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# Economic Impact of Headache and Psychiatric Comorbidities on Healthcare Expenditures Among Children in the United States: A Retrospective Cross-Sectional Study

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## Abstract

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*Conflicts of Interest:* None

**Objective.—**To examine the annual healthcare expenditures associated with childhood headache in the United States, and to evaluate whether psychiatric comorbidities increase the impact of headache on expenditures.

**Background.—**Headache is prevalent in childhood and co-occurs with anxiety disorders, depressive disorders, and attention deficit/hyperactivity disorder (ADHD), which may increase cost of illness.

**Methods.—**We conducted a secondary data analysis using a nationally representative sample of 34,633 children ages 2–17 from the 2012–2015 Medical Expenditure Panel Surveys (MEPS), of which 779 (weighted 2.6%) were identified as having headache based on health service use associated with headache. Using a comprehensive cost-of-illness approach, we assessed the incremental expenditures associated with headache and determined excess expenditures associated with psychiatric comorbidities using standard adjusted 2-part expenditure models.

**Results.—**Annual total healthcare expenditures were estimated to be 24.3% higher, 95% CI [1,55], in our headache group ($3036, 95% CI [2374,3699] vs $2350, 95% CI [2140,2559]). Total national expenditures associated with pediatric headache in the United States were estimated at $1.1 billion annually, 95% CI [.04, 2.2 billion]. Depression and ADHD were associated with higher incremental expenditures for the headache group (depression: $1815, 95% CI[676,2953] vs $1409, 95% CI[697,2112]; ADHD: $4742, 95% CI[1659,7825] vs $2935, 95% CI[1977,3894]); however, interactions between psychiatric comorbidities and headache did not reach statistical significance.

**Conclusion.—**Youth with headache exert a considerable economic burden on families, healthcare systems, and society. Due to the limitations in methods used to classify youth with headache in MEPS, our findings may underestimate the true prevalence and cost of pediatric headache in the United States. Further research with larger sample sizes is needed to understand the impact of psychiatric comorbidities on healthcare expenditures in this population.

### Keywords

healthcare expenditures; economic; cost; headache; migraine; pediatric

## INTRODUCTION

Headache is a prevalent medical condition in childhood. Up to 3 in 4 youth experience at least 1 major migraine or tension-type headache by the age of 15.[1] As headache increases in frequency, youth can experience difficulties attending school, participating in physical activities, and spending time with friends and family.[2,3] Psychiatric comorbidities are also common and are associated with adverse effects including greater disability and increased risk for persistence of headache into adulthood.[4–6] The most prevalent psychiatric comorbidities among youth with headache are anxiety disorders (15–56%), depressive disorders (4.7–25%), and attention deficit/hyperactivity disorder (ADHD) (6.3–18%).[7] Youth with headache are more likely to have at least 1 of these psychiatric comorbidities than the general population of youth in the United States, where prevalence estimates are 7.1% for anxiety disorders, 3.2% for depressive disorders, and 9.4% for ADHD.[8,9] Given the high prevalence and the associated health consequences, headache in childhood may result

in substantial economic costs to families, healthcare systems, and society. Furthermore, the presence of psychiatric comorbidities may modify the effect of headache on healthcare expenditures by increasing disease burden and risk for high expenditures. However, the economic burden of pediatric headache in the United States is largely unknown.

There are 2 studies that compared direct medical expenditures for youth with vs without headache from national databases in the United States. Bethell, Kemper, Gombojav, and Koch[10] examined direct healthcare expenditures (eg, expenditures due to office visits, hospital visits, emergency department visits, prescription medications)[11] among a cohort of youth from the 2007 National Health Interview Survey who self-identified as users of complementary and alternative medicine (CAM). Among CAM users, children with headache had greater direct healthcare expenditures compared to peers without headache ($2219 vs $1503 annually).[10] Pesa and Lage[12] examined direct healthcare expenditures associated with childhood migraine using the 1999–2000 MedStat Marketscan database, which provides health plan-sourced medical data on privately insured individuals. Children identified as having migraine had higher direct medical expenditures compared to peers without migraine ($4200 vs $1400 annually), and expenditures were highest for children with migraine and co-occurring anxiety or depression ($9875). These preliminary findings suggest that healthcare associated with childhood headache is costly and that psychiatric comorbidities may be associated with higher healthcare expenditures.

However, prior research is limited in several ways. First, Pesa and Lage[12] only assessed excess healthcare expenditures due to anxiety or depression in children with migraine and did not consider other psychiatric comorbidities or other headache conditions. Second, Bethell et al[10] assessed expenditures associated with headache only among CAM users and did not consider the broader population of youth with headache seeking healthcare. Third, the studies by Pesa and Lage[12] and Bethell et al[10] only assessed direct healthcare expenditures. Among adults with headache, indirect medical expenditures due to reductions in work productivity are known to exert a substantial burden on families and society.[13–17] Indirect medical expenditures associated with headache in childhood, such as parental productivity losses due to the child's healthcare needs, are largely unknown. In order to determine the total healthcare expenditures associated with pediatric headache, we need to use a comprehensive cost-of-illness approach[11] by evaluating both direct *and* indirect healthcare expenditures associated with childhood headache. Fourth, the annual national expenditures associated with childhood headache in the United States are unknown. This information is critical for administrators and policy makers who allocate resources to pediatric headache treatment and research.

To address these gaps, we used a comprehensive cost-of-illness approach to characterize the current economic burden associated with pediatric headache treated in healthcare settings in the United States including an evaluation of excess expenditures associated with 3 common comorbid psychiatric conditions: anxiety disorders, depressive disorders, and ADHD. We used a current and nationally representative sample of youth ages 2–17 from the 2012–2015 Medical Expenditure Panel Surveys (MEPS). We hypothesized that children with headache would have greater annual total, direct, and indirect healthcare expenditures compared to those without headache. Using these data, we also aimed to estimate the annual national

burden of healthcare expenditures associated with pediatric headache in the United States. Finally, we hypothesized that children with comorbid psychiatric conditions would have greater annual healthcare expenditures compared to those without psychiatric conditions in both groups (headache, non-headache), and that expenditures associated with psychiatric comorbidities would be highest for youth in the headache group.

## METHODS

### Study Design and Data Source.—

We conducted a retrospective cross-sectional analysis of pooled data on all participants ages 2–17 from the MEPS from years 2012 to 2015, which are the most current data available. MEPS is co-sponsored by the U.S. Agency for Healthcare Research and Quality and the Centers for Disease Control and Prevention. The purpose of MEPS is to provide the most contemporary and comprehensive data on healthcare expenditures for a nationally representative sample of the U.S. civilian noninstitutionalized population. Each year, MEPS samples about 39,000 individuals of whom about 10,000 are children 2–17 years of age. One parent per household with the most knowledge about their child's healthcare use is interviewed about their child's sociodemographic characteristics, health conditions, and healthcare utilization over the past year. MEPS then contacts participant's healthcare providers, health systems, and pharmacies to verify accuracy of the parent report data and acquire information about health diagnoses and healthcare expenditures. Detailed descriptions of the MEPS survey design and methods have been published elsewhere https://meps.ahrq.gov/mepsweb/.

This study was formally designated as exempt from review by our IRB because MEPS data are publicly available and de-identified.

### Participants.—

The cohort for our study includes all participants ages 2–17 years of age captured in MEPS from 2012 to 2015 (n = 34,633), which represents the 4 most recent years of available data. MEPS is designed with the intention of combining several years of data for analyses. We chose to analyze a cohort of participants from the 4 most recent years available in order to provide contemporary estimates of healthcare expenditures in this population. Initially, we examined a single year of MEPS data which revealed about 200 children with headache presented for healthcare associated with headache annually. Based on these data and our prior experience analyzing healthcare expenditures in pediatric populations using MEPS, we estimated that 4 years of data would be required in order to have sufficient sample size for our primary analyses.

**Case Definition of Pediatric Headache.——**All health conditions reported by parents were recorded. Children's healthcare providers, health systems, and pharmacies were then contacted to confirm that they had presented for healthcare associated with those health conditions. Health conditions were then coded by professional coders to International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9) codes. For confidentiality, MEPS collapses 5-digit ICD-9 codes to 3-digit ICD-9 codes.

Children were classed into the headache group if they had any of the following 3-digit ICD-9 codes for headache: 339 “primary headache syndromes, including tension headache, cluster headache, other headache syndromes,” 346 “migraine,” and 784 “headache symptoms.”

Due to MEPS sampling procedures, children were given an ICD-9 headache code only when their parents reported that they had headache *and* their healthcare provider/health system verified that they had presented for healthcare associated with headache in the past year. Therefore, our headache group is representative of youth presenting for healthcare associated with headache in the past year. The non-headache group includes all other children who did not have an ICD-9 headache code.

**Case Definition of Psychiatric Comorbidities.——**Psychiatric comorbidities were reported by parents, confirmed by healthcare providers, professionally coded to ICD-9 codes, and grouped into categories known as clinical classification codes (CCC). For our study, we used CCC codes 651 (anxiety disorders), 657 (depressive disorders), and 652 (ADHD) to identify children with psychiatric comorbidities of anxiety, depression, and ADHD.

**Measures.—**

**Healthcare Expenditures.——**We assessed the expenditures associated with childhood headache by calculating average direct and indirect healthcare expenditures per child per year. To allow for comparable estimates, all expenditures were converted to 2016 dollars, adjusted for inflation using the medical care component of the consumer price index.[18]

**Total Healthcare Expenditures.—:** Total healthcare expenditures were calculated by summing direct and indirect healthcare expenditures (described below).

**Direct Healthcare Expenditures.—:** Expenditures associated with the following direct healthcare services are available in MEPS: office visits, hospital outpatient visits, emergency department visits, inpatient stays, prescription medications, and other medical expenditures (eg, home hospital services). Expenditures include those paid by private insurance, public insurance, and out-of-pocket by patient families. Out-of-pocket expenditures for over-the-counter medications were not captured in MEPS and therefore this is not included in our analyses.

**Indirect Healthcare Expenditures.—:** In MEPS, indirect healthcare expenditures are calculated based on parents’ report of missed work due to their child’s healthcare needs. We used the standard human capital approach (number of missed days multiplied by the average daily wage of workers in the United States per the Bureau of Labor Statistics’ National Occupational Employment and Wage Estimates[19]) to estimate expenditures associated with parents’ lost work.

**Covariates.——**We used the Andersen Behavioral Model of Health Service Use[20] to specify covariates that are known to influence healthcare expenditures including predisposing factors, enabling resources, and need factors. Predisposing factors are

demographic characteristics that influence healthcare expenditures, and we included age, sex, race, and geographic region. Enabling resources are those that facilitate or impede healthcare use, and we included insurance status, poverty status, and access to a usual healthcare provider. Need factors refer to comorbid conditions influencing the perceived or evaluated need for healthcare, and for this we included self-reported health status (perceived physical health and perceived mental health) in addition to medical conditions previously identified (headache, psychiatric comorbidities) and medical comorbidity (evaluated need).

### Data Analysis Plan.—

Analyses were conducted using the survey package contained in Stata version 14.1 (StataCorp College Station, TX). The threshold for statistical significance was $P < .05$ and our hypothesis testing was 2 tailed. We adjusted for the complex sample design of MEPS by using sampling weights, regional stratification, and primary sampling unit information to provide nationally representative estimates of the U.S. population. We used descriptive statistics to summarize demographic and health condition characteristics among those with and without headache.

To test our first hypothesis, we compared mean annual total expenditures (direct and indirect) for children identified as having headache to those without headache using a standard 2-part expenditure model. Specifically, we used Stata's "twopm" command, which is compatible with complex survey commands.[21] The 2-part model isolates the effect of headache on expenditures and produces an estimation of incremental expenditures associated with headache, or otherwise stated: the difference between predicted annual expenditures of a child with headache and the predicted annual expenditures of a child without headache on the individual level. The first part of the model used logistic regression to estimate the probability of having any type of healthcare expenditure. The second part of the model consisted of a generalized linear model with gamma error distribution and a logarithmic link to estimate actual expenditures conditional if any expenditures during the year occurred. The main dependent variable in our 2-part models was total healthcare expenditures; however, we also created 2-part models for each direct healthcare expenditure category (office visits, hospital outpatient visits, emergency department visits, inpatient stays, prescription medications, and other medical expenditures) as well as indirect expenditures. For all analyses, the primary independent variable was headache diagnosis (yes/ no), and covariates included our a priori predisposing, enabling, and need factors. For our first hypothesis, we also controlled for perceived mental health status and comorbid anxiety, depression, and ADHD as identified by ICD-9/CCC codes. We calculated the incremental expenditures associated with childhood headache by subtracting expenditures of those identified with headache from those without headache, which represents the excess total healthcare expenditures associated with headache for individuals above and beyond the other factors already controlled for in our model. In our analysis of expenditures, we averaged the sampling weights between 2012 and 2015 to provide an estimate of the average yearly expenditures across 2012–2015.

To test our second hypothesis, we calculated the average annual national healthcare expenditures (and its confidence interval) associated with pediatric headache in the United

States by multiplying the incremental expenditures associated with headache by the number of children with headache.

To address our third hypothesis, we used a standard 2-part expenditure model (as described above) to determine whether comorbid anxiety, depression, or ADHD increases the impact of headache on healthcare expenditures. The primary outcome was total healthcare expenditures; the main independent variables were headache status, psychiatric comorbidity diagnosis (yes/no), and the interaction term psychiatric comorbidity diagnosis (yes/no) × group status (headache/no headache); covariates included our a priori predisposing, enabling, and need factors.

### Missing Data.—

In our sample, the only variable with missing data was the "usual source of care" variable with 2.3% of data missing. These participants were excluded from regression analysis.

## RESULTS

### Participant Characteristics.—

Our final sample consisted of 34,633 (weighted estimate: approximately 62 million each year) children 2–17 years of age captured in MEPS during 2012–2015 (see Table 1 for demographic and clinical characteristics). The weighted sample is consistent with contemporary estimates of the child and adolescent population according to the U.S. Census Bureau.[22] In our sample, 779 (weighted 2.6%) participants were classed into our headache group. The remaining 33,854 of youth (weighted 97.4%) were classed into our non-headache group. Extrapolated to a national level, the 2.6% of children classed into our headache group represents 1.6 million children in the United States presenting for healthcare associated with headache.

Table 1 presents characteristics of the study sample according to predisposing factors, enabling resources, and need factors. As compared to the non-headache group, children in the headache group were more likely to be adolescents (12–17 years), female, and white non-Hispanic. Children in the headache group were also more likely to have private insurance and have a usual source of healthcare. Perceived mental health and physical health were more likely to be rated as "excellent" in the non-headache group compared to the headache group.

### Total Healthcare Expenditures Associated With Childhood Headache.—

After controlling for known covariates that influence healthcare expenditures as specified by the Andersen model,[20] we found that the mean adjusted total annual healthcare expenditures for a child in our headache group was $3036, 95% CI[2374,3669], while the mean adjusted expenditures for a child without headache was $2350, 95% CI[2140,2559] (see Table 2). The incremental difference (ie, subtracting expenditures of those with headache from those without headache) was $687, 95% CI[26,1347], which represents the excess total healthcare expenditures associated with headache for individual children beyond the covariates already controlled for in our model. Consistent with our hypothesis, this incremental difference was

statistically significant ($P = .042$, see Table 2) and represents an estimated 24.3%, 95% CI [1,55], increase in total healthcare expenditures annually for children with headache compared to those without headache.

**Direct Healthcare Expenditures Per Child With Headache.——**After controlling for our a priori covariates, we found that the mean adjusted annual direct healthcare expenditures for a child in the headache group was $2665, 95% CI[2000,3331], compared to $2042, 95% CI[1829,2255], for youth in the non-headache group. Youth in our headache group had an excess of $623, 95% CI[−30,1276], in annual direct healthcare expenditures; however, this incremental difference did not reach statistical significance in our adjusted model ($P = .061$, see Table 2).

We also examined differences in annual direct healthcare expenditures for children in the 2 groups by expenditure type. In our adjusted model, children in our headache group had significantly higher mean annual expenditures on office visits (incremental expenditure associated with headache = $368, 95% CI[105,630], $P = .006$) and emergency department visits (incremental expenditure associated with headache = $97, 95% CI[43,150], $P < .0001$) compared to children in the non-headache group. For the remaining direct healthcare expenditure types, mean annual expenditures were similar for children in the 2 groups. This included hospital outpatient visits (incremental expenditure associated with headache = $119, 95% CI[−53,292], $P = .174$), inpatient admissions (incremental expenditure associated with headache = $7, 95% CI[−123,137], $P = .913$), prescription medications (incremental expenditure associated with headache = $ − 12, 95% CI[−275,250], $P = .926$), and other medical expenditures (incremental expenditure associated with headache = $128, 95% CI[−62,317], $P = .186$).

**Indirect Healthcare Expenditures Per Child With Headache.——**We found that parents of children in our headache group reported missing an average of 2.1 days of work annually, while parents of children without headache missed an average of 1.6 days. Using the human capital approach and controlling for factors as specified by the Andersen model, [20] we estimated that average annual indirect healthcare expenditures were $418, 95% CI[327,508], for youth in our headache group and $316, 95% CI[292,339], for youth without headache. Children in our headache group had an annual excess of $102, 95% CI[11,192], in indirect healthcare expenditures compared to children without headache, and this incremental difference was statistically significant ($P = .027$, see Table 2).

**National Expenditures Associated With Childhood Headache in the United States.—**

After multiplying the estimated number of children presenting for healthcare associated with headache (2.6%) by the estimated total incremental expenditures associated with headache, we found that mean annual total healthcare expenditures associated with childhood headache in the United States was $1.1 billion, 95% CI [.04,2.2 billion].

### Excess Expenditures Associated With Psychiatric Comorbidities.—

As expected, psychiatric comorbidities were more common among youth in the headache group compared to the non-headache group including higher rates of anxiety (8.8% vs 2.9%, $P < .001$), depression (7.8% vs 2.4%, $P < .001$), and ADHD (11.9% vs 7.6%, $P < .001$).

First, we examined whether psychiatric comorbidities were associated with increased expenditures within each group (headache, non-headache). We found a general pattern indicating that having a psychiatric comorbidity was associated with higher incremental adjusted total healthcare expenditures regardless of headache status (see Table 3). Within each group, incremental adjusted total healthcare expenditures were significantly higher among individuals with comorbid depression compared to those without depression (incremental expenditure associated with depression in the headache group = $1815, 95% CI[676,2953], $P = .002$, and in the non-headache group = $1409, 95% CI[697,2122], $P < .0001$). Similarly, within both groups, incremental adjusted total healthcare expenditures were significantly higher among individuals with comorbid ADHD compared to those without ADHD (incremental expenditure associated with ADHD in the headache group = $4742, 95% CI[1659,7825], $P = .003$, and in the non-headache group = $2935, 95% CI [1977,3894], $P < .0001$). Incremental adjusted total healthcare expenditures were also higher among those with comorbid anxiety compared to those without anxiety in both groups, although this reached statistical significance only for the non-headache group (incremental expenditure associated with anxiety in the headache group = $1353, 95% CI[−1353,949], $P = .285$, and in the non-headache group = $949, 95% CI[336,1513], $P = .002$).

Next, we examined whether psychiatric comorbidities were associated with greater expenditures for youth with headache compared to youth without headache. Although psychiatric comorbidities were associated with higher incremental expenditures for the headache group compared to children without headache, the interaction between psychiatric comorbidity (yes/no) and group status (headache group/non-headache group) did not reach statistical significance in any of our adjusted models (anxiety status × group $P = .078$; depression status × group $P = .896$; ADHD status × group $P = .610$).

## DISCUSSION

Our study used a comprehensive cost-of-illness approach to characterize the economic burden due to healthcare expenditures associated with childhood headache in the United States and to evaluate excess expenditures associated with common psychiatric comorbidities in a contemporary and nationally representative sample of youth ages 2–17 from the 2012–2015 MEPS database. Prior studies of healthcare expenditures for youth with headache have had a more limited scope, focusing on direct medical expenditures in youth with migraine[12] and youth with headache who use CAM.[10] Our study extends this prior work by accounting for the combined economic burden of both direct and indirect healthcare expenditures associated with headache on third-party payers and individual families in a broader sample of children with headache.

### Total, Direct, and Indirect Healthcare Expenditures Associated With Childhood Headache.—

Consistent with our hypothesis, we found that the mean adjusted total annual healthcare expenditures for children in the headache group were nearly 25% greater compared to children without headache. Among adults in the United States, headache accounts for a high proportion of office visits, emergency department visits, and prescription medications.[23] We also found that youth in our headache group had higher expenditures on office visits and emergency department visits compared to children without headache. However, other types of direct healthcare expenditures such as prescription medications were similar for children with and without headache in our sample. An important direction for future research will be to determine whether patterns of direct medical expenditures are associated with headache type (eg, migraine vs non-migraine) or different levels of headache-related disability (eg, mild vs severe). Due to the limitations in the MEPS database, we were not able to assess whether healthcare expenditures were higher for children with episodic or chronic headache or children with headache-related disability and this will be important to examine in future research.

Our findings indicate that the higher indirect healthcare expenditures incurred by adults with headache[13–17] appears to extend to families of children with headache. Parents of children in our headache group experienced significantly higher indirect medical expenditures due to missed work related to their child's healthcare needs. Consistent with recommendations for general chronic pain conditions in childhood, these findings suggest that clinicians caring for youth with headache should carefully consider the impact of headache on the child, parent, and broader family system when developing treatment plans.[24]

### National Expenditures Associated With Childhood Headache in the United States.—

We estimated the national healthcare expenditures associated with pediatric headache in the United States at $1.1 billion annually. To our knowledge, this study is the first to estimate national healthcare expenditures of pediatric headache in the United States. These findings have important public health implications; however, it is important to consider the limitations of the MEPS database when interpreting these results. Our headache group represents youth who presented for healthcare associated with headache in the past year. Using this methodology, only 2.6% of youth were classed into the headache group. In contrast, other national database studies have identified youth with headache using other methodologies (eg, self-report) and report higher prevalence estimates.[25] Our results also do not account for youth in the community who have headache but have not presented for healthcare. Because of these methodological limitations, our findings may underestimate the true prevalence and healthcare expenditures associated with pediatric headache at the individual and national level. For example, estimates of the national economic burden of general chronic pain conditions in childhood in the United States are much higher ($11.5-$19.5 billion annually).[26,27] Despite these limitations, our estimates of healthcare expenditures associated with pediatric headache are still substantial and stakeholders such as health policy makers and insurance companies may consider our findings when guiding initiatives aimed at reducing healthcare expenditures in this population.

### Excess Expenditures Associated With Psychiatric Comorbidities.—

We were also interested in whether common psychiatric comorbidities (anxiety, depression, ADHD) are associated with excess expenditures in our headache group. As expected, having comorbid depression or ADHD was associated with increased economic burden for children with and without headache. Among children with headache, comorbid depression was associated with a $1353 increase in total adjusted healthcare expenditures, while comorbid ADHD was associated with a $4742 increase in total adjusted healthcare expenditures. Comorbid anxiety was also associated with increased expenditures, although contrary to our expectation this incremental difference was not statistically significant for youth with headache in our adjusted model. This pattern of findings is generally consistent with the limited prior research which has shown that anxiety and depression are associated with increased direct healthcare expenditures among youth with migraine.[10,12] Healthcare expenditures are also known to be twice as high for adults with headache and anxiety or depression compared to those with headache alone.[12,28]

Although we identified a signal that indicates depression and ADHD may increase the impact of headache on healthcare expenditures, analyses of the interaction between psychiatric comorbidities and headache group status did not reach statistical significance. Expenditure data inherently have large variation which makes it difficult to estimate even main effects. In general, much greater sample sizes are needed to estimate interactions compared to main effects. Our effective sample size, as driven by the size of the headache group (n = 779), was likely not large enough to provide adequate power to detect interaction effects and future research with larger cohorts of children with headache are needed. Despite this limitation, our study extends previous work by providing contemporary estimates of the added economic burden of common psychiatric comorbidities in youth with headache.

### Future Directions.—

A critical next step will be to differentiate between avoidable and unavoidable healthcare expenditures for youth with headache. For example, emergency department visits are among the leading causes of avoidable healthcare expenditures in the United States.[29] In addition, further research is needed to understand whether psychiatric comorbidities contribute to excess healthcare expenditures for youth with headache. Due to the limitations in sample size, we did not have sufficient power to detect interactions between psychiatric comorbidities and headache in this sample. If an association between psychiatric comorbidities and excess healthcare expenditures can be established, future studies could aim to understand whether treating psychiatric comorbidities reduces potentially avoidable healthcare expenditures among youth with headache. There are known modifiable psychosocial and behavioral factors that influence the onset and maintenance of headache in youth (eg, coping skills, lifestyle factors such as sleep, parent and family distress, and adherence to daily preventive medications[30–34]). However, whether treatment targeting these factors can influence healthcare expenditures in youth with headache is unknown. We encourage the development of randomized controlled trials that evaluate the economic impact of interventions that specifically target modifiable psychosocial and behavioral factors known to influence headache in children and adolescents. This type of research has

the potential to provide valuable information to third-party payers and healthcare institutions who allocate psychosocial resources to youth with headache and their families.

### Additional Limitations.—

Our findings can be interpreted in light of several additional limitations. ICD-9-CM diagnosis codes used to identify physical and mental disorders were truncated at 3 digits in MEPS. Because MEPS uses truncated ICD-9-CM codes, we could not account for disease severity or chronicity in our analyses and this may have influenced the study results. Information on disease severity and duration/ chronicity could produce estimates that are more reliable. In addition, the study design was cross sectional, and we cannot establish temporality or causality between headache and economic expenditures. Again, our headache group represents youth presenting for healthcare associated with headache and does not account for youth with headache who have not sought healthcare for this condition. Nonetheless, this study provides useful insights into the effect of headache on healthcare expenditures for children in the United States.

## CONCLUSIONS

Children in our headache group had significantly higher adjusted total healthcare expenditures, emergency department visit expenditures, office visit expenditures, and indirect healthcare expenditures as compared to those without headache. We estimated that childhood headache is associated with $1.1 billion in annual healthcare expenditures in the United States, although this is likely an underestimate because our sample was limited to children presenting for healthcare associated with headache. It is possible that a different pattern of findings may emerge in future studies depending on the method used for classifying youth with headache (eg, parent or youth self-report only). Finally, we found that depressive disorders and ADHD were associated with higher incremental healthcare expenditures for youth with headache; however, due to the limitations in sample size, we did not have sufficient power to detect interactions between these psychiatric comorbidities and headache. Further research with larger sample sizes is needed to understand the impact of psychiatric comorbidities on healthcare costs for youth with headache. If a link between psychiatric comorbidities and healthcare expenditures can be established, future studies could explore whether expenditures could be reduced via behavioral interventions that target known, modifiable psychosocial risk factors.

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## Abbreviations:

| | |
|---|---|
| **ADHD** | attention deficit/hyperactivity disorder |
| **CAM** | complementary and alternative medicine |
| **CCC** | clinical classification codes |

| | |
|---|---|
| **ICD-9** | International Classification of Diseases 9th edition |
| **MEPS** | Medical Expenditure Panel Surveys |
| **U.S.** | United States |

## REFERENCES


1. Abu-Arafeh I, Razak S, Sivaraman B, Graham C. Prevalence of headache and migraine in children and adolescents: A systematic review of population-based studies. Dev Med Child Neurol. 2010;52:1088–1097. [PubMed: 20875042]
2. Powers SW, Patton SR, Hommel KA, Hershey AD. Quality of life in childhood migraines: Clinical impact and comparison to other chronic illnesses. Pediatrics. 2003;112:e1–e5. [PubMed: 12837897]
3. Palermo TM, Putnam J, Armstrong G, Daily S. Adolescent autonomy and family functioning are associated with headache-related disability. Clin J Pain. 2007;23:458–465. [PubMed: 17515745]
4. Machnes-Maayan D, Elazar M, Apter A, Zeharia A, Krispin O, Eidlitz-Markus T. Screening for psychiatric comorbidity in children with recurrent headache or recurrent abdominal pain. Pediatr Neurol. 2014;50:49–56. [PubMed: 24269169]
5. Arruda MA, Arruda R, Guidetti V, Bigal ME. Psychosocial adjustment of children with migraine and tension-type headache – A nationwide study. Headache. 2015;55:39–50. [PubMed: 25659227]
6. Huguet A, Tougas ME, Hayden J, et al. Systematic review of childhood and adolescent risk and prognostic factors for recurrent headaches. J Pain. 2016; 17:855–873.e858. [PubMed: 27102894]
7. O'Brien HL, Slater SK. Comorbid psychological conditions in pediatric headache. Semin Pediatr Neurol. 2016;23:68–70. [PubMed: 27017025]
8. Ghandour RM, Sherman LJ, Vladutiu CJ, et al. Prevalence and treatment of depression, anxiety, and conduct problems in US children. J Pediatr. 2018;206: 256–267.e3. [PubMed: 30322701]
9. Danielson ML, Bitsko RH, Ghandour RM, Holbrook JR, Kogan MD, Blumberg SJ. Prevalence of parent-reported ADHD diagnosis and associated treatment among U.S. children and adolescents, 2016. J Clin Child Adolesc Psychol. 2018;47:199–212. [PubMed: 29363986]
10. Bethell C, Kemper KJ, Gombojav N, Koch TK. Complementary and conventional medicine use among youth with recurrent headaches. Pediatrics. 2013;132: E1173–E1183. [PubMed: 24127466]
11. Larg A, Moss JR. Cost-of-illness studies: A guide to critical evaluation. Pharmacoeconomics. 2011;29:653–671. [PubMed: 21604822]
12. Pesa J, Lage MJ. The medical costs of migraine and comorbid anxiety and depression. Headache. 2004;44:562–570. [PubMed: 15186300]
13. Hawkins K, Wang S, Rupnow MF. Indirect cost burden of migraine in the United States. J Occup Environ Med. 2007;49:368–374. [PubMed: 17426520]
14. Hazard E, Munakata J, Bigal ME, Rupnow MF, Lipton RB. The burden of migraine in the United States: Current and emerging perspectives on disease management and economic analysis. Value Health. 2009;12:55–64. [PubMed: 18671771]
15. 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;159:813–818. [PubMed: 10219926]
16. 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;41:646–657. [PubMed: 11554952]
17. Vos T, Flaxman AD, Naghavi 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;380:2163–2196. [PubMed: 23245607]
18. Riley JL 3rd, Wade JB, Myers CD, Sheffield D, Papas RK, Price DD. Racial/ethnic differences in the experience of chronic pain. Pain. 2002;100:291–298. [PubMed: 12468000]
19. Occupational Employment Statistics. Available at: www.bls.gov/oes/. Accessed January 2019.
20. Andersen RM. National health surveys and the behavioral model of health services use. Med Care. 2008;46:647–653. [PubMed: 18580382]

21. Belotti F, Deb P, Manning WG, Norton EC. twopm: Two-part models. Stata J. 2015;15:3–20.
22. Keefe FJ, Lumley M, Anderson T, Lynch T, Studts JL, Carson KL. Pain and emotion: New research directions. J Clin Psychol. 2001;57:587–607. [PubMed: 11255208]
23. Burch R, Rizzoli P, Loder E. The prevalence and impact of migraine and severe headache in the United States: Figures and trends from government health studies. Headache. 2018;58:496–505. [PubMed: 29527677]
24. Palermo TM, Valrie CR, Karlson CW. Family and parent influences on pediatric chronic pain: A developmental perspective. Am Psychol. 2014;69:142–152. [PubMed: 24547800]
25. Lateef TM, Merikangas KR, He J, et al. Headache in a national sample of American children: Prevalence and comorbidity. J Child Neurol. 2009;24:536–543. [PubMed: 19406755]
26. Groenewald CB, Essner BS, Wright D, Fesinmeyer MD, Palermo TM. The economic costs of chronic pain among a cohort of treatment-seeking adolescents in the United States. J Pain. 2014;15:925–933. [PubMed: 24953887]
27. Groenewald CB, Wright DR, Palermo TM. Health care expenditures associated with pediatric pain-related conditions in the United States. Pain. 2015;156:951–957. [PubMed: 25734992]
28. Clouse JC, Osterhaus JT. Healthcare resource use and costs associated with migraine in a managed healthcare setting. Ann Pharmacother. 1994;28:659–664. [PubMed: 8069007]
29. Informatics IIfH. Avoidable Costs in US Healthcare. Parsippany, NY: IMS Institute for Healthcare Informatics; 2013.
30. Kashikar-Zuck S, Zafar M, Barnett KA, et al. Quality of life and emotional functioning in youth with chronic migraine and juvenile fibromyalgia. Clin J Pain. 2013;29:1066–1072. [PubMed: 23446072]
31. Esposito M, Gallai B, Parisi L, et al. Maternal stress and childhood migraine: A new perspective on management. Neuropsychiatr Dis Treat. 2013;9:351–355. [PubMed: 23493447]
32. Logan DE, Scharff L. Relationships between family and parent characteristics and functional abilities in children with recurrent pain syndromes: An investigation of moderating effects on the pathway from pain to disability. J Pediatr Psychol. 2005;8:698–707.
33. Rabner J, Kaczynski KJ, Simons LE, LeBel A. Pediatric headache and sleep disturbance: A comparison of diagnostic groups. Headache. 2018;58:217–228.
34. Connelly M, Bickel J. An electronic daily diary process study of stress and health behavior triggers of primary headaches in children. J Pediatr Psychol. 2011;36:852–862. [PubMed: 21441572]

**Table 1.—**

Baseline Characteristics of Children (2–17 Years of Age) in the 2012–2015 Medical Expenditure Panel Surveys

| Characteristic | Full Sample (n = 34,633) (n/%) | Headache Cohort (n = 779) (n/%) | Non-Headache Cohort (n = 33,854) (n/%) |
|---|---|---|---|
| Age category | | | |
| 3–5 years | 6881 (19.7) | 25 (3.6) | 6856 (20.1) |
| 6–11 years | 14,079 (39.1) | 248 (28.3) | 13,831 (39.4) |
| 12–17 years | 13,673 (41.2) | 506 (68.1) | 13,167 (40.5) |
| Sex | | | |
| Male | 17,727 (50.9) | 348 (41.2) | 17,379 (51.2) |
| Female | 16,906 (49.1) | 431 (58.8) | 16,475 (48.8) |
| Race/Ethnicity | | | |
| White/Non-Hispanic | 9389 (51.3) | 255 (60) | 9134 (51.1) |
| Black | 7301 (14) | 168 (14.5) | 7133 (14) |
| Hispanic | 14,233 (24.1) | 297 (18.7) | 13,936 (24.3) |
| Native American | 153 (0.6) | 4 (0.6) | 149 (0.6) |
| Asian/Pac Islander | 1968 (5) | 13 (0.9) | 1955 (5.1) |
| Multiple | 1589 (5) | 42 (5.3) | 1547 (5) |
| Region | | | |
| Northeast | 5052 (16.6) | 127 (22.2) | 4925 (16.5) |
| Midwest | 6392 (21.2) | 169 (23) | 6223 (21.1) |
| South | 13,103 (38) | 261 (33.1) | 12,842 (38.2) |
| West | 10,086 (24.2) | 222 (21.6) | 9864 (24.3) |
| Insurance coverage | | | |
| Any private | 13,604 (58.1) | 339 (64.3) | 13,265 (57.9) |
| Public only | 19,158 (37.7) | 409 (33.4) | 18,749 (37.9) |
| Uninsured | 1871 (4.2) | 31 (2.3) | 1840 (4.2) |
| Income category | | | |
| Poor/negative | 11,900 (20.3) | 266 (19.6) | 11,634 (20.3) |
| Near poor | 2691 (5.7) | 51 (5.3) | 2640 (5.7) |
| Low | 6508 (16.3 | 142 (16.8) | 6366 (16.3) |
| Middle | 8285 (29.9) | 199 (30.7) | 8086 (29.9) |

| Characteristic | Full Sample (n = 34,633) (n/%) | Headache Cohort (n = 779) (n/%) | Non-Headache Cohort (n = 33,854) (n/%) |
|---|---|---|---|
| High | 5249 (27.8) | 121 (27.5) | 5128 (27.8) |
| Usual source of care | | | |
| No | 3488 (8.4) | 44 (4.6) | 3444 (8.5) |
| Yes | 30,325 (91.6) | 728 (95.4) | 29,597 (91.5) |
| Anxiety | | | |
| No | 33,906 (97) | 729 (91.2) | 33,177 (97.1) |
| Yes | 727 (2.9) | 50 (8.8) | 677 (2.9) |
| Depression | | | |
| No | 33,943 (97.6) | 725 (92.2) | 33,218 (97.7) |
| Yes | 690 (2.4) | 54 (7.8) | 636 (2.3) |
| ADHD | | | |
| No | 32,385 (92.4) | 676 (88.1) | 31,709 (92.5) |
| Yes | 2248 (7.6) | 103 (11.9) | 2145 (7.5) |
| Perceived mental health | | | |
| Excellent | 18,598 (56.5) | 311 (39.5) | 18,287 (56.9) |
| Very Good | 8392 (24.6) | 210 (30.8) | 8182 (24.4) |
| Good | 6388 (15.7) | 180 (21.5) | 6208 (15.5) |
| Fair | 991 (2.7) | 64 (7.3) | 927 (2.5) |
| Poor | 208 (0.6) | 13 (1) | 195 (0.6) |
| Perceived physical health | | | |
| Excellent | 17,775 (55.4) | 278 (37.2) | 17,497 (55.9) |
| Very Good | 9407 (27.4) | 237 (32.7) | 9170 (27.3) |
| Good | 6323 (14.8) | 199 (23.5) | 6124 (14.6) |
| Fair | 957 (2.1) | 54 (5.5) | 903 (2) |
| Poor | 115 (0.3) | 11 (1.1) | 104 (0.3) |

Frequency counts are based on observed frequencies. Percentages are based on survey weighted data in order to be nationally representative of the non-institutionalized childhood population in the United States.

**Table 2.—**

Mean Annual Estimated Incremental Total, Direct, and Indirect Expenditures of Children With Headache vs Children Without Headache, Adjusted For Covariates Specified in the Anderson Behavioral Model of Healthcare Use. Reported in 2016 U.S. Dollars

| | Headache Cohort | | Non-Headache Cohort | | Incremental Adjusted Expenditures Associated with Headache | | |
|---|---|---|---|---|---|---|---|
| **Expenditure Type** | **$** | **95% CI** | **$** | **95% CI** | **$** | **95% CI** | ***P* Value** |
| Total expenditures (Sum of direct and indirect expenditures) | 3036 | [2374,3699] | 2350 | [2140,2559] | 687[†] | [26,1347] | .042 |
| Direct expenditures (total) | 2665 | [2000,3331] | 2042 | [1829,2255] | 623[‡] | [−30,1276] | .061 |
| Office visits | 914 | [654,1175] | 547 | [501,592] | 368 | [105,630] | .006 |
| Hospital outpatient visits | 278 | [80,477] | 159 | [101,277] | 119 | [−53,292] | .174 |
| ED visits | 197 | [145,250] | 101 | [91,111] | 97 | [43,150] | <.0001 |
| Inpatient stays | 208 | [84,332] | 201 | [148,254] | 7 | [−123,137] | .913 |
| Prescription medications | 499 | [238,761] | 512 | [370,653] | −12 | [−275,250] | .926 |
| Other | 230 | [37,423] | 103 | [78,127] | 128 | [−62,317] | .186 |
| Indirect expenditures | 418 | [327,508] | 316 | [292,339] | 102 | [11,192] | .027 |

For all analyses, dollar amounts were adjusted for inflation to reflect 2016 dollar costs using the consumer price index medical care inflation component and expenditures were estimated using regression models adjusted for age group, sex, race/ethnicity, income category, insurance, geographical region of the United States, usual source of healthcare, perceived mental health, and perceived physical health.

Source: MEPS 2012–2015.

[†]Total does not equal to the sum of service types or sum because of separate regression estimates.

[‡]Regression estimation for expenditures used a standard 2-part expenditure model.

**Table 3.—**

Incremental Total Healthcare Expenditures Associated With Psychiatric Comorbidity Within the Headache and Non-Headache Cohorts, Adjusted For Covariates Specified in the Anderson Behavioral Model of Healthcare Use Reported in 2016 U.S. Dollars

| | Incremental Adjusted Total Healthcare Expenditures Associated With Psychiatric Comorbidity | | | | | |
|---|---|---|---|---|---|---|
| | Headache Cohort | | | Non-Headache Cohort | | |
| **Psychiatric Comorbidity** | **$** | **95% CI** | ***P* Value** | **$** | **95% CI** | ***P* Value** |
| Anxiety | 1353 | [−1137,3845] | .285 | 949 | [336,1513] | .002 |
| Depression | 1815 | [676,2953] | .002 | 1409 | [697,2122] | <.0001 |
| ADHD | 4742 | [1659,7825] | .003 | 2935 | [1977,3894] | <.0001 |

For all analyses, dollar amounts were adjusted for inflation to reflect 2016 dollar costs using the consumer price index medical care inflation component. Incremental expenditures were estimated using regression models adjusted for age group, sex, race/ethnicity, mother's education, income category, insurance, geographical region of the United States, usual source of healthcare, perceived mental health, and perceived physical health.

Source: MEPS 2012–2015.