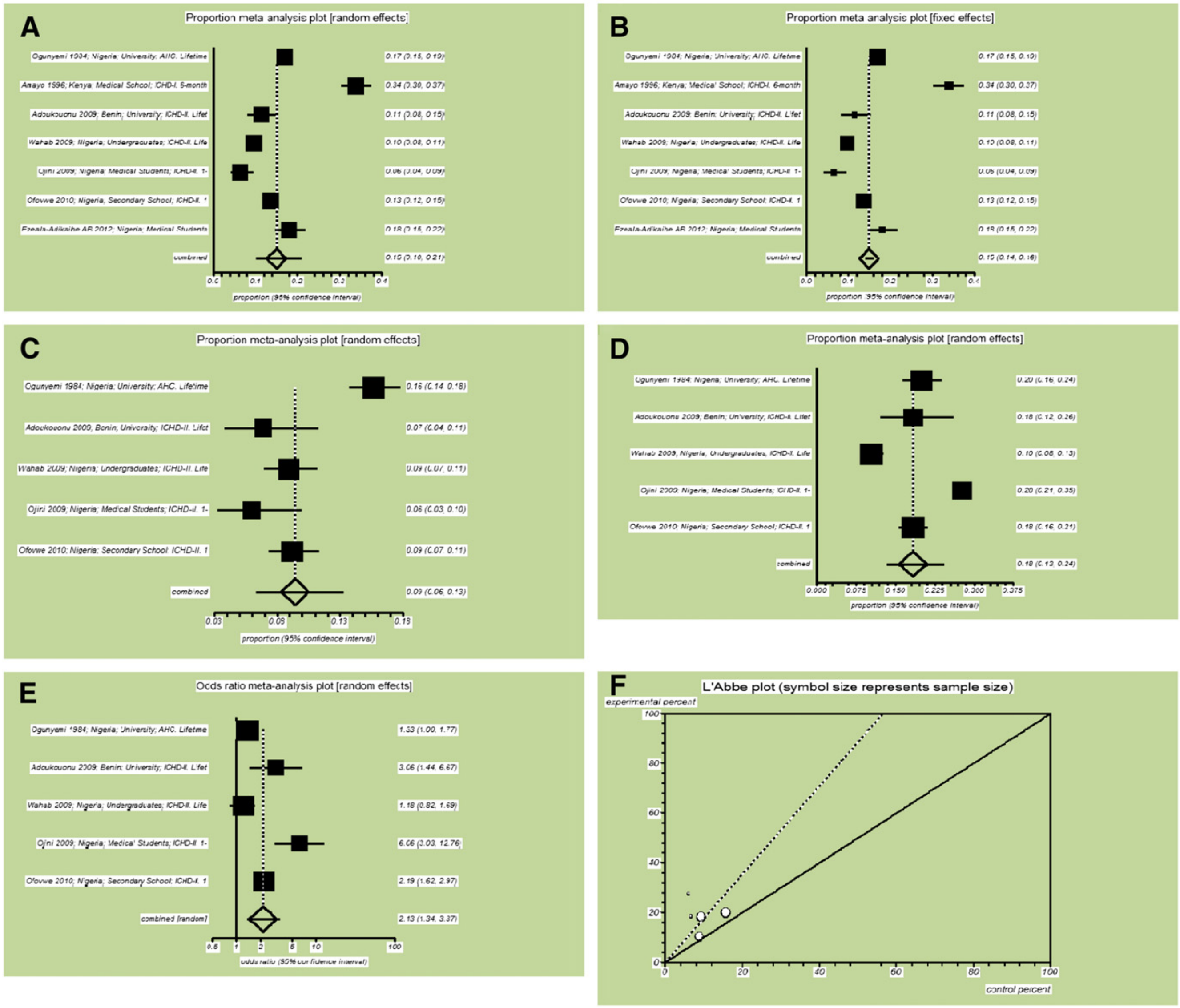


Fig. 8. Migraine prevalence among student population: A. Random-effects forest plot meta-analysis (Der-Simonian Laird[13]) revealed migraine prevalence among students of both sexes (high school, undergraduates, and medical school) to be 14.95% (95% CI 10.00, 20.67). B. Fixed-effects forest plot meta-analysis (inverse-variance weighted[15]) revealed migraine prevalence among students of both sexes (high school, undergraduates, and medical school) to be 14.89% (95% CI 14.06, 15.74). C. Random-effects forest plot meta-analysis (Der-Simonian Laird[13]) revealed migraine prevalence among male students to be 9.40 (95% CI 6.24, 13.13). D. Random-effects forest plot meta-analysis (Der-Simonian Laird[13]) revealed migraine prevalence among female students to be 18.30 (95% CI 13.13, 24.11). E. Random-effects forest plot meta-analysis (Der-Simonian Laird[13]) revealed OR for migraine prevalence among female students to be 2.13 (95% CI 1.34, 3.37; $p < 0.0013$), higher than Fig. 7b (all females), and Fig. 10c (urban females), Fig. 9a–c (rural females). F. L'Abbe´ plot. Event rate (%) of migraine prevalence among female students (y-axis) plotted against that among male students (x-axis) to help explore heterogeneity of effect estimates. Each circle represents an individual study with bigger circles representing larger sample sizes. Solid diagonal line indicates that the prevalence of migraine in female students is identical to that in males. The *dotted line* can be referred to as *'the overall pooled OR line'*. Female gender represented a higher risk for migraine, i.e., *dotted line* shifting above the *solid line*.

Interpretations of results from chronic pain studies (e.g. headache disorders) need to be made within the context of inter-cultural variations in tolerability of pain perception in Africa compared with regions in the Western hemisphere. In a continent where diseases are largely perceived in a religious-animistic insight, and where local traditional healers play important and early catchment role, burden measurements of headache disorders need careful understanding. Primary headache disorders are characterized by chronification, further worsening YLDs and lowering economic productivity owing to lost work and school hours; hence, headache problems need to be properly addressed because such measures can lead to enormous long-term cost-benefit and progressive development.

Although most studies followed the diagnostic criteria suggested by the International Headache Society [52,53], it is important to consider some inconsistency of diagnostic tools used among the community-based studies in relation to systematic inter-study heterogeneity between the prevalence values. All studies included within this systematic review arise from door-to-door non-clinical population, employing 'cold-calling' recruitment methods at randomly selected households and participants; this provides a sentinel for estimating true

Fig. 7. Migraine prevalence in male and female urban population: A. Random-effects forest plot meta-analysis (Der-Simonian Laird[13]) revealed migraine prevalence among urban males to be 5.14% (95% CI 2.62, 8.44). B. Random-effects forest plot meta-analysis (Der-Simonian Laird[13]) revealed migraine prevalence among urban females to be 9.83% (95% CI 4.56, 16.82). C. Random-effects forest plot meta-analysis (Der-Simonian Laird[13]) revealed OR for migraine prevalence among urban females to be 2.03 (95% CI 1.73, 2.38; $p < 0.0001$) as compared to urban males.

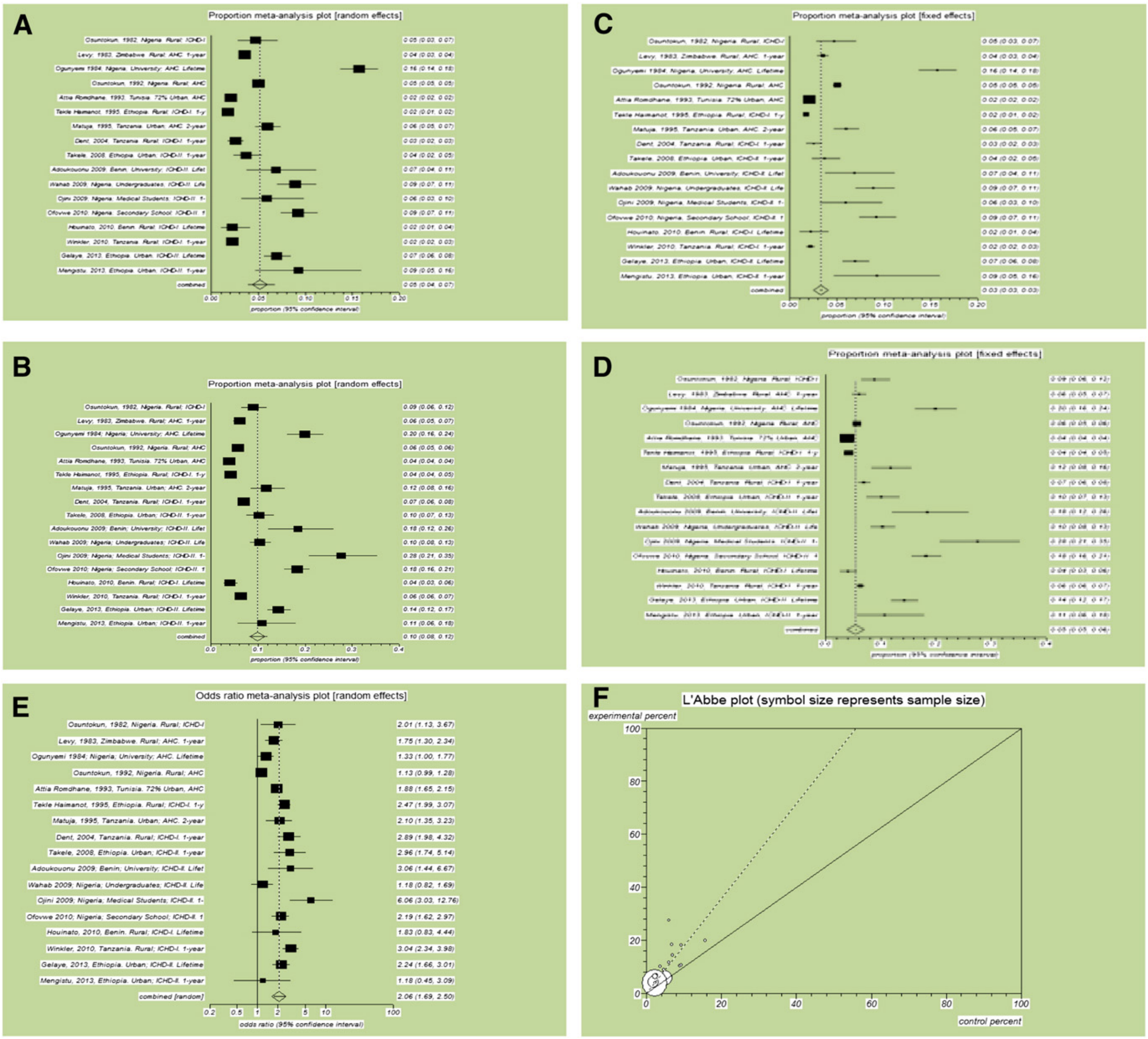


Fig. 9. A. Random-effects forest plot meta-analysis (Der-Simonian Laird[13]) revealed migraine prevalence among all male cohorts (urban, rural, and students) to be 5.15% (95% CI 3.81, 6.67). B. Fixed-effects forest plot meta-analysis (inverse-variance weighted[15]) revealed migraine prevalence among all males (rural, urban, and students) to be 3.29% (95% CI 3.13, 3.44). C. Random-effects forest plot meta-analysis (Der-Simonian Laird[13]) revealed migraine prevalence among all females (rural, urban, and students) to be 9.83 (95% CI 8.00, 11.82). D. Fixed-effects forest plot meta-analysis (inverse-variance weighted[15]) revealed migraine prevalence among all females (rural, urban, and students) to be 5.40% (95% CI 5.20, 5.60). E. Random-effects forest plot meta-analysis (Der-Simonian Laird[13]) showed weighted OR for females (urban, rural, and students) with migraine to be 2.06 (95% CI 1.69, 2.50; $p < 0.0001$, i.e., tests OR differs from '1'), as compared to males. F. L'Abbe´ plot. Event rate (%) of migraine prevalence among all females (y-axis) plotted against that among all males (rural, urban, and students), to help explore heterogeneity of effect estimates. Each circle represents an individual study with bigger circles representing larger sample sizes. Solid diagonal line indicates that the prevalence of migraine in females is identical to that in males. The *dotted line* can be referred to as *'the overall pooled OR line'*. Female gender represented a higher risk for migraine, i.e., *dotted line* shifting above the *solid line*.

population-based migraine prevalence. Recently, it has been shown that migraine carries similar stigma to that of epilepsy [54]. Long-term follow-up studies have revealed increased risk of comorbidity of metabolic syndrome among migraineurs [55]. Keeping with previous studies, identification of migraine causation remains multi-factorial and continued critical appraisal of community-based studies can help reveal further understanding. There is no single magic bullet for migraine prevention, however combination of different lifestyle factors are relevant in addressing and reducing its burden.

Africa is home to the earliest civilization where specific migraine references have been made by physicians such as Imhotep from Kemet (Ancient Egypt); the continent needs to have accurate migraine burden measurement and evidence-driven recommendations for beneficial change in care and education delivery. Addressing this emerging public health problem within the subtext of rapid urbanization and non-communicable diseases [56] will undoubtedly reassure Africa to profit from its demographic shift endowment - where favorable outcomes of sustained economic growth can be harnessed. Equally so do measures to address migraine and its accrued disability, in countries laden with tropical diseases and burgeoning western diseases.

8. Conclusion

In Africa, migraine is a common disorder among the youth, urban residents, and female students. Recent studies further indicate a rapid increase in migraine prevalence within the coming decades.

This calls for improvement of ongoing low awareness, low information on societal impact, and low quality of care delivery at primary health units and facilities where lengthy referrals culminate. Promoting access points for early headache management at community-level, developing health infra-structure, and training and research at facility-level can help reduce this multi-faceted problem. Urban wellness and healthy lifestyle modification to address such non-communicable causes of emerging disease burden in Africa should receive due attention. Reducing causes of chronic disability will undoubtedly sustain economic productivity.

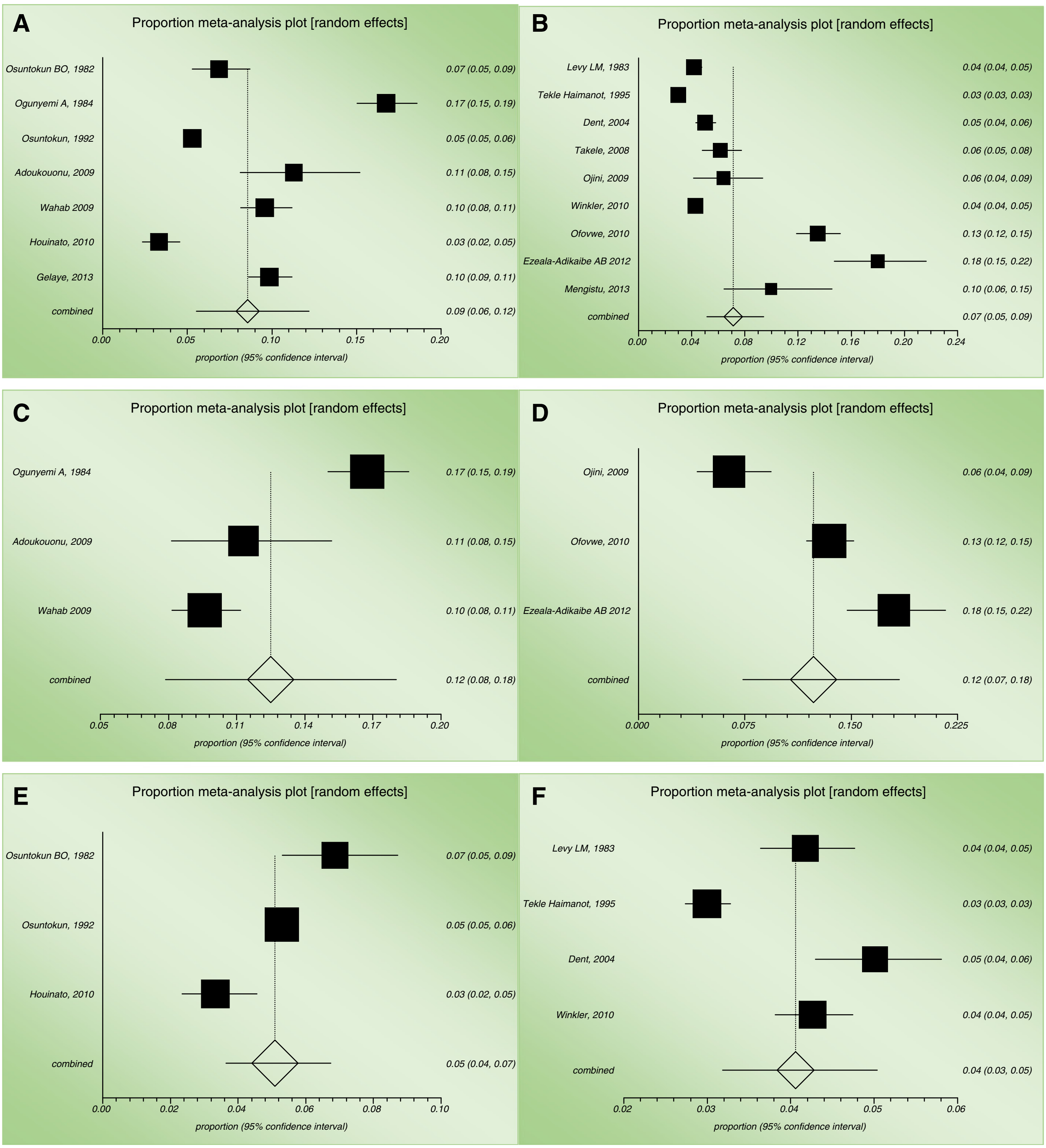


Fig. 10. Comparison between lifetime *vs* one-year prevalence among the different studies. A. Prevalence was 8.58 (5.54, 12.20; DerSimonian-Laird) among studies conducted for prevalence during lifetime period. B. Prevalence was 7.13 (5.14, 9.42; DerSimonian-Laird) among studies conducted for prevalence during one-year period. C. Prevalence was 12.50 (7.87, 18.02; DerSimonian-Laird) among studies on student cohorts conducted for prevalence during lifetime period. D. Prevalence was 12.34 (7.34, 18.40; DerSimonian-Laird) among studies on student cohorts conducted for prevalence during one-year period. E. Prevalence was 5.08 (3.65, 6.75; DerSimonian-Laird) among studies from rural settings conducted for prevalence during lifetime period. F. Prevalence was 4.06 (3.19, 5.04; DerSimonian-Laird) among studies on rural settings conducted for prevalence during one-year period. G. Bar chart displaying lifetime *vs* one-year prevalence comparisons.

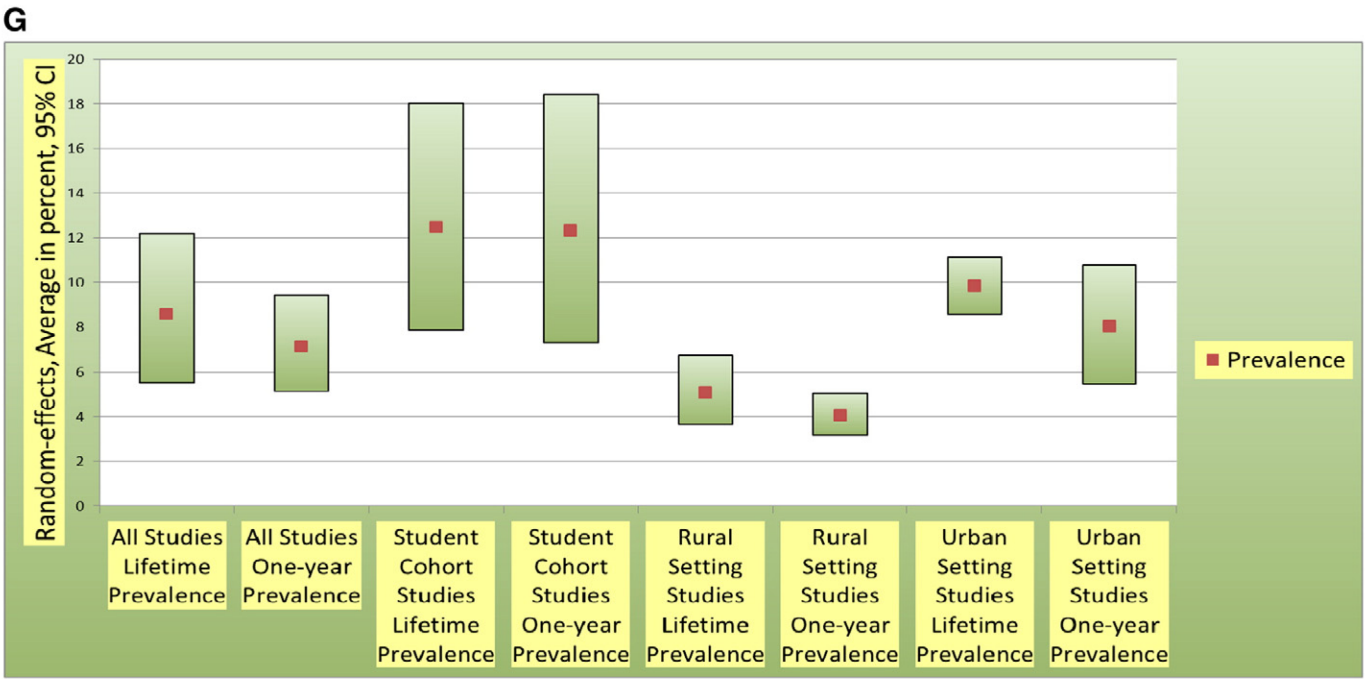


Fig. 10 (*continued*).

Table 2
Pooled migraine prevalence and pooled odds ratio female-to-male burden comparison among different population cohorts.

	Population	Random-effects weighted prevalence and 95% CI	Females-to-Males pooled odds ratio (OR) (random-effects weighted and 95% CI)
Urban and rural cohort	General population (Rural + Urban); Both sexes	5.61 (4.61, 6.70)	
Students cohort	Both sexes	14.95 (10.00, 20.69)	
Rural population	Both sexes	4.75 (3.95, 5.61)	
Urban population	Both sexes	7.60 (3.91, 12.37)	
Rural + urban + students	Males	5.15 (3.81, 6.67)	
Rural + urban + students	Females	9.83 (8.00, 11.82)	2.06 (1.69, 2.50; $p < 0.0001$; Fig. 7a and b]
Rural	Males	3.03 (1.95, 4.35)	
Rural	Females	5.81 (4.87, 6.83)	2.06 (1.41, 3.01; $p = 0.0002$;
Urban	Males	5.14 (2.62, 8.44)	
Urban	Females	9.83 (4.56, 16.82)	2.03 (1.73, 2.38; $p = 0.0001$;
Students	Males	9.40 (6.24, 13.13)	
Students	Females	18.29 (13.13, 24.11)	2.13 (1.34, 3.37; $p = 0.0013$;

High migraine burden was found among female students and female urban inhabitants. Urban–rural differences were notable, particularly among female cohorts. Similarly, when studying both sexes, students and urban inhabitants were found to have higher burden.

9. Clinical relevance summaries

- With an estimated 5.61% prevalence among general population, migraine afflicts nearly 56 million people in Africa. Higher prevalence was found among recent urban studies and female student cohorts; this indicates the need to improve lifestyle modification among urban residents, and school- and college-goers to maintain urban economic productivity and academic performance, respectively.
- That African population is primarily within the working-age younger demographics indicates that migraine not only causes high medical disability but also greater socioeconomic consequences.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Conflict of interests

The Authors declare that there is no conflict of interest.

References

[1] The International Classification of Headache Disorders, 3rd edition (beta version). Cephalalgia 2013;33(9):629–808 (Epub 2013/06/19).
[2] Goadsby PJ. Recent advances in understanding migraine mechanisms, molecules and therapeutics. Trends Mol Med 2007;13(1):39–44 (Epub 2006/12/05).
[3] Lipton RB, Bigal ME. The epidemiology of migraine. Am J Med 2005;118(Suppl. 1):3S–10S (Epub 2005/04/22).
[4] Vos T, Flaxman AD, Naghavi M, Lozano R, Michaud C, Ezzati M, et al. Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet 2012;380(9859):2163–96 (Epub 2012/12/19).
[5] WHO. The global burden of disease: 2004 update; 2008.
[6] Tekle Haimanot R, Seraw B, Forsgren L, Ekbom K, Ekstedt J. Migraine, chronic tension-type headache, and cluster headache in an Ethiopian rural community. Cephalalgia 1995;15(6):482–8 (Epub 1995/12/01).

[7] Osuntokun BO, Adeuja AO, Nottidge VA, Bademosi O, Alumide AO, Ige O, et al. Prevalence of headache and migrainous headache in Nigerian Africans: a community-based study. East Afr Med J 1992;69(4):196–9 (Epub 1992/04/01).
[8] WHO. Atlas of headache disorders and resources in the world 2011 A collaborative project of World Health Organization and Lifting The Burden; 2011.
[9] WorldBank. Population Estimates and Projections. ([cited 2014 March 21]; Available from:) http://datatopics.worldbank.org/hnp/popestimates#edu; 2012.
[10] Fineberg NA, Haddad PM, Carpenter L, Gannon B, Sharpe R, Young AH, et al. The size, burden and cost of disorders of the brain in the UK. J Psychopharmacol Sep. 2013;27(9):761–70 (Epub 2013/07/26).
[11] Stokes M, Becker WJ, Lipton RB, Sullivan SD, Wilcox TK, Wells L, et al. Cost of health care among patients with chronic and episodic migraine in Canada and the USA: results from the International Burden of Migraine Study (IBMS). Headache 2011;51(7):1058–77 (Epub 2011/07/19).
[12] Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med 2009;6(7):e1000097 (Epub 2009/07/22).
[13] DerSimonian R, Kacker R. Random-effects model for meta-analysis of clinical trials: an update. Contemp Clin Trials 2007;28(2):105–14 (Epub 2006/06/30).
[14] WHO. Health statistics and health information systems. Previous disease/injury and risk factors estimates. [cited 2014 March 21]; Available from: http://www.who.int/healthinfo/global_burden_disease/estimates_previous/en/index.html; 2013.
[15] Hedges LV, Pigott TD. The power of statistical tests in meta-analysis. Psychol Methods 2001;6(3):203–17 (Epub 2001/09/26).
[16] UN. United Nations, Department of Economic and Social Affairs, Population Division (2013). World Population Prospects: The 2012 Revision. World Population Prospects: The 2012 Revision. [cited 2014 March 21]; Available from: http://esa.un.org/unpd/wpp/Excel-Data/population.htm; 2012.
[17] Osuntokun B, Schoenberg B, Nottidge V, Adeuja A, Kale O, Adeyefa A, et al. Migraine Headache in a Rural Community in Nigeria: Results of a Pilot Study. Neuroepidemiology 1982;1(1):31–9.
[18] Levy LM. An epidemiological study of headache in an urban population in Zimbabwe. Headache 1983;23(1):2–9 (Epub 1983/01/01).
[19] Ogunyemi A. Prevalence of headache among Nigerian university students. Headache 1984;24(3):127–30.
[20] Longe AC, Osuntokun BO. Prevalence of migraine in Udo, a rural community in southern Nigeria. East Afr Med J 1988;65(9):621–4 (Epub 1988/09/01).
[21] Attia Romdhane N, Ben Hamida M, Mrabet A, Larnaout A, Samoud S, Ben Hamda A, et al. Prevalence study of neurologic disorders in Kelibia (Tunisia). Neuroepidemiology 1993;12(5):285–99 (Epub 1993/01/01).
[22] Matuja WB, Mteza IB, Rwiza HT. Headache in a nonclinical population in Dar es Salaam, Tanzania. A community-based study. Headache 1995;35(5):273–6 (Epub 1995/05/01).
[23] Amayo E, Jowi J, Njeru E. Migraine headaches in a group of medical students at the Kenyatta National Hospital, Nairobi. East Afr Med J 1996;73(9):594–7.
[24] Jelsma J, Mielke J, Powell G, De Weerdt W, De Cock P. Disability in an urban black community in Zimbabwe. Disabil Rehabil 2002;24(16):851–9 (Epub 2002/11/27).
[25] Dent W, Spiss H, Helbok R, Matuja W, Scheunemann S, Schmutzhard E. Prevalence of migraine in a rural area in South Tanzania: a door-to-door survey. Cephalalgia 2004;24(11):960–6 (Epub 2004/10/16).
[26] Takele GM, Tekle Haimanot R, Martelletti P. Prevalence and burden of primary headache in Akaki textile mill workers, Ethiopia. J Headache Pain 2008;9(2):119–28 (Epub 2008/02/20).
[27] Adoukonou T, Houinato D, Kankouan J, Makoutode M, Paraiso M, Tehindrazanarivelo A, et al. Migraine among university students in Cotonou (Benin). Headache 2009;49(6):887–93 (discussion 94; Epub 2009/04/25).
[28] Wahab K, Ugheoke A. Migraine: prevalence and associated disability among Nigerian undergraduates. Can J Neurol Sci 2009;36(2):216–21.
[29] Ojini FI, Okubadejo NU, Danesi MA. Prevalence and clinical characteristics of headache in medical students of the University of Lagos, Nigeria. Cephalalgia 2009;29(4):472–7 (Epub 2009/01/28).
[30] Houinato D, Adoukonou T, Ntsiba F, Adjien C, Avode DG, Preux PM. Prevalence of migraine in a rural community in south Benin. Cephalalgia 2010;30(1):62–7 (Epub 2009/06/06).
[31] Winkler AS, Dent W, Stelzhammer B, Kerschbaumsteiner K, Meindl M, Kaaya J, et al. Prevalence of migraine headache in a rural area of northern Tanzania: a community-based door-to-door survey. Cephalalgia 2010;30(5):582–92 (Epub 2009/09/09).
[32] Ofovwe GE, Ofili AN. Prevalence and impact of headache and migraine among secondary school students in Nigeria. Headache 2010;50(10):1570–5 (Epub 2010/10/16).
[33] Ezeala-Adikaibe A, Stella E, Ikenna O, Ifeoma U. Frequency and pattern of headache among medical students at Enugu, South East Nigeria. Niger J Med Apr-Jun 2012;21(2):205–8.
[34] Gelaye B, Peterlin BL, Lemma S, Tesfaye M, Berhane Y, Williams MA. Migraine and psychiatric comorbidities among sub-Saharan African adults. Headache 2013;53(2):310–21 (Epub 2012/10/26).
[35] Mengistu G, Alemayehu S. Prevalence and burden of primary headache disorders among a local community in Addis Ababa, Ethiopia. J Headache Pain 2013;14(1):30 (Epub 2013/04/12).
[36] Lipton RB, Stewart WF, Diamond S, Diamond ML, Reed M. Prevalence and burden of migraine in the United States: data from the American Migraine Study II. Headache 2001;41(7):646–57 (Epub 2001/09/14).
[37] Carson AP, Rose KM, Sanford CP, Ephross SA, Stang PE, Hunt KJ, et al. Lifetime prevalence of migraine and other headaches lasting 4 or more hours: the Atherosclerosis Risk in Communities (ARIC) study. Headache 2004;44(1):20–8 (Epub 2004/02/26).
[38] Steiner T, Scher A, Stewart W, Kolodner K, Liberman J, Lipton R. The prevalence and disability burden of adult migraine in England and their relationships to age, gender and ethnicity. Cephalalgia 2003;23(7):519–27.
[39] Brennan KC, Romero Reyes M, Lopez Valdes HE, Arnold AP, Charles AC. Reduced threshold for cortical spreading depression in female mice. Ann Neurol 2007;61(6):603–6 (Epub 2007/05/03).
[40] Walters AB, Hamer JD, Smitherman TA. Sleep Disturbance and Affective Comorbidity Among Episodic Migraineurs. Headache Jan. 2014;54(1):116–24 (Epub 2013/07/03).
[41] Oztora S, Korkmaz O, Dagdeviren N, Celik Y, Caylan A, Top MS, et al. Migraine headaches among university students using ID Migraine test as a screening tool. BMC Neurol 2011;11:103 (Epub 2011/08/23).
[42] Kobor J, Nyari T, Benedek G, Turi S. Age-related prevalence and features of migraine headache in Hungarian schoolchildren and adolescents. Eur J Paediatr Neurol Nov. 2013;17(6):600–7 (Epub 2013/06/12).
[43] Rasmussen BK. Migraine and tension-type headache in a general population: precipitating factors, female hormones, sleep pattern and relation to lifestyle. Pain 1993;53(1):65–72 (Epub 1993/04/01).
[44] Molarius A, Tegelberg A, Ohrvik J. Socio-economic factors, lifestyle, and headache disorders - a population-based study in Sweden. Headache 2008;48(10):1426–37 (Epub 2008/07/16).
[45] Rains JC. Optimizing circadian cycles and behavioral insomnia treatment in migraine. Curr Pain Headache Rep 2008;12(3):213–9 (Epub 2008/09/18).
[46] Kelman L, Rains JC. Headache and sleep: examination of sleep patterns and complaints in a large clinical sample of migraineurs. Headache 2005;45(7):904–10 (Epub 2005/06/30).
[47] Neususs K, Neumann B, Steinhoff BJ, Thegeder H, Bauer A, Reimers D. Physical activity and fitness in patients with headache disorders. Int J Sports Med 1997;18(8):607–11 (Epub 1998/01/27).
[48] Buse DC, Loder EW, Gorman JA, Stewart WF, Reed ML, Fanning KM, et al. Sex Differences in the Prevalence, Symptoms, and Associated Features of Migraine, Probable Migraine and Other Severe Headache: Results of the American Migraine Prevalence and Prevention (AMPP) Study. Headache Sep. 2013;53(8):1278–99 (Epub 2013/07/03).
[49] Robberstad L, Dyb G, Hagen K, Stovner LJ, Holmen TL, Zwart JA. An unfavorable lifestyle and recurrent headaches among adolescents: the HUNT study. Neurology 2010;75(8):712–7 (Epub 2010/08/20).
[50] Hu XH, Markson LE, Lipton RB, Stewart WF, Berger ML. Burden of migraine in the United States: disability and economic costs. Arch Intern Med 1999;159(8):813–8 (Epub 1999/04/29).
[51] Zwart JA, Dyb G, Hagen K, Odegard KJ, Dahl AA, Bovim G, et al. Depression and anxiety disorders associated with headache frequency. The Nord-Trondelag Health Study. Eur J Neurol 2003;10(2):147–52 (Epub 2003/02/27).
[52] The International Classification of Headache Disorders: 2nd edition. Cephalalgia 2004;24(Suppl. 1):9–160 (Epub 2004/02/26).
[53] Classification and diagnostic criteria for headache disorders, cranial neuralgias and facial pain. Headache Classification Committee of the International Headache Society. Cephalalgia 1988;8(Suppl. 7):1–96 (Epub 1988/01/01).
[54] Young WB, Park JE, Tian IX, Kempner J. The stigma of migraine. PLoS One 2013;8(1):e54074 (Epub 2013/01/24).
[55] Winsvold BS, Sandven I, Hagen K, Linde M, Midthjell K, Zwart JA. Migraine, headache and development of metabolic syndrome: An 11-year follow-up in the Nord-Trondelag Health Study (HUNT). Pain 2013;154(8):1305–11 (Epub 2013/06/04).
[56] Karenberg A, Leitz C. Headache in magical and medical papyri of ancient Egypt. Cephalalgia 2001;21(9):911–6 (Epub 2002/03/21).