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Economic Burden of Attention-Deficit/Hyperactivity Disorder among Pediatric Patients in the United States

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ABSTRACT

Objectives: To determine the adjusted incremental total costs (direct and indirect) for patients (aged 3–17 years) with attention-deficit/hyperactivity disorder (ADHD) and the differences in the adjusted incremental direct expenditures with respect to age groups (preschoolers, 0–5 years; children, 6–11 years; and adolescents, 12–17 years). **Methods:** The 2011 Medical Expenditure Panel Survey was used as the data source. The ADHD cohort consisted of patients aged 0 to 17 years with a diagnosis of ADHD, whereas the non-ADHD cohort consisted of subjects in the same age range without a diagnosis of ADHD. The annual incremental total cost of ADHD is composed of the incremental direct expenditures and indirect costs. A two-part model with a logistic regression (first part) and a generalized linear model (second part) was used to estimate the incremental costs of ADHD while controlling for patient characteristics and access-to-care variables. **Results:** The 2011 Medical Expenditure Panel Survey database included 9108 individuals aged 0 to 17 years, with 458 (5.0%) having an ADHD diagnosis. The ADHD cohort was 4.90 times more likely (95% confidence interval [CI] 2.97–8.08; $P < 0.001$) than the non-ADHD cohort to have an expenditure of at least $1, and among those with positive expenditures, the ADHD cohort had 58.4% higher expenditures than the non-ADHD cohort ($P < 0.001$). The estimated adjusted annual total incremental cost of ADHD was $949.24 (95% CI $593.30–$1305.18; $P < 0.001$). The adjusted annual incremental total direct expenditure for ADHD was higher among preschoolers ($989.34; 95% CI $402.70–$1575.98; $P = 0.001$) than among adolescents ($894.94; 95% CI $428.16–$1361.71; $P < 0.001$) or children ($682.71; 95% CI $347.94–$1017.48; $P < 0.001$). **Conclusions:** Early diagnosis and use of evidence-based treatments may address the substantial burden of ADHD.

Keywords: attention-deficit/hyperactivity disorder, children, cost of illness, health care costs.

Introduction

Attention-deficit/hyperactivity disorder (ADHD) is one of the most common neurological disorders diagnosed in children. ADHD is characterized by a developmentally incongruous pattern of inattention, hyperactivity, and impulsivity. Although the exact cause of ADHD is unknown, a multitude of complex neurobiological and environmental factors have been proposed to cause ADHD [1,2]. The prevalence of ADHD among children in the US civilian noninstitutionalized population has increased from 2.9% in 1996 to 5.2% in 2009 [2].

ADHD poses a significant burden in the form of increased medical costs and increased indirect cost related to absenteeism and reduced productivity. It also imposes intangible costs in terms of reduced quality of life for patients as well as their families. A study by Stagnitti [2] estimated that the total health care expenses (direct and indirect) for children with ADHD, aged 17 years and younger, increased over 250% in 12 years, from $3.3 billion in 1996 to $12.6 billion in 2008 [2]. Stimulant and nonstimulant medications are the mainstay of therapy in children with ADHD and constitute a major category of direct expenditure. Prescription medication expenses for patients with ADHD have risen dramatically, resulting in an increase in the total prescription drug expense from $0.9 billion in 1996 to $4.3 billion in 2008 [3–5]. In addition to medications, physician office and inpatient visits for ADHD and cost of care for comorbid conditions are associated with increased disease burden in patients with ADHD [3,6,7].

In addition to the direct cost associated with ADHD care, parents or caregivers of children with ADHD are affected by missed workdays and decreased job productivity. Because children with ADHD are more accident-prone, they might miss school, sports, and other childhood activities. Consequently, parents of children with ADHD miss work to take care of their children or to accompany them during physician visits [8]. In 1998, the annual direct cost was $1574 per patient with ADHD as compared with $541 per matched control. Similarly, the annual total cost (direct and indirect) per family member was $2728 for family members of patients with ADHD during the period 1996 to 1998 [8]. Current estimates of the parents' or caregivers' work productivity loss secondary to missed school days of children with ADHD are lacking. Despite the increasing prevalence and

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associated costs of ADHD, little is known about the impact of ADHD on health care costs in recent years [3–9].

Thus, the objectives of this study were to determine (1) the adjusted incremental total costs (direct and indirect) for patients (aged 3–17 years) with ADHD and (2) the differences in the adjusted incremental direct expenditures for patients with ADHD with respect to age groups (preschoolers, 0–5 years; children, 6–11 years; and adolescents, 12–17 years).

Methods

Data Source

The study used a retrospective design to measure the cost of illness for ADHD using data from the 2011 Medical Expenditure Panel Survey (MEPS). MEPS is a nationally representative survey of health care use, expenditures, sources of payment, and insurance coverage for the US civilian noninstitutionalized population. In MEPS, one respondent per household is interviewed about the medical events of household members including health status, health care utilization, and health insurance. Information on expenditure data is also collected from medical service providers and pharmacies to supplement and improve the quality of the household data. The study was approved by the Institutional Review Board of the University of Texas at Austin.

Study Sample

The sample for the 2011 MEPS consisted of 15,000 households that participated in the previous year's National Health Interview Survey conducted by the National Center for Health Statistics. The MEPS sampling frame provides a nationally representative sample of the US civilian noninstitutionalized population and reflects an oversample of blacks and Hispanics. The overall annual response rate for the 2011 MEPS was 54.9% [10]. The ADHD cohort consists of all individuals aged between 0 and 17 years with a diagnosis of ADHD (*International Classification of Diseases, Ninth Revision, Clinical Modification* code = 314), identified from the 2011 MEPS database for the period January 1, 2011, to December 31, 2011. During the same time period, individuals aged between 0 and 17 years without a diagnosis of ADHD were included in the non-ADHD cohort.

Measures

All-cause total cost for the ADHD cohort consists of the sum of the direct expenditures and indirect costs for patients with ADHD. Direct expenditures included the cost of hospital inpatient care, ambulatory care provided in offices and hospital outpatient departments, emergency department care, home health care visits, and prescribed medications. These costs included direct payments for care such as out-of-pocket payments and payments by private insurance, Medicaid, Medicare, and other sources. Payments for over-the-counter drugs are not included in MEPS expenses. Indirect costs consist of costs of parents' loss of productivity due to children's missed school days. MEPS captures data on indirect costs for individuals aged at least 3 years and thus individuals younger than 3 years could not be included in the indirect cost calculation. The parents' loss of productivity was estimated by calculating the number of missed school days multiplied by the average daily wage rate for all occupations. Although information pertaining to hourly wage rate and number of hours worked per week is available in the database, a preliminary assessment of the data revealed that there were just 17 patients with ADHD (3.7% of the 458 patients in the ADHD cohort) with complete information in all the fields (i.e., missed school days *and* wage rate) required to calculate productivity loss. Therefore, an alternative approach based on the methods used by Rappaport and Bonthapally and Barnett and Nurmagambetov [11–14] was used. Because the average daily wage rate was based on all occupations rather than the specific occupations of the respondents, sensitivity analysis was conducted by varying the average daily wage rate to understand the impact of lower and upper bound estimates on the overall cost. This average daily wage rate was obtained from the National Occupational Employment and Wage Estimates file listed on the Bureau of Labor Statistics Web site [15].

On the basis of the literature, two groups of variables, patient characteristics and access to health care, were postulated to be related to direct expenditures and indirect costs of ADHD. Patient characteristics included sex, race, and ethnicity categorical variables as well as age and comorbidity burden continuous measures. Comorbidity burden was measured by D'Hoores adaptation of the Charlson comorbidity index (CCI), which is calculated by summing the weights of the comorbidities [16]. D'Hoores adaptation of the CCI uses three-digit *International Classification of Diseases, Ninth Revision*, codes to measure comorbidity burden. Access to health care variables consisted of poverty status, health insurance coverage, having a usual source of care, area status, and region, which were included as categorical variables. To assess the incremental direct expenditures across age groups, age was categorized as preschoolers (0–5 years), children (6–11 years), and adolescents (12–17 years).

Statistical Analysis

Baseline characteristics were computed to compare patients with and without ADHD. Bivariate comparisons of variables for individuals with and without ADHD were carried out using chi-square analyses and *t* tests. Next, a standard two-part expenditure model was used to determine the cost of illness for individuals with ADHD compared with those without ADHD. The first part of the model consisted of a logistic regression model to estimate the probability of having any type of health care expenditure, whereas the second part consisted of a generalized linear model with a gamma distribution and a log link to estimate the total costs conditional on individuals with positive expenditures. The modified Park test was used to select the distribution and variance function for the generalized linear model. The main dependent variable was all-cause total cost, whereas the primary independent variable categorized individuals into ADHD or non-ADHD groups. Furthermore, individual two-part regression models were computed with dependent variables consisting of all-cause direct expenditures associated with inpatient visits, prescription medications, outpatient visits, emergency room visits, office-based visits, and home health care visits, and the primary independent variable consisting of the ADHD indicator variable. Marginal effects conditional on the three age groups (preschoolers [0–5 years], children [6–11 years], and adolescents [12–17 years]) were computed to determine differences in direct expenditures between individuals with and without ADHD within each age group. The "margins" command in STATA (StataCorp LLC, College Station, TX) was used to compute the incremental effect of age on the direct expenditures considering both parts of the two-part expenditure model [17]. In all models, the results were projected to the US civilian noninstitutionalized population using the sampling weights provided by MEPS while adjusting for the complex survey design in computing the parameter estimates and their respective standard errors. The "svy" command was used in STATA to adjust for the complex survey design in computing the parameter estimates and their respective standard errors. All analyses were conducted using SAS version 9.3 (SAS Institute Inc., Cary, NC) and STATA 12.0 with an a priori significance level of P less than 0.05.