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ORIGINAL RESEARCH

Incidence and Prevalence of Juvenile Myasthenia Gravis in the United States Between 2010 and 2020: Analysis of Two Claims Databases

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ABSTRACT

***Introduction*:** Few published population-based studies report the incidence or prevalence of juvenile myasthenia gravis (JMG) due to the rarity of the disorder. Despite recent progress in new targeted treatments and ongoing developments, there remains a critical need for novel and effective therapies specifically for JMG. Most treatments used for JMG are only approved for adult patients with MG. Thus, a thorough evaluation and understanding of the basic epidemiology of JMG is needed.

***Methods*:** We conducted a population-based retrospective study to estimate the annual incidence and prevalence of JMG in the US from 2010 to 2020 by analyzing the Merative™ MarketScan® Commercial Claims and Encounters Database (CCAE) and Multi-State Medicaid Database (MDCD).

***Results*:** The incidence of JMG in 2020 was 5.9 [95% confidence interval (CI) 3.3–9.7] per million person-years in CCAE and 8.7 (95% CI 6.0–12.3) per million person-years in MDCD, with considerable variation across the study period. The prevalence of diagnosed JMG remained fairly consistent, with 25.3 (95% CI 19.9–32.2) per million population in CCAE and 37.6 (95% CI 31.9–44.4) per million population in MDCD in 2020. Both databases consistently showed higher incidence and prevalence among girls compared with boys. No clear pattern was observed in incidence by age of onset over the study period, whereas prevalence generally increased with age. Both incidence and prevalence by age of onset were higher in MDCD than CCAE. Furthermore, higher incidence and prevalence were observed among Black population compared with White population. Overall, no obvious increasing or decreasing trend was observed during the study period.

***Conclusion*:** The incidence and prevalence of JMG in the US, previously understudied, may be higher than earlier research suggested, possibly due to limited research into the epidemiology of JMG. This finding implies that the actual burden of JMG could be greater than previously estimated.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s40120-025-00750-w.

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Key Summary Points

Why carry out this study?

Knowledge about the incidence or prevalence of juvenile myasthenia gravis (JMG) is limited due to the rarity of the disorder.

This population-based retrospective study was conducted to estimate the annual incidence and prevalence of JMG in the US from 2010 to 2020.

What was learned from this study?

Across two claims databases, the incidence of diagnosed JMG in 2020 was 5.9/8.7 per million person-years, and the prevalence was 25.3/37.6 per million population, with both databases showing higher incidence and prevalence among girls than boys, and among the Black population compared with the White population.

The findings enhance the understanding of the demographic characteristics of the JMG population and suggest that its incidence and prevalence may be higher than indicated in earlier research, highlighting a potentially greater burden of the disease.

INTRODUCTION

Myasthenia gravis (MG) is a rare, chronic, heterogeneous autoimmune neuromuscular disease characterized by fluctuating skeletal muscle weakness and fatigue. The incidence of MG shows a bimodal distribution with two peaks: a predominance among women in their third decade and a slight predominance among men over 60 years of age. However, MG can occur at any age, including childhood [1]. MG in children younger than 18 years of age is classified as juvenile myasthenia gravis (JMG) [2]. There is no fundamental difference in the pathogenesis, manifestation, or clinical course of MG in adults and the pediatric population, especially in postpubertal children (symptom onset at 12 years or older). Prepubertal children (symptom onset before 12 years of age) with JMG exhibit some differences in the presentation and course of their disease compared with postpubertal adolescents and adults; for example, prepubertal children present with higher rates of purely ocular JMG [3, 4]. A second autoimmune disorder, the most common comorbidity, was identified in 32% of patients with JMG, and there was no significant difference in the occurrence of autoimmune disorders between the postpubertal and prepubertal onset groups [5].

JMG is recognized as a very rare disorder, and data on the prevalence and incidence are lacking. The epidemiology of JMG has been reported in various population studies in Asia, Australia, South Africa, and Europe [5–13]. A recent national analysis in the United States (US) using open claims data reported that, in 2021, the prevalence of MG was 0.4, 2.1, 3.7, and 5.6 per 100,000 persons aged 0–1, 2–5, 6–11, and 12–17 years, respectively, with corresponding incidence of 0.3, 0.5, 0.2, and 0.4 per 100,000 persons [14]. Studies specifically focusing on the epidemiology of JMG in the US are even more scarce—one study reported the incidence to be 0.12 per 100,000 < 19 years of age in Olmsted County, Minnesota, with only 2 JMG cases [10].

As of 2024, eculizumab was approved in the European Union and Japan for expanded use to include the treatment of refractory generalized MG in children and adolescents aged 6 years and above who are anti-acetylcholine receptor antibody-positive; five other new targeted treatments for JMG are currently under evaluation in children in ongoing phase 2 and 3 clinical trials [15, 16]. These ongoing advancements in new targeted treatments highlight the importance of understanding the patient population and their characteristics, which will enable efficient resource allocation, raise awareness for earlier diagnoses, and inform tailored treatment strategies. This study aimed to further investigate the incidence and prevalence of JMG in the US over the decade from 2010 to 2020 by analyzing two large, closed claims databases, and to explore variations across age of onset, sex, and race/ethnicity groups. The insights gained will help

narrow the knowledge gap of JMG epidemiology and contribute towards improving healthcare planning and outcomes for patients with JMG.

METHODS

Study Design

This observational study of patients younger than 18 years of age estimated JMG incidence and prevalence from 2010 to 2020 in the US by analyzing two administrative healthcare claims databases, one nationwide and one multistate. This time period was divided into 11 calendar years of interest for the estimation of annual incidence and prevalence.

Data Source

The Merative™ MarketScan® nationwide Commercial Claims and Encounters Database (CCAE) and Multi-State Medicaid Database (MDCD) were analyzed in this study. The CCAE database contains health insurance claims spanning various types of care, including inpatient, outpatient, outpatient pharmacy, and behavioral health services, along with enrollment records from major employers and health plans across the US offering private healthcare coverage to employees, their spouses, and dependents. This administrative claims resource encompasses a range of plan types, such as fee-for-service, preferred provider organizations, and capitated health plans. MDCD reflects the healthcare service use of individuals covered by Medicaid programs in numerous geographically dispersed states. Both CCAE and MDCD are closed payer-claims databases that capture nearly all of a patient's healthcare activities within a defined enrollment period, with data provided directly by payers [17].

The MarketScan® databases contain fully de-identified/anonymized data and are fully compliant with the Health Insurance Portability and Accountability Act; therefore, this study was exempt from institutional review board approval and patient consent was not required.

JMG Case Ascertainment

Individuals younger than 18 years of age with a minimum of two International Classification of Disease (ICD) codes for MG (ICD-9 358.0, including 358.00 and 358.01, or ICD-10 G70.0, including G70.00 and G70.01) at least 90 days apart were confirmed as a diagnosed JMG case. MG codes that occurred before 2 years of age were not included in the analyses. Because the MarketScan® databases only contain the year of birth, a date of birth was assigned to each individual, corresponding to the last date of their recorded birth year.

Underlying Population

Eligible individuals for each calendar year of interest had to be younger than 18 years of age at the start of the calendar year of interest, have at least 1 year continuous insurance coverage prior to the calendar year of interest (up to 60 days' gap in insurance enrollment allowed) and have at least 90-day insurance coverage during the calendar year of interest.

Prevalent and Incident Case Definitions

For each calendar year of interest, the previous 1-year period was used to surveil for existing cases with a JMG diagnosis to distinguish between incident and prevalent cases [18]. Incident cases were defined as no JMG observed during the previous 1-year period but occurring during the calendar year of interest. Prevalent cases were JMG cases observed to occur during the previous 1-year period of the calendar year of interest. The second MG code could either fall in the previous 1-year period or after. Full-year data for 2021 were available at the time of analysis but were not reported because the absence of 2022 data for the second code could potentially bias the prevalence estimates for 2021.

Estimation of Incidence and Prevalence

JMG incidence was defined as the number of at-risk patients who developed JMG relative to the total amount of at-risk person-time during the year of interest. Incidence for each calendar year was estimated as a rate by dividing the number of patients who were not JMG cases in the previous year and were JMG cases during the calendar year of interest by at-risk person-time over the calendar year of interest. Once anyone received a JMG diagnosis during the calendar year of interest, they were no longer considered at risk. Eligible underlying individuals for each calendar year of interest had to have at least 90 days of insurance coverage during the calendar year of interest. Surveilling for existing disease using a specific retrospective look-back period was aligned with the method described by Rassen et al. [18]. The exact method was used to calculate the confidence interval (CI) for the incidence. JMG prevalence was defined as the proportion of JMG cases in the entire eligible population during the year of interest. Its numerator was the count of all eligible JMG cases, including both JMG cases during the previous year and newly diagnosed JMG cases during the year of interest. CI for prevalence was estimated using the Wilson score interval.

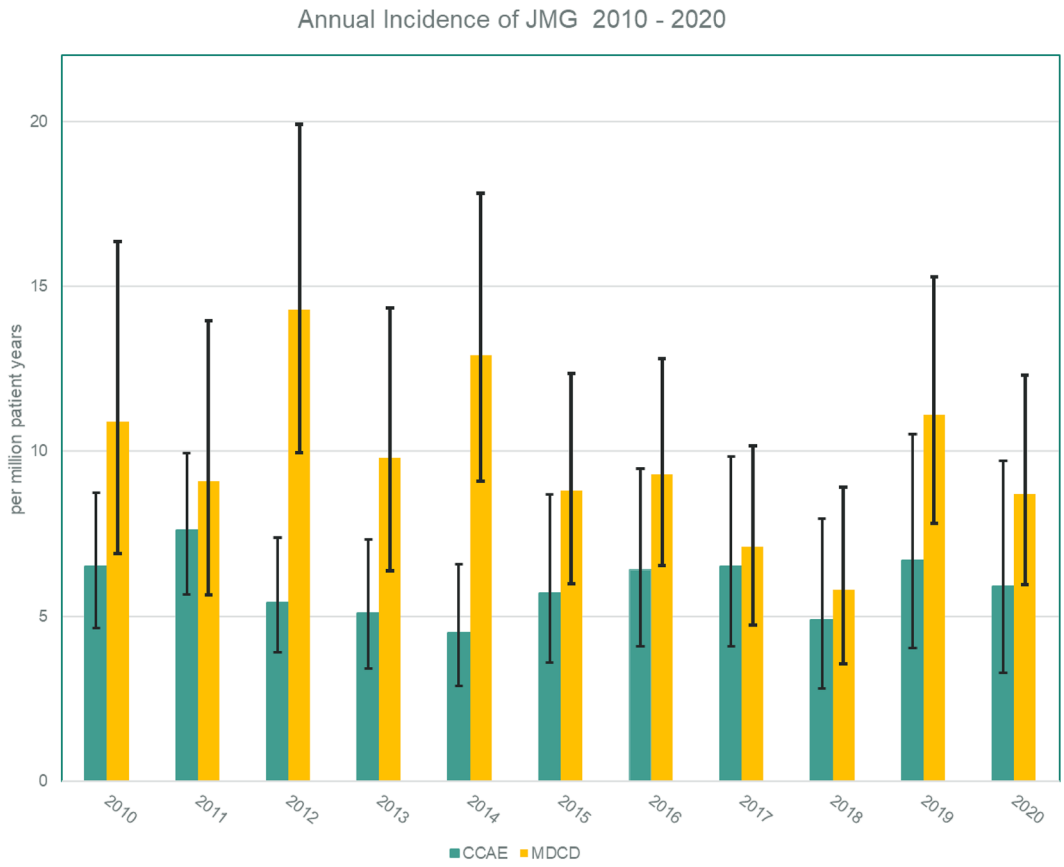

Fig. 1 Annual incidence and 95% CI per million person-years in the period 2010–2020. *CCAE* commercial claims and encounters database, *CI* confidence interval, *MDCD* multi-state medicaid database

RESULTS

Incidence and Prevalence of JMG

As reported in Fig. 1 and Supplement Table 1, across both data sources there was a moderate variation in the annual incidence of JMG, ranging from 4.5 (2014) to 7.6 (2011) per million person-years in the CCAE, and from 5.8 (2018) to 14.3 (2012) per million person-years in the MDCD, possibly due to the relatively small number of incident cases occurring in each calendar year. The annual prevalence demonstrated less variation than the annual incidence within each database over the study period, ranging from 22.7 (2014) to 25.3 (2019–2020) per million persons in the CCAE and from 37.6 (2020) to 43.9 (2014) per million persons in the MDCD (Fig. 2; Supplement Table 2). Throughout the entire study period, both incidence and prevalence of JMG in the MDCD were consistently higher than in the CCAE; however, no statistical test was performed to compare the two populations. Additionally, there were no clear increasing or decreasing trends in incidence or prevalence in either database over the study period.

Incidence and Prevalence of JMG by Sex

The female-to-male sex ratio in the underlying study population remained stable (49% female, 51% male) across both the 2–11 years and 12–17 years age groups from 2010 to 2020 in both databases. As reported in Table 1, incidence and prevalence were higher in the female population in both the MDCD and CCAE database

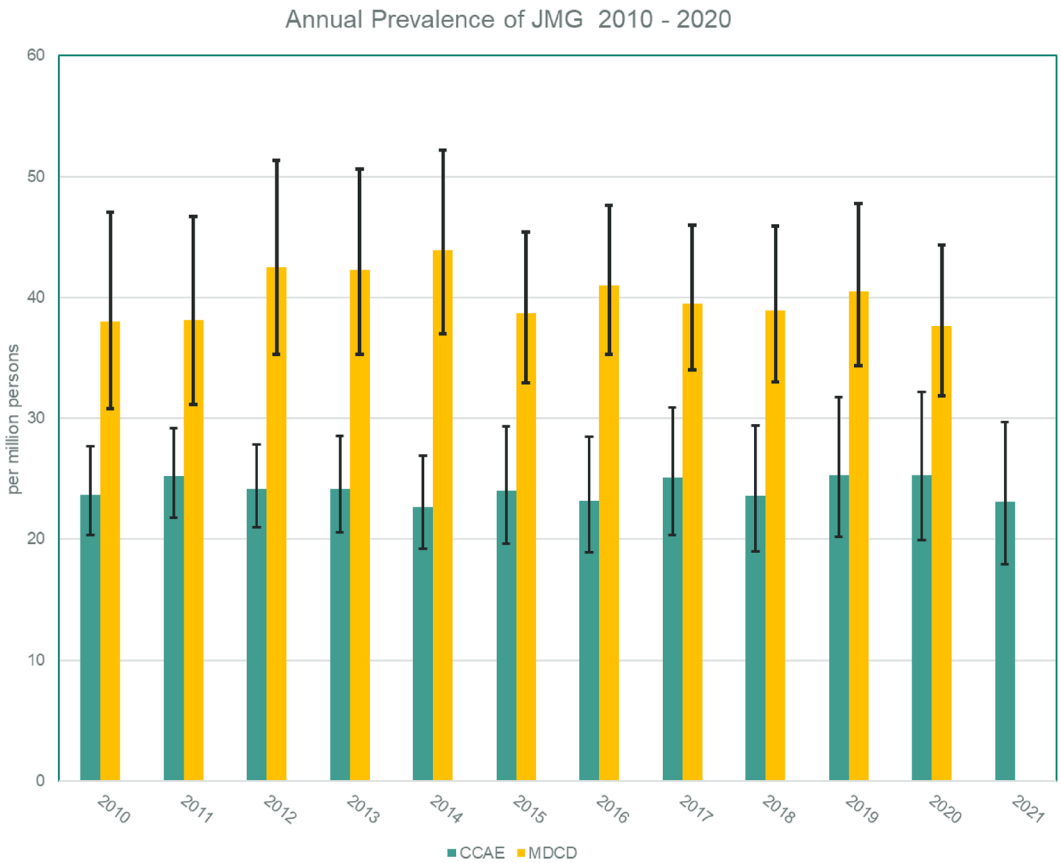

Fig. 2 Annual prevalence and 95% CI per 1,000,000 persons in the period 2010–2020. *CCAE* commercial claims and encounters database, *CI* confidence interval, *MDCD* multi-state medicaid database

Table 1 Annual incidence and prevalence in the period 2010–2020 by sex

Year	CCAE						MDCD					
	Incidence per million person-years			Prevalence per million persons			Incidence per million person-years			Prevalence per million persons		
	Female	Male	IR	Female	Male	PR	Female	Male	IR	Female	Male	PR
2010	9.1	3.9	2.3	30.4	17.3	1.8	12.7	9.3	1.4	49.9	27.1	1.8
2011	10.1	5.1	2.0	32.2	18.5	1.7	9.9	7.6	1.3	49.9	26.5	1.9
2012	6.2	4.7	1.3	30.4	18.2	1.7	21.1	8.0	2.6	55.6	29.8	1.9
2013	6.1	4.1	1.5	28.6	20.1	1.4	12.4	7.4	1.7	55.4	29.5	1.9
2014	4.7	4.2	1.1	28.4	17.3	1.6	18.0	8.2	2.2	60.7	27.2	2.2
2015	8.5	3.1	2.8	33.2	15.2	2.2	11.2	6.5	1.7	49.9	27.7	1.8
2016	7.6	5.2	1.5	31.8	15.0	2.1	11.5	7.3	1.6	55.1	27.7	2.0
2017	8.5	4.6	1.8	33.1	17.3	1.9	10.1	4.3	2.4	52.0	28.3	1.8
2018	4.4	5.4	0.8	28.4	19.1	1.5	8.5	3.4	2.5	48.8	30.1	1.6
2019	10.1	–	–	31.1	19.8	1.6	12.5	9.9	1.3	49.8	32.2	1.5
2020	8.8	–	–	34.0	17.0	2.0	9.6	7.9	1.2	46.3	29.8	1.6

Data cells with five or fewer cases were suppressed

CCAE Commercial Claims and Encounters Database, *IR* incidence ratio of female versus male population, *MDCD* Multi-State Medicaid Database, *PR* prevalence ratio of female versus male population

in every year during the study period, except for incidence in 2018 in the CCAE database. Although prevalence was substantially higher in MDCD than CCAE for both sexes across all years, the female-to-male prevalence ratio remained relatively consistent throughout the study period and was similar across the two databases. In 2020 (the most recent timepoint), girls had 1.6–2.0 times the prevalence of JMG versus boys in the two databases.

Incidence and Prevalence of JMG by Age of Onset

Within each age-of-onset group, no clear trends in the incidence or prevalence of JMG were observed over the study period (Table 2). When comparing between age-of-onset groups, the incidence was generally higher in the MDCD database than the CCAE database, and especially for the 2- to 5-year-old group. Prevalence generally increased with age within each database, with the MDCD database showing higher prevalence for each age group versus the CCAE database. When comparing prevalence ratios between females and males in the 11–17 years and 2–10 years age groups separately, the older group consistently exhibited a higher ratio (Supplement Table 3).

Incidence and Prevalence of JMG by Race/Ethnicity

Race/ethnicity information was only included in MDCD and only results for the White and Black subgroups are reported here. The annual median proportion of Black people was 32.6%, and of White people was 41.7% in the underlying MDCD study population from 2010 to 2020. As shown in Table 3, the incidence was observed to be higher in the Black population than the White population for all years with available

Table 2 Annual incidence and prevalence in the period 2010–2020 by age-of-onset groups

Year	CCAE						MDCD					
	Incidence per million person-years			Prevalence per million persons			Incidence per million person-years			Prevalence per million persons		
	2–5 years	6–11 years	12–17 years	2–5 years	6–11 years	12–17 years	2–5 years	6–11 years	12–17 years	2–5 years	6–11 years	12–17 years
2010	5.1	5.4	8.0	13.3	18.5	33.5	13.1	7.6	12.7	23.4	34.7	58.1
2011	5.6	5.1	10.7	13.9	23.8	32.2	9.3	9.2	8.8	27.6	33.8	55.1
2012	3.8	4.3	7.2	11.0	21.7	32.8	19.0	10.8	13.8	41.0	34.0	55.1
2013	5.1	2.9	7.0	9.8	19.6	35.3	15.0	5.8	9.7	42.8	34.1	52.0
2014	–	–	7.5	11.6	17.9	32.3	13.5	11.5	14.2	39.1	33.4	61.3
2015	–	4.2	7.9	16.0	20.2	31.1	10.8	6.8	9.5	33.6	38.6	43.2
2016	–	–	11.7	7.6	17.9	35.1	6.7	7.5	13.3	28.5	44.1	46.9
2017	8.8	–	8.9	14.1	17.1	37.0	6.6	7.4	7.1	20.8	46.5	45.5
2018	–	–	5.0	13.0	19.4	32.4	7.9	4.4	5.8	22.5	45.0	44.2
2019	–	7.8	5.7	16.6	27.8	27.3	11.7	6.9	15.2	24.5	38.8	53.9
2020	–	–	9.9	18.6	20.9	32.2	10.8	8.5	7.5	25.4	34.9	49.0

Data cells with five or fewer cases were suppressed

CCAE Commercial Claims and Encounters Database, *MDCD* Multi-State Medicaid Database

Table 3 Annual incidence and prevalence in the period 2010–2020 by race/ethnicity in MDCD

Year	Incidence per million person-years			Prevalence per million persons		
	Black	White	IR	Black	White	PR
2010	8.7	9.5	0.9	45.3	30.1	1.5
2011	9.2	6.2	1.5	44.6	25.3	1.8
2012	25.6	–	–	54.9	22.1	2.5
2013	10.2	–	–	59.3	17.6	3.4
2014	17.9	8.7	2.0	61.4	20.2	3.0
2015	11.2	6.3	1.8	57.5	17.3	3.3
2016	13.1	7.5	1.8	53.3	23.2	2.3
2017	9.2	–	–	50.8	23.1	2.2
2018	6.4	5.5	1.2	49.9	23.5	2.1
2019	11.3	7.9	1.4	50.5	24.7	2.1
2020	14.8	8.4	1.8	55.7	22.7	2.5

Data cells with five or fewer cases were suppressed

IR incidence ratio of Black versus White, *MDCD* Multi-State Medicaid Database, *PR* prevalence ratio of Black versus White

data, except for 2010. The prevalence by race was 1.5–3.4 times higher in the Black population than in the White population throughout the study period.

DISCUSSION

This study contributes to filling the knowledge gap in JMG by describing the incidence and prevalence of JMG over the decade from 2010 to 2020 overall and across different sex, age, and race/ethnic groups. For the most recent timepoint of 2020, we estimated the JMG incidence to be 5.9 per million person-years in the CCAE database and 8.7 per million person-years in the MDCD database. The prevalence of JMG remained fairly consistent over the years within each database, with 25.3 per million population in CCAE and 37.6 per million population in MDCD in 2020. We did not observe an obvious trend for change of the JMG incidence or prevalence over the study period. Our study found that both the incidence and prevalence of JMG were higher in girls than boys under 18, as well as the highest incidence among 2- to 5-year-olds in MDCD, aligning with findings from another recent US claims database study [14]. We found that the incidence of JMG in the MDCD database was higher than reported in the previous US study, but the prevalence was comparable for all age groups. In contrast, the prevalence in the CCAE database was lower than both MDCD and the previous study [14]. Although COVID-19 likely had a significant impact on the diagnosis and management of JMG, including delayed diagnoses and reduced access to healthcare visits, the overall incidence and prevalence of JMG in 2020—when the pandemic began—did not show notable increases or decreases compared to previous years in either database.

Epidemiological studies of JMG are very limited due to the rarity of the disease, with even fewer examining differences by race. JMG has been reported in a smaller study to be more common in individuals with African ancestry in South Africa [8]. The Medicaid program, a public health insurance program that provides health coverage to low-income US populations, overall enrolls a higher proportion of Black and a lower proportion of White people compared

with their representation in the overall national population [19]. The 2022 American Community Survey showed that 39% of the Black nonelderly population were covered by Medicaid, compared with just 20% of the White nonelderly population [20]. Although the MDCD database represents a limited population, it has provided significant value for clinical research by including some detailed demographic information, such as race [21]. We found both incidence and prevalence of JMG to be higher in the Black population than in the White population over the study period, with the MDCD database consistently reporting higher incidence and prevalence of JMG than the CCAE database. This pattern can likely be attributed to the different demographic composition of the two databases, with a larger Black population in the MDCD. However, the lack of race/ethnicity information in CCAE and more detailed classifications in MDCD prevented us from further examining the difference across race/ethnicity groups.

As with any secondary data source, there are limitations with MarketScan® data that must be acknowledged. CCAE and MDCD are both convenience samples (private and government-funded medical insurance) and, therefore, generalizability of the findings to the general US population is limited. This limitation is particularly pronounced, given the smaller sample size of CCAE in the later years of the study period. The CCAE data size started declining around 2015 as some insurers and employers stopped contributing data. The reduction in annual population size has the potential to reduce statistical power and make the results less generalizable in the more recent years. Further research into JMG epidemiology is warranted in the future as larger and more comprehensive databases become available. Additionally, ICD codes in claims databases are unable to distinguish between possible and confirmed cases. Misclassification of JMG cases could occur in the case of doctors misdiagnosing patients with JMG or wrongly coding in the claims. Requiring two MG diagnosis codes at least 90 days apart to confirm a JMG case was intended to ensure robustness against erroneous misclassification. MG codes recorded before the age of 2 were excluded from JMG identification to minimize the possibility of congenital myasthenic syndrome or other similar diagnoses which occur at younger ages. However, this approach also carries the risk of underestimating the true values of incidence and prevalence, as some cases may have been lost to follow-up following the first diagnosis. Furthermore, we were unable to distinguish between ocular MG, the subtype that affects only the muscles that move the eyes and eyelids, and generalized MG, which affects muscles throughout the body, because the current ICD coding system assigns the same code to the two subtypes.

CONCLUSION

JMG is a rare disease and the lack of knowledge about its incidence and prevalence makes planning diagnostic, therapeutic, and care services for children with JMG difficult.

Limited studies are available that report the incidence and prevalence of JMG, especially in the US. Understanding the incidence and prevalence of JMG is crucial for optimizing its management. Therefore, the findings from this comprehensive evaluation significantly contribute to the expanding knowledge of the demographic characteristics of the JMG population. Specifically, we found incidence and prevalence to be markedly higher in girls and Black people under 18. The data from this large population study reveal that age, race/ethnicity, and sex collectively may influence JMG occurrence. Furthermore, our findings indicate that the burden of JMG might have been underestimated, and that further research or investigation may be warranted to explore the impact of JMG on affected individuals and their caregivers in the US.

Authorship. All named authors meet the International Committee of Medical Journal Editors (ICMJE) criteria for authorship for this article, take responsibility for the integrity of the work as a whole and have given their approval for this version to be published

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Data Availability. The MarketScan® datasets analyzed during the current study are commercially available from Merative (https://www.merative.com/real-world-evidence).

Declarations

Conflict of Interest. Jiachen Zhou, Anna Kuba, Sigrid Nilius, Thaïs Tarancón and Frank Tennigkeit are employees and shareholders of UCB. Olga Pilipczuk is an employee of UCB.

Ethical Approval. The MarketScan® databases used in this study contain fully de-identified/anonymized data and are fully compliant with the Health Insurance Portability and Accountability Act (HIPAA); therefore, this study was exempt from institutional review board approval and patient consent was not required.

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