

## Systematic Review

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# Multiple Sclerosis Epidemiology in Middle East and North Africa: A Systematic Review and Meta-Analysis

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Mohammad Ali Sahraian<sup>a</sup><sup>a</sup>MS Research Center, Neuroscience Institute, Tehran University of Medical Sciences, and <sup>b</sup>Department of Community Medicine, Iran University of Medical Sciences, Tehran, Iran**Key Words**

Multiple sclerosis · Epidemiology · Prevalence · Middle East · North Africa

**Abstract**

**Background:** Multiple sclerosis (MS) is one of the most common neurological disorders and a leading cause of nontraumatic disability in young adults in many countries. Recent reports from the Middle East and North Africa have suggested a moderate to high risk of MS in these countries. **Methods:** A literature search was performed in August 2014 in MEDLINE, EMBASE, and IMEMR to retrieve original population-based studies on MS epidemiology in the Middle East and North African countries published between 1st January 1985 and 1st August 2014. We designed search strategies using the key words: MS, prevalence, incidence, and epidemiology. According to the inclusion criteria, 52 studies were included in this systematic review. **Results:** McDonald's criteria were the most widely used diagnostic criteria in the studies. Most studies were conducted in single hospital-based centers with a defined catchment area. The female/male ratio ranged from 0.8 in Oman to 4.3 in Saudi Arabia.

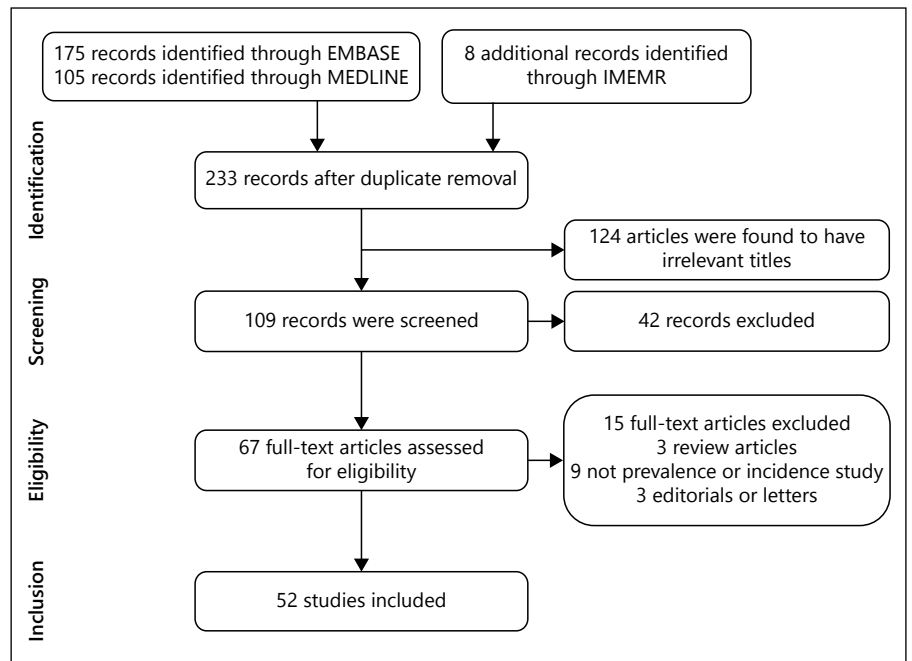
MS prevalence ranged from 14.77/100,000 population in Kuwait (2000) to 101.4/100,000 in Turkey (2006). The overall MS prevalence in the region was 51.52/100,000. The mean age at disease onset ranged from 25.2 years in Kuwait to 32.5 years in Northeastern Iran, with an overall estimate of 28.54 years. **Conclusions:** Recent advances in MS registries will allow nation-wide studies and temporal comparisons between countries, provided that age- and sex-standardized estimates are available.

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**Background**

Multiple sclerosis (MS) is an inflammatory demyelinating and neurodegenerative disease affecting more than 2 million people worldwide [1]. MS may have a variable clinical course; episodic acute periods of relapses, gradual progressive decline of neurologic function, or combinations of both [2]. MS typically begins in early adulthood;

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**Fig. 1.** Flow diagram of studies based on the PRISMA statement.

15 years after the onset of disease, up to 50 percent of patients will need help in walking [3]. An almost universal increase in prevalence and incidence of MS over time with a general increase in the incidence of MS in females has been observed in meta-analyses of studies on MS epidemiology since 1965 [4]. A longitudinal study in Canada over the past 50 years suggests that different smoking habits could explain the increase in the female/male sex ratio [5].

Middle Eastern and North African countries are located in a low- to moderate-risk zone for MS based on the 2013 MS Atlas [6]; however, recent studies suggest a moderate-to-high prevalence in areas within this region, with an increase in the incidence and prevalence especially among women [7–11]. Increasing burden of MS in Middle Eastern countries, in addition to high costs of managing this condition, denotes a special notice to reliable epidemiological data for healthcare planning and policy-making purposes.

Disparities in environmental risk factors and genetic predispositions modulate the risk of MS at the population level [12]. Studying changes in the incidence and prevalence could reveal temporal and spatial patterns contributing to variable MS risk across populations. Given the limited epidemiological data on MS in Middle East and North African countries, this systematic review aims to pool all available data to elucidate trends in the incidence, prevalence, and natural history of MS in these countries.

## Materials and Methods

### Screening and Eligibility Criteria

The following criteria were used to select papers for inclusion in this systematic review: (1) the population defined primarily as those living in Middle Eastern/North African countries; our definition of the Middle East and North African countries was based on the global burden of diseases definition of North Africa and the Middle East region, including the following 21 countries: Algeria, Bahrain, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Palestine, Qatar, Saudi Arabia, Sudan, Syria, Tunisia, Turkey, United Arab Emirates, Western Sahara, and Yemen [13]. (2) MS was defined according to accepted international diagnostic criteria in use at the time of the study (Poser et al. [14] or McDonald's criteria) [15–17]. (3) The prevalence, incidence, or number of MS cases were reported in the study. (4) Articles in English language were included in this study. We excluded articles primarily focusing on other fields of MS: neuroimaging, neuroimmunology, and not providing estimates on MS prevalence. Studies before 1985, when magnetic resonance imaging (MRI) became a part of clinical practice and substantially influenced the diagnosis of MS, were few in this region and we have incorporated this exclusion criteria similar to other systematic reviews on MS epidemiology in other regions [18–20]. We did not include Israel in our study because WHO considered it as a high-income European country; thus, it is beyond the scope of this review [21, 22].

The flow diagram of study selection was developed according to PRISMA statement (fig. 1).

### Search Strategy

We have queried the MEDLINE, EMBASE, and IMEMR with the following keywords: 'MS', 'incidence', 'prevalence', and 'epidemiology'. Our search strategy is provided in the online supplement.

tary files (for all online suppl. material, see [www.karger.com/doi/10.1159/000431042](http://www.karger.com/doi/10.1159/000431042)). We also did a manual search of reference lists from primary articles and relevant reviews.

#### Quality Assessment and Data Extraction

Two independent reviewers (P.H. and S.K.) used the Joanna Briggs Institute critical appraisal tools to assess the methodological quality of each study [23]. If the two reviewers disagreed on the final critical appraisal and this could not be resolved through discussion, a third reviewer's opinion was sought (S.A.). Quality scores of the studies are presented in detail in online supplementary table 1. A trained reviewer extracted following data into a standardized form: the study period, location, diagnostic criteria, number of cases, female/male ratio, average age of the study population, mean age at disease onset, and MS subtype proportions. Crude and standardized prevalence and incidence estimates were documented overall and by sex, region, time period, and subgroup as applicable.

#### Statistical Analysis

Meta-analysis was performed for pooled data for prevalence, mean age at disease onset, female proportion of patients, and MS subtype proportions using STATA software version 13 (Stata Corp., College Station, Tex., USA). A moment-based random model was used for estimating pooled measures because of heterogeneity of studies. We used metaregression to find trend of changes in the above-mentioned variables over time.

## Results

Our literature review resulted in 233 studies after duplicate removals. Among these studies, 124 studies had irrelevant titles and 42 studies did not pass the eligibility criteria during the abstract/full-text screening. Finally, we included 52 studies in this systematic review (fig. 1). Table 1 shows the study period, type, location, diagnostic criteria, number of cases, female/male ratio, mean age at disease onset, prevalence rates, incidence rates, and quality scores in these studies.

Our search on epidemiology of MS in Middle East and North African countries yielded no results in Bahrain, Morocco, Palestine, Syria, Western Sahara, and Yemen. Single hospital-based studies covering mainly capital cities were the only source of information on MS epidemiology in UAE, Saudi Arabia, Qatar, Oman, Lebanon, Iraq, and Algeria. We have presented these studies separately in table 2. Detailed quality scores of studies included in this systematic review are presented in online supplementary tables 1 and 2.

McDonald's criteria were the most widely used diagnostic criteria (44%), Poser et al. criteria were used in 36% of studies. The 2005 revision of McDonald's criteria was used in 14%, while the 2010 revision was only used in two

studies and Schumacher and McAlpine criteria were used in one study.

Community-based surveys were conducted in 7% of the studies to estimate the prevalence of MS [24–27]. Regional MS registries were used as the data source to obtain patient records in 30% of studies [7–9, 28–40], while single hospital-based studies accounted for 34% of studies [10, 41–57] and 23% of studies were conducted in a multicenter hospital-based setting [11, 58–68]. One study used the ministry of health data for interferon therapy as the data source [69].

The female/male sex ratio varied among studies in the region, ranging from 0.8 in Oman [50] to 4.3 in Saudi Arabia [54]. The overall pooled estimate of female proportion of MS patients was 0.67 (0.65–0.69) and this proportion slightly increased over time (Coef. 0.004,  $p = 0.03$ ; fig. 2).

Study methodologies and the quality of the methods can influence the estimates of prevalence rates in epidemiological studies; figure 3 depicts the heterogeneity of prevalence rates (with confidence intervals) in this region. Prevalence rates range from 14.77/100,000 in Kuwait (2005 [46]) to 101.4/100,000 in Turkey (2006 [27]). Meta-analysis of the pooled estimates are presented in table 3, an overall prevalence of 51.52/100,000 (36.10–66.95/100,000) was estimated for countries in this region (heterogeneity statistic = 4,835.85,  $I^2 = 99.8\%$ ). A metaregression analysis showed a significant increase in MS prevalence in this region over time (Coef. 2.89,  $p = 0.03$ ).

The annual MS incidence rate in the Middle East and North African countries was only reported in few studies ranging from 0.8 in Libya (1985 [65]) to 9.1/100,000 in Isfahan (2011 [7]). The 3-year incidence rate in Isfahan was reported to be 26.03/100,000 in a later study (2013 [9]).

The mean age at disease onset was similar in these countries, ranging from 25.2 in Kuwait [64] to 32.5 in Northeastern Iran [38]. Figure 4 demonstrates studies reporting the mean age at disease onset. Meta-analysis revealed an overall mean age at the onset of 28.54 years for MS patients (27.61–29.48); the age at disease onset did not change significantly over time (Coef. 0.09,  $p = 0.23$ ).

Several studies reported the following course of disease in patients: relapsing-remitting MS (RRMS), secondary-progressive MS (SPMS), primary-progressive MS (PPMS), and relapsing-progressive MS (RPMS). The overall proportions of these MS subtypes are presented in table 4. We only found a slight decrease in PPMS in the region over time (Coef.  $-0.006$ ,  $p = 0.01$ ).

Age- and sex-specific prevalence rates were reported in few studies; as these measures provide the most useful estimates to compare MS among countries, we have pro-

**Table 1.** Comparative analysis of MS in Middle East and North Africa in multicenter hospital-based studies, community-based studies and regional registries

Study	Study period	Source of data	Diagnostic criteria	Number of cases	F:M ratio	Mean age at disease onset	Prevalence/100,000	Incidence/100,000	Quality score
<i>Egypt</i>									
Tallawy et al. [24]	2009–2012	Community-based survey	–	–	–	–	13.74	–	7/9
Hashem et al. [58]	–	Multicenter hospital based	McDonald's criteria	648	1.6:1	M: 33.36 F: 32.65	–	–	10/10
<i>Iran</i>									
Etemadifar et al. [9]	2003–2013	Regional MS registry	McDonald's criteria	4,536	3.41:1	–	85.80 (83.3–88.4)	26.03 <sup>a</sup> (25.79–28.96)	9/9
Etemadifar and Maghzi [7]	2003–2010	Regional MS registry	McDonald's criteria and 2005 revisions	3,522	3.37:1	28.2±9	73.37 (70.9–75.8)	9.1 (8.3–10.0)	9/9
Saadatnia et al. [31]	2003–2006	Regional MS registry	McDonald's criteria	1,718	–	25.36±8.6	43.80 (41.7–46)	3.64	9/9
Etemadifar et al. [28]	2004–2005	Regional MS registry	McDonald's criteria	1,391	3.6:1	–	35.5 (33.6–37.3)	–	10/10
Heydarpour et al. [8]	1991–2011	Regional MS registry	Poser (to 2001) and McDonald's criteria	–	–	–	74.28	–	8/9
Elhami et al. [29]	1989–2009	Regional MS registry	Poser (to 2001) and McDonald's criteria	7,896	3.11:1	27.53±8.12	50.57 (49.46–51.68)	2.93 (2.67–3.18)	10/10
Sahraian et al. [30]	1999–2008	Regional MS registry	Poser (to 2001) and McDonald's criteria	8,146	2.6:1	27.24±8.32	51.90	–	10/10
Kalanie et al. [59]	1996–2001	Multicenter hospital based	Poser's criteria	265	2.5:1	27±7.4	–	–	9/10
Jajvandian et al. [40]	2005–2011	Regional MS registry	–	105	2.38:1	27.10±8.41	12.94	–	–
Ghandehari et al. [32]	2009	Regional MS registry	McDonald's criteria	71 <sup>b</sup> 721 <sup>c</sup> 34 <sup>d</sup>	3.8:1 <sup>a</sup> 1.8:1 <sup>b</sup> 3.2:1 <sup>c</sup>	–	8.75 <sup>a</sup> 12.89 <sup>b</sup> 5.34 <sup>c</sup>	–	7/9
Ebrahimi and Sedighi [33]	–	Regional MS registry	–	932	3:1	28.35	31.75	–	9/9
Moghaddam et al. [72]	2010	–	McDonald's criteria	83	4:1	–	30	–	7/9
Saman-Nezhad et al. [34]	2012	Regional MS registry	–	448	–	30.8	43.3	–	9/9
Majdimasab et al. [35]	2005–2011	Regional MS registry	McDonald's criteria	1,057	3.2:1	27.6±8.2	25	–	8/9
Sharafaddinzadeh et al. [36]	1997–2009	Regional MS registry	McDonald's criteria	569	3.11:1	–	16.28	2.20	10/10
Rezaali et al. [37]	2011	Regional MS registry	Poser (to 2001) and McDonald's criteria	581	3.4	34.25±9.01	50.4	–	10/10
Hashemilar et al. [38]	2005–2009	Regional MS registry	McDonald's criteria	1,000	2.7:1	32.5±8.3	27.7	–	7/9

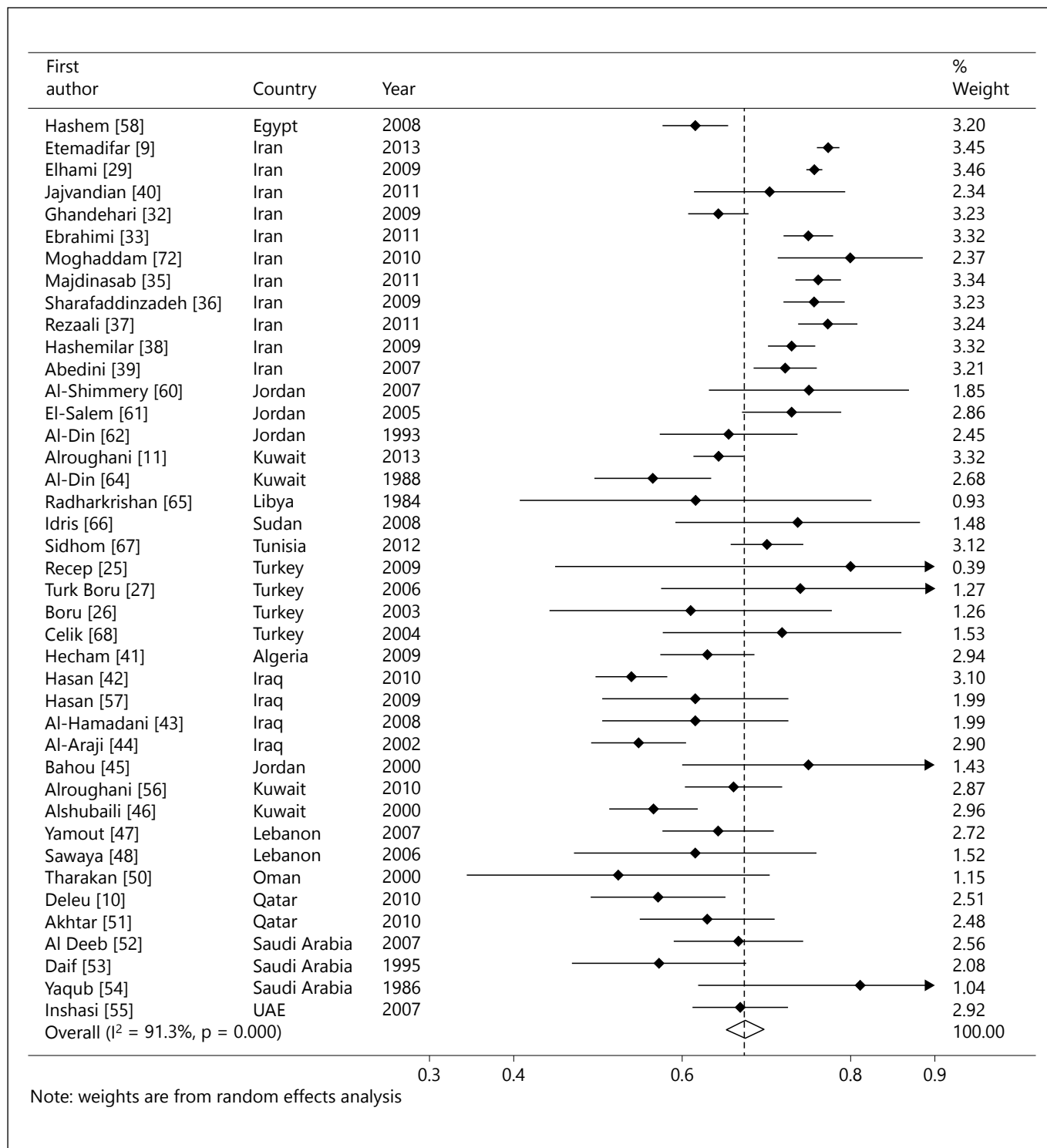
**Table 1.** (continued)

Study	Study period	Source of data	Diagnostic criteria	Number of cases	F:M ratio	Mean age at disease onset	Prevalence/100,000	Incidence/100,000	Quality score
Abedini et al. [39]	2007	Regional MS registry	McDonald's criteria	582	2.6:1	26.9±8.3	20.1 (18.7–22.1)	–	7/9
Izadi et al. [69]	2011	Ministry of health and medical education	–	34,605	–	–	45	–	5/7
<i>Jordan</i>									
Al-Shimmery and Bzaini [60]	2004–2007	Multicenter hospital based	McDonald's criteria	52	3:1	28.6	–	–	7/10
El-Salem et al. [61]	2004–2005	Multicenter hospital based	McDonald's criteria	224	2.7:1	29.3±9.6	38 <sup>c</sup> (32.9–45.3) 39 <sup>f</sup> (32.9–45.3)	1.14	9/10
al-Din et al. [62]	1992–1993	Multicenter hospital based	Poser's criteria	131	1.9:1	29.6±8.1	32.1 (19.7–55.4)	–	6/10
Najim al-Din et al. [63]	1992–1993	Multicenter hospital based	Poser's criteria	126	1.9:1	29.6±8.1	20 (9.5–47.2)	–	7/10
<i>Kuwait</i>									
Alroughani et al. [11]	2010–2013	Multicenter hospital based	2010 revisions to McDonald's criteria	1,176	1.8:1	–	85.05 (82.80–87.04)	6.88	10/10
al-Din et al. [64]	1988	Multicenter hospital based	Poser's criteria	201	1.3:1	25.2±7.97	10.2	–	7/10
<i>Libya</i>									
Radhakrishnan et al. [65]	1982–1984	Multicenter hospital based	Schumacher and McAlpine	21	1.6:1	26.5	4	0.8	7/9
<i>Sudan</i>									
Idris et al. [66]	1998–2008	Multicenter hospital based	Poser's criteria	35	2.8:1	–	–	–	7/9
<i>Tunisia</i>									
Sidhom et al. [67]	2010–2012	Multicenter hospital based	2005 and 2010 revisions to McDonald's criteria	437	34:1	30.3	–	–	8/9
<i>Turkey</i>									
Recep et al. [25]	2008–2009	Community based survey	McDonald's criteria	5	4:1	27.3	68.97	–	9/9
Türk Börü et al. [27]	2006	Community based survey	Poser's criteria	27	2.85:1	30.5	50.6 (33.34–73.61)	–	10/10
Börü et al. [26]	2002–2003	Community based survey	Poser's criteria	33	1.56:1	31.7±8.7	101.4 (69.84–142.47)	–	9/9
Çelik et al. [68]	2003–2004	Multicenter hospital based	McDonald's criteria	39	2.55:1	29.2±8.5	33.9 (32–36)	3.48	7/9

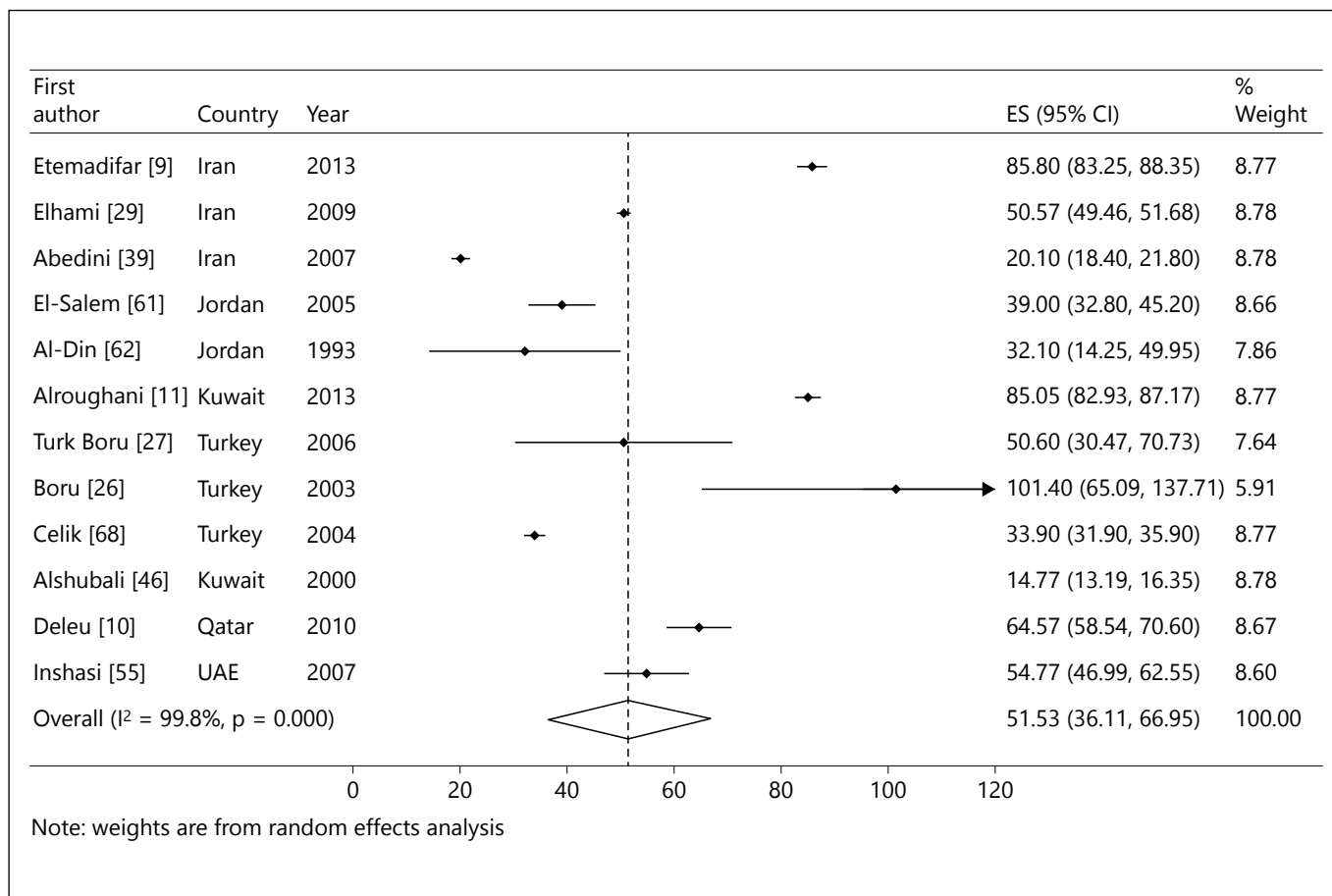
<sup>a</sup> 3-year cumulative incidence rate; <sup>b</sup> North Khorasan; <sup>c</sup> Razavi Khorasan; <sup>d</sup> South Khorasan; <sup>e</sup> Amman; <sup>f</sup> Ibid.

**Table 2.** Comparative analysis of MS in Middle East and North Africa in single hospital ceter studies

Study	Study period	Source of data	Diagnostic criteria	Number of cases	F:M ratio	Mean age at disease onset	Prevalence/100,000	Incidence/100,000	Quality score
<i>Algeria</i> Hecham [41]	2000–2009	Single hospital based	–	307	1.7:1	39	–	–	7/9
<i>Iraq</i> Hasan [42]	2008–2010	Single hospital based	2005 revisions to McDonald's criteria	500	1.17:1	30.92±7.71	–	–	6/9
Hasan et al. [57]	2008–2009	Single hospital based	2005 revisions to McDonald's criteria	77	1.6:1	14.95	–	–	6/9
Al-Hamadani et al. [43]	2000–2008	Single hospital based	McDonald's criteria	77	1.6:1	14.95±3.21	–	–	7/9
Al-Araji et al. [44]	2000–2002	Single hospital based	Poser's criteria	300	1.21:1	29.2±7.8	–	–	8/9
<i>Jordan</i> Bahou [45]	10 years period	Single hospital based center	Poser's criteria	32	3:1	31.4	–	–	8/10
<i>Kuwait</i> Alroughani et al. [56]	2010	Single hospital based center	2005 revisions to McDonald's criteria	257	1.95:1	26.8±9.1	–	–	10/10
Alshubaili et al. [46]	1991–2000	Single hospital based center	Poser's criteria	338	1.3:1	26.0±7.7	14.77 (13.18–16.35)	1.63	9/10
<i>Lebanon</i> Yamout et al. [47]	2005–2007	Single hospital based center	McDonald's criteria	202	1.8:1	30.2±10.2	–	–	10/10
Sawaya et al. [48]	1995–2006	Single hospital based center	–	45	1.6:1	–	–	–	7/10
<i>Oman</i> Tharakan et al. [49]	1990–2000	Single hospital based center	Poser's criteria	30	1.1:1	27	4	–	7/10
Tharakan et al. [50]	1992–1996	Single hospital based center	Poser's criteria	18	0.8:1	27	1.2	–	7/10
<i>Qatar</i> Deleu et al. [10]	2010	Single hospital based center	2005 revisions to McDonald's criteria	154	1.33:1	27±8.6	64.57 (58.31–70.37)	–	10/10
Akhtar et al. [51]	2005–2010	Single hospital based center	2005 revisions to McDonald's criteria	142	1.7:1	–	–	–	9/10
<i>Saudi Arabia</i> Al-deeb [52]	1997–2007	Single hospital based center	–	150	2:1	30	–	–	6/9
Daif et al. [53]	1986–1995	Single hospital based center	Poser's criteria	89	1.34:1	27.7±7.8	25	–	8/10
Yaqub and Daif [54]	1983–1986	Single hospital based center	Poser's criteria	16	4.3:1	29	–	–	8/10
<i>United Arab Emirates</i> Inshasi and Thakre [55]	2000–2007	Single hospital based	McDonald's criteria	284	2.02:1	28.48	54.7 (46.99–62.55)	6.8	9/10



**Fig. 2.** Female proportion of MS patients in studies from Middle East and North Africa.



**Fig. 3.** Prevalence of of MS in studies from Middle East and North Africa.

**Table 3.** Meta-analysis of the pooled estimates for prevalence, mean age at disease onset, and female proportion of patients

Overall estimate	Pooled estimate	Lower limit	Upper limit	Heterogeneity statistic	Degrees of freedom	p value	$I^2$ , %
Prevalence	51.52	36.10	66.95	4,835.85	11	0.000	99.8
Mean age at onset	28.54	27.61	29.48	487.96	15	0.000	96.9
Female proportion	0.67	0.65	0.69	459.38	40	0.000	91.3

vided them in online supplementary table 3. We have also presented the annual number of cases (incidence data) by the calendar year of onset in online supplementary table 4.

A brief description of the epidemiology and natural history of MS in each country is presented here:

#### Algeria

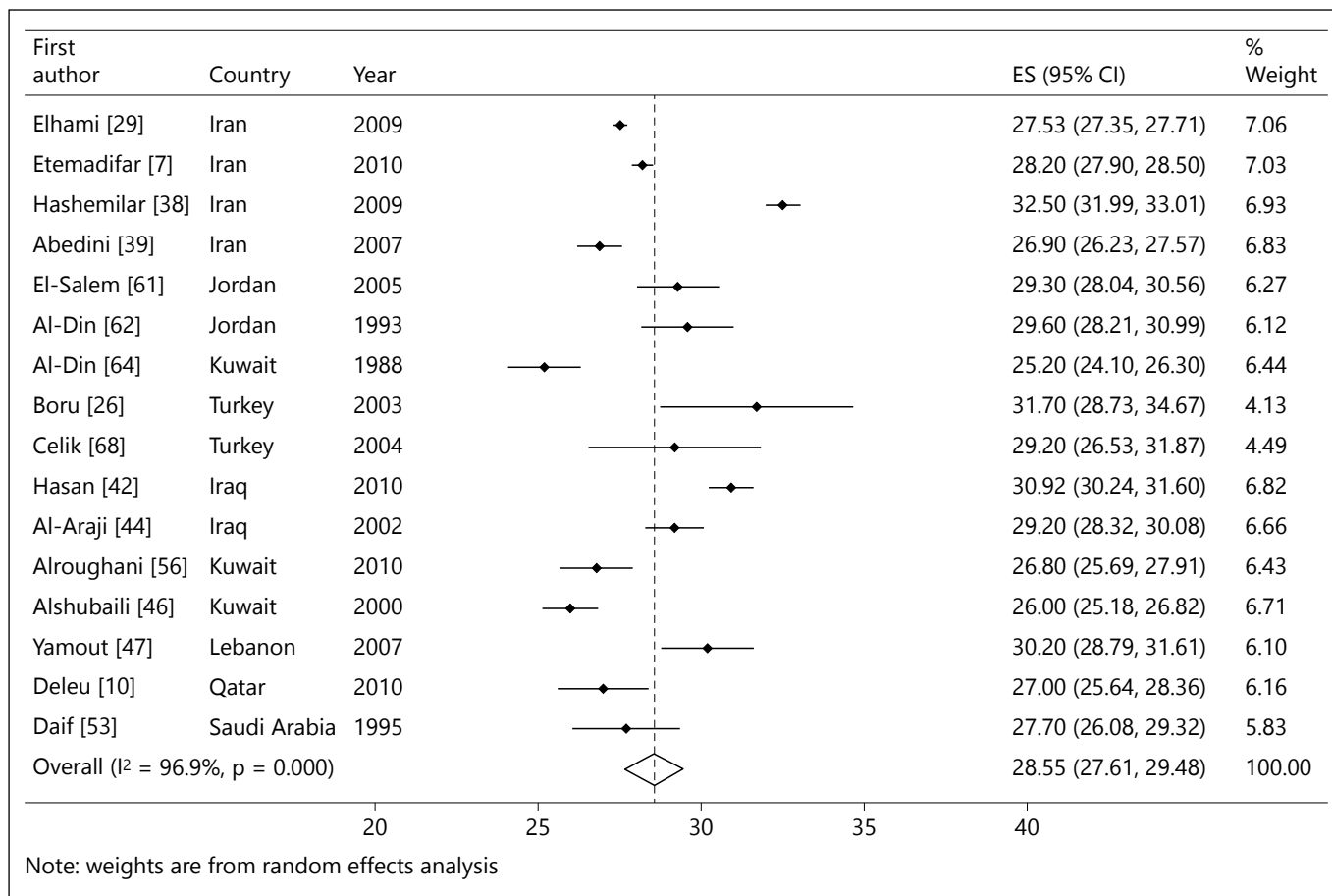
MS has been scarcely documented in Algeria, 307 patients were reported to have MS in a single hospital-based study. Most patients experienced motor symptoms as the

presenting symptom (73.6%); RRMS was reported in 61.9%, secondary progressive in 19.5%, and progressive in 18.6% patients [41].

#### Egypt

A community-based survey in Al Quseir, Egypt, has found an MS prevalence of 13.74/100,000 [24]. A retrospective meta-analysis in different referral centers of Egypt has found 648 patients with definite MS. The most frequent presenting symptom was weakness (57%), fol-





**Fig. 4.** The mean age at MS onset of studies in Middle East and North Africa.

**Table 4.** Meta-analysis of MS subtype proportion estimates

MS subtype proportions	Pooled estimate	Lower limit	Upper limit	Heterogeneity statistic	Degrees of freedom	p value	$I^2$ , %
RRMS	0.74	0.71	0.77	578.27	32	0.000	94.5
SPMS	0.12	0.10	0.15	1,250.50	30	0.000	97.6
PPMS	0.08	0.06	0.11	1,097.72	28	0.000	97.4
RPMS	0.06	0.02	0.10	97.00	29	0.000	70.1

lowed by sensory symptoms (19.9%), visual symptoms (15.9%), and ataxia (15.8%). 73.45% of these patients had a relapsing-remitting course, primary-progressive course was seen in 17% of patients, and 9.55% had the secondary-progressive course.

#### Iran

The MS prevalence in Tehran has increased from 51.9/100,000 in 2008 to 74.28/100,000 in 2011. The annual MS incidence has significantly increased over the

last two decades from 0.68 (1989) to the peak of 5.68/100,000 (2005). The disease was almost 3 times more common in females than in males. RRMS was recognized in 84.9% of patients. The mean age at disease onset was 27.24 years; there was a positive family history of MS in 9.5% of the patients [8, 29, 30].

Population-based studies in Isfahan have revealed a general increase in MS prevalence and incidence over a decade, the MS prevalence has increased from 35.5 in 2006 to 85.8 per 100,000 in 2013, with an incidence of 9.1

in 2009. Similar to Tehran, a female to male ratio of 3.37 was seen with a family history of MS in 12.2% of patients. The clinical course of MS was RRMS in 87.8%, SPMS in 6.4%, and PPMS in 5.7% of patients. The initial presentation was sensory in 51.7%, and visual disturbances were seen in 47.5% of patients. Early and late onset MS was seen in 5 and 1.1% of patients, respectively, and the mean age at disease onset was 28.2 years [7, 9, 28, 31, 70].

Variable prevalence rates have been reported from other regions in Iran, prevalence rate was 20.1 per 100,000 in Mazandaran (North Iran) [39], 27.7 in East Azerbaijan (Northwest Iran) [38], 16.28 in Khuzestan (Southwest Iran) [36], 13.96 in Sistan and Balouchestan (Southeast Iran) [71], and ranging from 5.3 to 12.9 in Khorasan (Northeast Iran) [32]. A higher prevalence of MS was seen in central provinces of Qom (50.4) and Kerman (31.5), similar to reports from Tehran and Isfahan [33, 37].

#### *Iraq*

A progressive increase in MS prevalence and a trend toward more female patients was observed in Iraq in the last two decades. The initial symptom was reported as motor in 31.7%, sensory in 28.3%, optic nerve in 24% and brainstem or cerebellar in 22.3% of patients. The course was relapsing remitting in 66.3% patients, secondary progressive in 18.7%, and primary progressive in 15% patients. However, a different medical care pattern among the male and female patients in Iraq resulted in a lower female to male gender ratio (1.2:1) compared to the western nations [44]. In another study, the mean age at clinically definite MS onset was 30.92 [42]; Hasan et al. showed that 6.8% of their patients attending an MS clinic in Iraq experienced MS symptoms before the age of 18 years [57].

#### *Jordan*

Jordan has been considered as an area of low to medium risk of MS, a 2-year hospital-based study on 126 MS patients (1992–1993) reported a prevalence of 42/100,000 among patients with Palestinian origin, while the prevalence among patients with Jordanian origin was 20 [62, 63]. However, a more recent study reported a prevalence rate of 39/100,000 in the city of Amman and 38 in Irbid, regardless of the origin of the ancestors. Fifty-seven new cases were diagnosed in the study year, resulting in an incidence of 1.14/100,000. The mean age of onset was 29.3 years. The most common clinical presentation was weakness (30.8%), followed by optic neuritis (20.1%), sensory impairment (19.6%), and ataxia (14.3%). A positive family history of MS was found in 9.4% of the cases [61].

#### *Kuwait*

Alshubaili et al. reported that the MS incidence rate has increased from 1.05 in 1993 to 2.62/100,000 in 2000. An increasing pattern was also observed in the prevalence rates (6.68/100,000 at the end of 1993 to 14.77/100,000 by 2000). The estimated prevalence was markedly higher for Kuwaitis (31.15) than for non-Kuwaitis (5.55) [46]. Najim Al-Din et al. found a statistically different prevalence rate among Kuwaitis (9.5) and Palestinians (23.8) resident in Kuwait. The most common symptom at diagnosis were sensory (52.4%) and motor weakness (50.0%), followed by unilateral optic neuritis (32.5%), ocular palsy (25.7%), and cerebellar signs (24.6%) [64]. A more recent study reported an 85.05/100,000 crude prevalence rate of MS in Kuwait in 2011, with a higher prevalence in women [11].

#### *Lebanon*

Based on the Lebanese ministry of health records, total number of MS patients is estimated to be between 1,200 and 1,700. The most frequent presenting symptoms were brainstem-cerebellar (46.2%), followed by sensory (42.5%), motor (33.9%), and visual (29.6%). RRMS was seen in 85.1% of patients at onset, and 7.9% had PPMS. The female patients outnumbered males with a female to male ratio of 1.8:1. The mean age at onset of disease was 30.2 years. A positive family history of MS was reported by 5% of patients; however, Sawaya and Kanso found 30% of their group of patients had a first- or second-degree relative diagnosed with MS [47, 48].

#### *Libya*

The sole study on MS epidemiology in Libya dates back to 1985, where MS cases were detected yielding a crude prevalence rate of 4 per 100,000 and the age-adjusted prevalence rate of 5.9/100,000. A high prevalence of brainstem involvement and cerebellar dysfunction was seen in this study [65].

#### *Oman*

Oman has the lowest reported MS occurrence in the Arabian Peninsula; however, the MS prevalence has increased from 1.2/100,000 in 1996 to 4/100,000 in 2000. Among 30 patients with MS diagnosis, 23 patients had the relapsing-remitting course, 4 were secondary progressive, and 3 were primary progressive. Twelve patients presented with blurred vision, 6 with sensory symptoms, 5 with ataxia, 3 with diplopia, and 2 with hemiplegia [49].

### *Qatar*

MS in Qatar is an emerging neurologic disorder; in the first epidemiological study of MS in Qatar, the crude prevalence was reported 64.57/100,000 (2010). The female/male ratio (1.33:1) was remarkably lower than that observed in the remaining countries of the region. A positive family history was found in 10.4% of patients. The most common symptom at presentation was sensory manifestations, followed by optic neuritis or pyramidal symptoms [10]. In another study, 58.5% patients had the RRMS disease course, 4.5% had SP, 2% had PP, and 7% had CIS.

### *Saudi Arabia*

MS prevalence is low in Saudi Arabia (25/100,000) [54]. The clinical course was relapsing remitting in 60.7%, progressive relapsing in 20.2%, and primary progressive in 19.1%. The mean age at onset in Saudi patients (25.9 years) was lower than that of the non-Saudis (29.4 years). In the Saudi and non-Saudi group, the female/male ratio was 1.32:1 and 1.4:1, respectively. Weakness was the most common presenting symptom in both the Saudi and non-Saudi patients, followed by sensory impairment [53].

### *Sudan*

Only 35 patients were seen during one decade in a central-tertiary specialized neurology center in Sudan. The most common presentation was paralysis of one or more extremities (68.6%), followed by optic neuritis (37.1%), cerebellar ataxia (11.4%), and diplopia (5.7%). The relapsing-remitting course was seen in 56% of patients, secondary progressive in 32%, and 9% had the primary-progressive course [66].

### *Tunisia*

In a multicenter hospital-based study conducted in Tunisia, 437 MS patients were included. Their disease course was relapsing remitting in 91% of patients and primary progressive in 9%. The most frequent symptoms at onset were motor (28%), optic neuritis (20%), and sensory (16%) dysfunction [67].

### *Turkey*

MS prevalence in urban Istanbul (101.3/100,000) was nearly more than twice the prevalence in rural regions of Northern Turkey: Kandıra (61/100,000), Geyve (41/100,000), Erbaa (53/100,000), and Caucasus (68.97/100,000) [25–27]. The previous MS prevalence rate from Edrine city was reported to be 33.9/100,000 in 2003 [68].

Türk Börü et al. reported that the initial symptoms in 51.5% of subjects were sensory, brainstem-related signs (42%), cerebellar signs (33%), motor signs (30%), optic neuritis (30%), and sphincter disturbances (15%) [27].

### *United Arab Emirates*

The crude prevalence rate of MS in Dubai was 19.2 per 100,000 in the whole population, while in the Dubai native population was 54.77. The annual incidence rate was 6.8/100,000 during 2000–2007. Majority of Dubai native patients had the RRMS disease course (76.9%), 10.6% were SP, 7.8% were CIS, and 4.4% were RP. The mean age of onset was 26.6 years and the female/male ratio was 2.85:1. The most common symptom at presentation was motor (72.78%), followed by sensory (48.41%), cerebellar (19.96%), and ocular (16.13%) [55].

## **Discussion**

Our systematic review yielded 52 studies on epidemiology of MS in the Middle East countries. Main findings are: (1) McDonald's criteria were the most widely used diagnostic criteria. (2) Most of the studies were conducted in single hospital-based centers. (3) The female/male ratio ranged from 0.8 (Oman) to 4.3 (Saudi Arabia). (4) The overall MS prevalence in the region was 51.52/100,000. (5) The mean age at disease onset ranged from 25.2 years (Kuwait) to 32.5 years (Northeastern Iran), with an overall estimate of 28.54 years.

The geographical distribution of MS patients has been the subject of numerous studies worldwide. Recent systematic reviews on the prevalence of MS in different regions of the world illustrate the changing epidemiology of disease and point to genetic and environmental disparities among these communities, leading to a global increase of MS. Reports from regions lacking sufficient epidemiological studies could be of particular importance in this regard. In this study, we tried to gather studies from the MENA countries.

Reports on MS prevalence with higher quality scores were derived from multicenter studies and regional registries in the capital or large cities within the country; nationwide studies were rare in the MENA countries. Higher quality scores of recent publications, and an increased prevalence in studies from the same areas over time, bring the conclusion of an increasing disease prevalence in the region.

Prevalence rates in our study ranged from 14.77/100,000 in Kuwait (2000) to 101.4/100,000 (Turkey).

The role of latitude was underscored in a systematic review on MS incidence and prevalence in European countries. Estimates tended to be higher in the Northern regions of the United Kingdom and in the Nordic countries. The highest prevalence estimates in the Nordic region (over 200/100,000) were reported in Finland and Sweden [18].

A systematic review of studies on MS epidemiology in Americans reported a prevalence of 240/100,000 from a national health survey in Canada; the highest prevalence in US was reported from Olmstead County, Minn., USA (191.2/100,000) [19]. A similar study in South America reported a prevalence rate ranging from 1.48 to 17 per 100,000 inhabitants in these countries [20].

The increase in disease prevalence in various MENA countries might be due to the western lifestyle changes in these countries. Smoking, sun protection products, low vitamin D levels, and environmental factors such as air pollution might be possible candidates.

This review has some limitations. The included studies are limited to publications in English. The lack of standardized age- and sex-specific estimates of prevalence data is an obstacle in combining studies from the same regions and comparing the changes over time. Strengths of the study included the comprehensive assessment of study quality and the independent data extraction by two reviewers.

## Conclusion

The prevalence and incidence of MS are not well-documented in many countries of North Africa and Middle East. Although most prevalence estimates are derived from single hospital-based centers within a country, recent advances in MS registries will allow nation-wide studies. Temporal and spatial comparisons would be possible, provided that age- and sex-standardized estimates are available.

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