

Estimating the Economic Burden of Migraine on US Employers

Aylin Yucel, PhD; Andrew Thach, PhD; Sharanya Kumar, PhD; Catherine Loden, BS; Mark Bensink, PhD; Neil Goldfarb, BA; and Robert Cowan, MD

Migraine is among the most common neurological diseases worldwide. It is characterized by recurrent headaches that can last from 4 to 72 hours¹ and is often accompanied by other disabling symptoms such as nausea or vomiting and/or photophobia and phonophobia.^{1,2} Migraine is classified as episodic migraine (EM; < 15 headache days per month for > 3 months) or chronic migraine (CM; ≥ 15 headache days per month for > 3 months, which on ≥ 8 days per month has features of migraine headache).^{1,3}

In the 2016 Global Burden of Disease Study, migraine was the fifth leading cause of years lived with disability in the United States.⁴ More than 28% of individuals with migraine experience reduced work and school productivity.⁵ In addition to headache, disabling symptoms (such as fatigue, irritability, difficulty concentrating, stiff neck, phonophobia, and nausea) are reported in 80% of adults with migraine and may further decrease work and school productivity.² The total indirect cost associated with migraine in the United States has been estimated at \$19.3 billion (inflated to 2019 US\$),⁶ 81% of which is attributable to absenteeism (full days of productive workforce loss).⁷ This estimate does not include presenteeism (days worked with diminished productivity), which may add further indirect costs.⁷

Compared with the general population, individuals with migraine incur substantially higher health care costs. In a retrospective analysis of US health care claims data from January 1, 2007, to June 30, 2013, the annual direct health care costs (including outpatient and inpatient care, prescriptions, and emergency department [ED] care) for individuals with migraine were estimated at \$22,364 per person, compared with \$15,697 for individuals without migraine (inflated to 2019 US\$).^{6,8}

Migraine thus represents a substantial economic burden to the health care system and employers in the United States.⁹ However, because migraine is often not diagnosed or coded correctly, its impact on workers and costs is unrecognized or underestimated.¹⁰ It is critical for employers to be aware of the severity of the economic burden of migraine on their workforces and to emphasize to payers or insurers the importance of migraine management in reducing this burden. Because there are impactful new prevention and

ABSTRACT

Migraine is a leading cause of disability globally. Individuals with migraine experience reduced work productivity and greater health care costs compared with the general population. The Migraine Impact Model (MIM) is an interactive calculator developed to estimate the economic burden of migraine on United States–based employers. We demonstrate use of the model with 4 case studies from different industries (education, manufacturing, retail/trade, and entertainment).

The MIM estimates migraine prevalence among employees and the employer's annual migraine-associated costs by applying published, licensed, and publicly available data and several underlying assumptions to employee population information that is inputted by users.

User inputs include the employer's industry, geographic location, and workforce characteristics (number of employees, gender distribution, and average age and compensation). Model outputs include estimated migraine prevalence, annual workdays affected by migraine, and annual migraine-associated indirect and direct costs to the employer.

In the case studies presented, workforce size ranged from 18,800 to 250,000, representing midsized to larger employers. Employee gender distribution ranged from 29% to 74% women, and mean employee age was either 41 or 44 years. The model-estimated percentage of employees with migraine ranged from 14% to 19%. The model projected approximately 60,000 to 686,000 annual workdays to be affected by lost productive time due to migraine (often referred to as "absenteeism" and "presenteeism") and estimated annual indirect costs to total between 6.2 and 8.5 times the annual direct costs.

The MIM estimates the economic burden of migraine on a company's workforce, which may aid employers in making data-driven decisions to reduce that burden for employees and business.

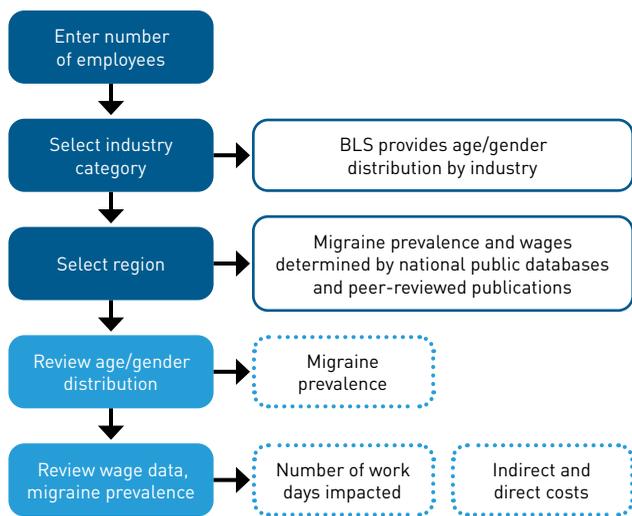
Am J Manag Care. 2020;26(12):e403-e408. doi:10.37765/ajmc.2020.88547

TAKEAWAY POINTS

Individuals with migraine experience reduced work productivity and greater health care costs compared with the general population. The evidence-based interactive Migraine Impact Model estimates the economic burden of migraine to educate employers on the potential prevalence and impact of migraine in their workforce.

- ▶ Model inputs were data from peer-reviewed publications; licensed and publicly available statistics; and users' input regarding company's industry, geographic location, and employee information (total number of employees, gender distribution, average age, and average compensation).
- ▶ Resulting outputs were estimated number of affected employees with migraine (by gender and migraine classification), annual workdays affected by migraine, and indirect and direct costs.

FIGURE. Calculation Framework: How the Model Works



BLS, Bureau of Labor Statistics.

treatment options available today, employers could benefit from estimating the burden of migraine in their workforce. Inspired by an earlier effort, the Productivity Impact Model developed by Newristics LLC with support from the Pharmaceutical Research and Manufacturers of America,¹¹ developers produced the Migraine Impact Model (MIM) based on peer-reviewed data sources to help US-based employers estimate the cost of migraine for their workforce, aiding data-driven decisions that may help reduce the burden on their employees and their business. Here we present results from 4 case studies from different industries to demonstrate the value of the model in estimating the differential impact of migraine burden across industries.

Overview of the MIM

The MIM is a web-based calculator application that is available at www.migraineburden.com. The model is based on an interactive calculator that guides the user to enter information about the subject company, including size, type of industry, and geographic

location. This information is used to estimate the prevalence of migraine within the workforce. Using an estimate of days lost per year due to migraine (absenteeism plus presenteeism; ie, lost productive time [LPT]) and of total employee compensation (wages plus benefits), the model produces annualized estimates of indirect costs due to migraine (Figure). In addition, the model uses health care costs directly related to migraine treatment, including cost of prescription drugs, outpatient visits, ED visits, and urgent care visits, to estimate direct health

care costs. Direct and indirect estimates are summed to present the total annual economic burden of migraine for the employer.

Model assumptions. Although about half of the population with migraine may never have been diagnosed, the model assumes that all employees affected by migraine are diagnosed and treated because (1) this assumption will help estimate the maximal costs of treatment for all affected employees and (2) all employees with migraine will suffer from its burden, regardless of having been diagnosed. Additionally, the model relies on the human capital approach to represent the value of time missed from work (ie, absenteeism) and/or from reduced productivity (ie, presenteeism). This approach assumes that an employee's compensation is directly related to the economic output or productivity of that employee. When an employee is absent, the company might replace the employee with a temporary worker, incurring replacement costs that are likely to be equal to or higher than the absent employee's compensation. Alternatively, the company might not replace the employee and suffer a loss in output, which is also related to the employee's compensation. In both cases, the employee's daily compensation is used as a proxy for the impact to the employer.

Indirect cost estimations assume that employees are full-time employees who work 8 hours per day, 5 days per week (not including personal time off or holidays). Each year is assumed to be composed of 52 weeks and 12 calendar months. The model also assumes that all employees suffering from migraine experience absenteeism and presenteeism.

Additionally, the model assumes that employees without migraine or any illness are 100% productive.

Model inputs. The model relies on information input by the user and published, licensed, and publicly available data related to the following 4 parameters, which are summarized in Table 1.^{3,5,12-15}

- **Company information.** The user is prompted to select the industry (or up to 4 industries) that best represents the workforce of the company. Industry categories are based on the North American Industry Classification System and Bureau of Labor Statistics (BLS) data.¹² Based on the industry classification and location of the company, the model uses BLS data to estimate the percentage of men and women employed and their average age. The user may enter more specific information for the company on age and gender if available. Age and gender distribution

TABLE 1. Migraine Impact Model Inputs^{3,5,12-15}

Model parameter	Source
Company information	
Industry category	BLS ¹²
Age and gender distribution	Estimated according to BLS ¹² or input by user
Migraine prevalence	
National estimates of migraine prevalence	CDC (2015) ¹³
Prevalence of chronic migraine vs episodic migraine in men and women	Buse et al (2012) ³
Prevalence of high-frequency and low-frequency episodic migraine	Lipton et al (2007) ⁵
Indirect costs	
Lost productive time	AMPP study (Stewart et al [2010]) ¹⁴
Cost associated with lost time based on average wages and benefits	Estimated according to BLS ¹² or input by user
Direct costs	
Direct costs in patients with migraine	Retrospective analysis of the Truven Health MarketScan Research Databases (Bonafede et al [2017]) ¹⁵

AMPP, American Migraine Prevalence and Prevention; BLS, Bureau of Labor Statistics.

is important because the prevalence of migraine is higher in women than in men and varies according to age (Table 2^{3,13}).⁵ The amount of LPT also varies by age.¹⁶

- **Prevalence of migraine.** The prevalence of migraine within the company is estimated based on the national prevalence of migraine obtained from the CDC,¹³ accounting for an estimated distribution of CM vs EM³ (Table 2). Note that CDC data include employed and unemployed individuals and the model assumes that migraine prevalence between the 2 groups is comparable.
- **Estimates of indirect cost.** The burden of migraine is related to LPT, which includes absenteeism and presenteeism.¹⁷ The model uses estimates for lost workday equivalents per year based on the national longitudinal American Migraine Prevalence and Prevention study (Table 3).¹⁴ The cost associated with the LPT is projected using average wages and fringe benefits based on BLS data.¹² The user may also input company-specific wages and benefits data if available. The LPT cost for the company is calculated by multiplying the LPT by BLS or user-inputted wage data.
- **Estimates of direct cost.** The model uses cost estimates from a retrospective analysis of the licensed Truven Health MarketScan Research Databases.¹⁵ The databases contain commercial and Medicare claims data from employer-sponsored health plans across the United States. Annual migraine-related direct cost (outpatient, inpatient, and prescription medication [acute and preventive] costs) is estimated to be \$1887 per patient for high-frequency EM and CM. Patients with low-frequency EM are not eligible for preventive therapy according to the American Academy of Neurology/American Headache Society guidelines; the annual cost for these patients is estimated at \$163.80 (Amgen, data on file for low-frequency EM, 2018), which is the cost of acute medications used by these patients. Costs for hospital visits are not included for low-frequency EM, as it is assumed that these patients are less likely to access such services.

TABLE 2. Prevalence of Migraine Used in the Migraine Impact Model^{3,13}

Patient group	Prevalence (%)		Source
	Men	Women	
Age range in years			CDC (2015) ¹³
20-34 ^a	11.3	24.7	
35-44 ^a	11.3	24.7	
45-54	10.9	22.5	
55-64	8.4	16.5	
≥ 65	4.7	6.3	
Migraine classification			Buse et al (2012) ³
Episodic	91.5	92.5	
Chronic ^b	8.5	7.5	

^aIn this model, age groups were redefined as 20 to 34 years and 35 to 44 years, and the prevalence reported by the CDC for the group aged 18 to 44 years was used for both groups.

^bChronic migraine was defined as more than 44 headache days in the last 3 months.

Model outputs. Model outputs include estimates of the prevalence of migraine (number of affected employees), the number of annual workdays affected by migraine (by gender and migraine classification [episodic vs chronic]), LPT costs, and annual direct costs (including outpatient, inpatient, and prescription drug costs).

Case Studies

We demonstrate use of the MIM via 4 case studies estimating the annual economic burden of migraine based on data inputs from employers across 4 different industries.

Case study 1: education. This case study illustrates a school district in the mid-Atlantic that has 18,800 full-time employees. The average age of employees is 44 years and 74% of employees are female. With this input information, the model estimates that 19% (n=3480) of employees are affected with migraine (Table 4; eAppendix Figure A [eAppendix available at ajmc.com]). Of the

TABLE 3. Estimates of Lost Productive Time Used in the Migraine Impact Model^{14,a}

Lost productive time, days/person/year	Headache days in the past 3 months			Total N = 6204
	Low-frequency EM (< 10 days) n = 3697	Moderate- and high-frequency EM (10–44 days) n = 2232	CM (> 44 days) n = 275	
Absenteeism ^b	4.6	7.4	9.1	5.8
Presenteeism ^c	9.1	17.3	28.0	12.9
Total	13.7	24.7	37.1	18.7

CM, chronic migraine; EM, episodic migraine.

^aBased on the American Migraine Prevalence and Prevention study [Stewart et al [2010]].¹⁴

^bAbsenteeism estimated as total hours per week absent from work.

^cPresenteeism estimated as total hours per week of health-related reduced performance on days at work.

TABLE 4. Case Study Results

	Case study			
	1	2	3	4
Employer characteristic				
Industry category	Education	Manufacturing	Retail/trade	Entertainment
Size of workforce	18,800	138,000	250,000	90,000
Geographic region	Mid-Atlantic	South Central	National	Pacific West
Gender, %				
Male	26	71	52	54
Female	74	29	48	46
Average age in years	44	44	41	41
Average daily wage				
Male, US\$	249.92	223.05	209.80	229.88
Female, US\$	236.97	164.08	155.40	169.06
Benefits, %	30.0	35.1	29.9	29.5
Number of affected employees with migraine				
3480	18,866	39,699	13,991	
By gender, %				
Male	15	54	34	36
Female	85	46	66	64
By migraine type, %				
Chronic	8	8	8	8
Episodic	92	92	92	92
Annual indirect costs				
Workdays affected by migraine	60,069	329,101	685,919	240,749
Lost productive time, ^a US\$	18,579,642	87,083,805	154,910,940	59,484,075
Annual direct costs				
Direct costs including outpatient, inpatient, and prescription drug costs, US\$	2,187,276	11,988,006	25,088,402	8,844,918

^aAbsenteeism and presenteeism.

affected employees, 86% (n=2978) are projected to be women and 92% (n=3213) are classified as having EM. When inputting an average daily wage of \$249.92 for men and \$236.97 for women with 30% benefits, 60,069 annual workdays are estimated to be affected by migraine and the projected annual LPT costs are approximately \$18.6 million. The direct costs for this school district are estimated to be nearly \$2.2 million annually, producing a total annual economic impact of \$20.8 million.

Case study 2: manufacturing. This case study describes a manufacturing equipment company in the South Central United States that includes 138,000 full-time employees. The average age of employees is 44 years and 29% of employees are women. The model estimates that 14% (n=18,866) of employees are affected with migraine (Table 4; **eAppendix Figure B**). Of employees affected with migraine, 46% (n=8736) are projected to be women and 92% (n=17,323) are classified as having EM. Although a lower percentage of women compared with men are employed with this company, the percentage of men and women affected with migraine is comparable. This is consistent with the observation that migraine prevalence is higher in women than in men.⁵ With an average daily wage of \$223.05 for men and \$164.08 for women, with 35.1% benefits, the model calculates that 329,101 annual workdays are affected by migraine and the projected LPT costs are greater than \$87 million per year. This employer's MIM estimated annual direct costs totaling almost \$12 million, producing a total annual economic impact of \$99 million.

Case study 3: retail/trade. This case study illustrates a national retail pharmacy chain that includes 250,000 full-time employees. The average age of employees is 41 years and 48.1% of employees are women. Based on these company specifics, 16% (n=39,699) of employees are estimated to be affected with migraine (Table 4; **eAppendix Figure C**). Although similar proportions of women and men are employed, a greater proportion of women are projected to be affected with migraine (66% [n=26,265]) compared with men (34% [n=13,434]). Of employees affected with migraine, 92% (n=36,553) are predicted to be classified as having EM. With average daily wages of \$209.80 for men and \$155.40 for women and 29.9% benefits, 685,919 workdays

were estimated to be affected and LPT is calculated to cost roughly \$155 million annually. The model calculated the employer's annual direct costs to be just more than \$25 million, producing a total annual economic impact of \$180 million.

Case study 4: entertainment. This case study details an entertainment company in the Pacific West that includes 90,000 full-time employees. The average employee age is 41 years and 46.1% of employees are women. The model estimates that 16% (n = 13,991) of employees are affected by migraine (Table 4; [Appendix Figure D](#)). Of those affected, 64% (n = 8998) are projected to be women and 92% (n = 12,880) are classified as having EM. With an average daily wage of \$229.88 for men and \$169.06 for women and 29.5% benefits, 240,749 annual workdays were projected to be affected, and the model calculates LPT to cost the company approximately \$59 million. The annual direct costs are estimated to be \$8.8 million annually, producing a total annual economic impact of \$68 million.

DISCUSSION

The MIM was developed and is managed by Amgen Inc and Novartis Inc. It was designed to assist employers with estimating the prevalence of affected employees with migraine in their workforce and the associated indirect, direct, and total costs. The MIM was developed based on peer-reviewed data and licensed and publicly available statistics, combined with inputs from the user about their workforce, to produce an estimated employer burden.

Our model assumes that all employees experiencing migraine have a diagnosis of migraine to help estimate the total migraine burden. However, underdiagnosis and misdiagnosis are ongoing barriers to appropriate treatment for those affected by migraine^{11,18,19} and may likely cause estimates of migraineurs from the company's claims database to differ from MIM estimates. Regardless of diagnosis, employees suffer from absenteeism and presenteeism on migraine days and recovery days, which can significantly affect indirect costs. The MIM may provide a more accurate estimation of indirect costs because it includes presenteeism in its calculation, unlike previously reported indirect costs that included only absenteeism. This is exemplified in the first case study of the school district (Table 4; [Appendix Figure A](#)), for which the estimated LPT costs totaled a substantial \$18.6 million, despite having the fewest number of employees (n = 18,800). Moreover, the presented case studies demonstrate that workforce size and total costs are not linearly correlated. Various employer characteristics factor into the estimation and outcome of total costs (direct and indirect costs), further emphasizing the need to assess economic burden with individual employer-specific characteristics.

This model's estimations do not include other potential consequential costs that employers may experience due to migraine burden, such as costs associated with missed daily quotas or deadlines. These additional industry-specific productivity and performance metrics may further increase economic burden on the employer and highlight the value for employers in evaluating the economic burden

of migraine on their business.²⁰ This value has been demonstrated by the development and launch of economic burden calculators for other conditions such as alcohol and substance abuse, diabetes, depression, and food insecurity.²¹⁻²⁴

The model also focuses exclusively on migraine-specific costs. There may be an inverse relationship between expenditures in one area of health care (eg, migraine treatment) and costs in others (eg, ED visits).²⁵ With additional evidence of this relationship, it may be important to broaden the perspective and include total health care costs in future models.

The proper diagnosis and treatment of migraine leads to a reduction in direct and indirect costs and therefore represents a potential modifiable expense to employers.²⁶ Additionally, reducing the burden of migraine to employees constitutes a significant quality-of-life benefit.²⁷ This underlines the importance of and potential for migraine management in reducing the economic burden associated with migraine, which should be further emphasized to payers/insurers.

Although migraine is recognized as a principal cause of disability globally, and US guidelines for the diagnosis of migraine were updated in 2018, individuals with migraine remain underdiagnosed and undertreated.^{1,18,20} Therefore, the effects of migraine in the US workforce and its economic burden on the employer may be underestimated, highlighting the need for better management of this disorder. The underestimation in prevalence of migraine in the US workforce, and consequently its economic burden, may be due to potential challenges in optimal diagnosis and suboptimal management of the disease. The prevalence of migraine is shown to be 2 to 3 times higher in women than in men⁵; however, studies caution against the lack of diagnosis and management of this disease among men because of a possible misconception that the disease affects women more.^{10,28,29} Furthermore, individuals with migraine have reported that stigma in the workplace minimizes their perceived value and credibility and worsens their migraine-associated disability.²⁸ They may also suffer from comorbidities such as depression and chronic pain, which can further add to direct and total costs.¹⁷ Employers who promote education and migraine intervention in the workplace and, when appropriate, accommodation in the work environment (eg, adjusting lighting, noise, odor exposure, and level of computer work) may mitigate discomfort and disability in their workers, as well as increase productivity and reduce health care costs.^{28,30} Therefore, adapted workplace environments that are more supportive of individuals with migraine may assist in reducing this disability and consequently reducing lost income. This underscores the potential economic benefit to a company taking these and other measures to better support their employees burdened by migraine.

Limitations

Although the MIM was developed to serve as a useful tool to estimate the burden of migraine on employers, several limitations to the model exist. Data used to develop the model were taken from a variety of studies with different study populations and include self-reported

information from those with migraine, which could be potentially unreliable. Additionally, the publicly available wage and benefits data from the BLS are limited to those in the US population who are 20 years and older. However, in this model, these data are applied to those in the workforce estimated to be affected with migraine who are 18 years and older. Lastly, the actual costs incurred by the employer may differ from those estimated by the calculator. This may be driven by how closely the inputs reflect the user's workforce characteristics, as user inputs may be modified to more optimally reflect the user's workforce. At the same time, a number of these limitations are potentially remediable with further development (eg, in the future, data acquired passively or in real time from wearable devices may address limitations with self-reported data). Additionally, the MIM does not capture or account for practice patterns or certain patient-related factors such as treatment adherence or degree of disability suffered from migraine, which are beyond the scope of the model.

CONCLUSIONS

Employers can now use the MIM as a useful tool to estimate the economic burden of migraine and make better decisions for workplaces afflicted by its disabling effects. By doing so, employers will be better equipped to introduce mitigating measures (education, migraine screening, real-time monitoring, and improved prevention) and more appropriately manage resources, sickness policies, health insurance, wellness, care management, and other programs to reduce the impact of migraine on their employees and, ultimately, their business. ■

Acknowledgments

The authors wish to thank Stephanie Weng, PhD, and Claudette Knight, PharmD, of Fishawack Health for medical writing assistance in the preparation of this manuscript, which was funded by Amgen Inc.

Author Affiliations: Amgen Inc (AY, AT, MB), Thousand Oaks, CA; Newristics LLC (SK, CL), Scottsdale, AZ; Philadelphia Business Coalition on Health (NG), Philadelphia, PA; Stanford University (RC), Stanford, CA.

Source of Funding: Funding for this work was provided by Amgen Inc.

Author Disclosures: Dr Yucel, Dr Bensink, and Dr Thach are former employees of Amgen, which has an antimigraine product, Aimovig. Dr Goldfarb was funded by Amgen to do research on costs of care for migraine and has had paid speaking engagements where that work was presented. The remaining authors report no relationship or financial interest with any entity that would pose a conflict of interest with the subject matter of this article.

Authorship Information: Concept and design (AY, AT, SK, CL, NG, RC); acquisition of data (AY, AT, SK, CL); analysis and interpretation of data (AY, AT, MB, NG); drafting of the manuscript (AY, AT, MB, NG, RC); critical revision of the manuscript for important intellectual content (AY, AT, SK, CL, MB, NG, RC); obtaining funding (AT); administrative, technical, or logistic support (AT); and supervision (AT, MB).

Address Correspondence to: Aylin Yucel, PhD, c/o David Chandler, Amgen Inc, One Amgen Center Drive, Mail Stop 36-2-B, Thousand Oaks, CA 91320. Email: dchandle@amgen.com.

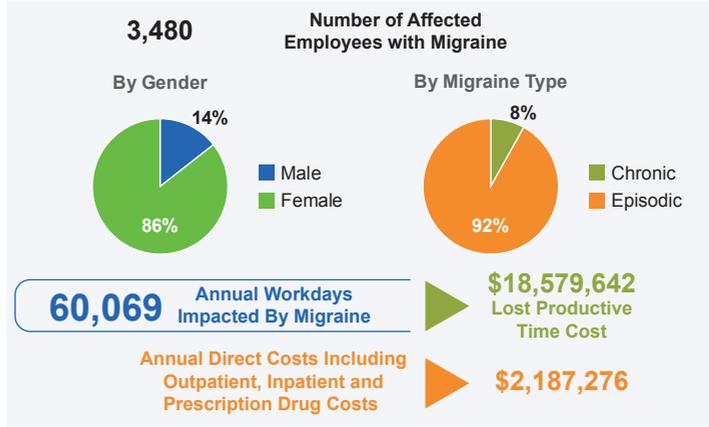
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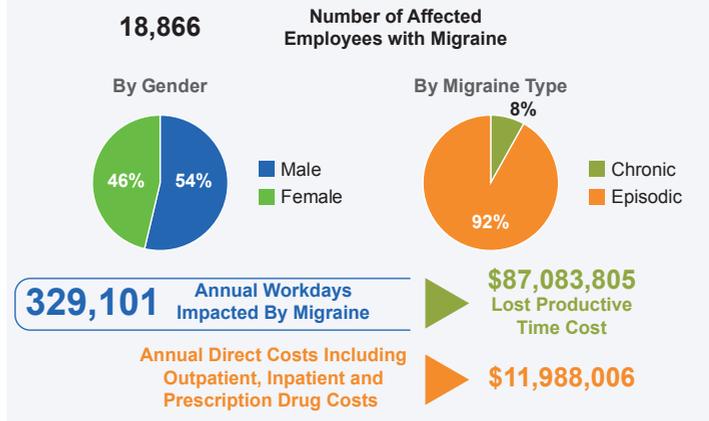
a Case Study 1: School District

Employer Characteristic	Input
Size of Workforce	18,800
Industry	Education
Geographic Region	Mid Atlantic
Composition of Workforce by Age and Gender	
Male	26%
Female	74%
Average age, years	44
Average Daily Wage	
Male	\$249.92
Female	\$236.97
Benefits	30.0%



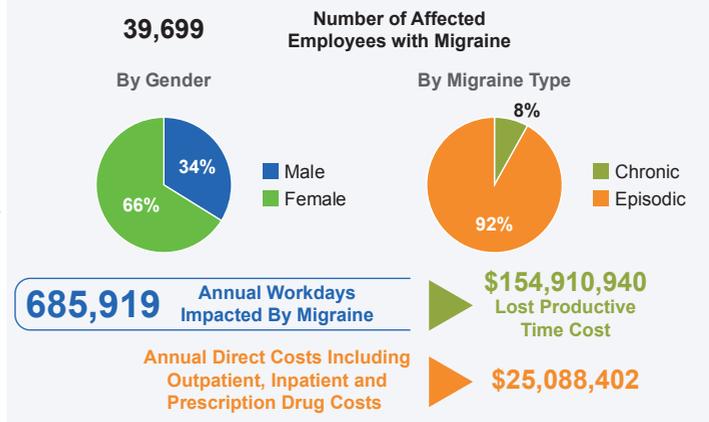
b Case Study 2: Manufacturing Equipment Company

Employer Characteristic	Input
Size of Workforce	138,000
Industry	Manufacturing
Geographic Region	South Central
Composition of Workforce by Age and Gender	
Male	71%
Female	29%
Average age, years	44
Average Daily Wage	
Male	\$223.05
Female	\$164.08
Benefits	35.1%



c Case Study 3: Retail Pharmacy Chain

Employer Characteristic	Input
Size of Workforce	250,000
Industry	Retail/Trade
Geographic Region	National
Composition of Workforce by Age and Gender	
Male	51.9%
Female	48.1%
Average age, years	41
Average Daily Wage	
Male	\$209.80
Female	\$155.40
Benefits	29.9%



d Case Study 4: Entertainment

Employer Characteristic	Input
Size of Workforce	90,000
Industry	Entertainment
Geographic Region	Pacific West
Composition of Workforce by Age and Gender	
Male	53.9%
Female	46.1%
Average age, years	41
Average Daily Wage	
Male	\$229.88
Female	\$169.06
Benefits	29.5%

