The Economic Impact of Attention-Deficit/Hyperactivity Disorder in Children and Adolescents

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Using a cost of illness (COI) framework, this article examines the economic impact of attention-deficit/hyperactivity disorder (ADHD) in childhood and adolescence. Our review of published literature identified 13 studies, most conducted on existing databases by using diagnostic and medical procedure codes and focused on health care costs. Two were longitudinal studies of identified children with ADHD followed into adolescence. Costs were examined for ADHD treatment-related and other health care costs (all but 1 study addressed some aspect of health care), education (special education, 2 studies; disciplinary costs: 1 study), parental work loss (2 studies), and juvenile justice (2 studies). Based on this small and as yet incomplete evidence base, we estimated annual COI of ADHD in children and adolescents at $14,576 per individual (2005 dollars). Given the variability of estimates across studies on which that number is based, a reasonable range is between $12,005 and $17,458 per individual. Using a prevalence rate of 5%, a conservative estimate of the annual societal COI for ADHD in childhood and adolescence is $42.5 billion, with a range between $36 billion and $52.4 billion. Estimates are preliminary because the literature is incomplete; many potential costs have not been assessed in extant studies. Limitations of the review and suggestions for future research on COI of ADHD are provided.

Key words  attention-deficit/hyperactivity disorder; cost of illness; economic impact.

Attention-deficit/hyperactivity disorder (ADHD) is among the most common mental health (MH) disorders of childhood; prevalence rates range from 2% to 9%.1 By definition, children with ADHD lag children of the same age in sustained attention, impulse control, and modulation of activity level. These symptoms begin at an early age, are displayed across environments, and continue throughout the lifespan.2 Importantly, they lead to a host of limitations within multiple domains of life, including adult relationships (e.g., noncompliance with parent and teacher requests), school functioning (e.g., classroom disruption and poor achievement), and peer and sibling relationships (e.g., annoying, intrusive, overbearing, and aggressive behaviors). These difficulties lead to serious limitations in life functioning not only for the children with ADHD but also for their peers, families, and schools. Further, for the great majority of children with ADHD, these limitations in daily functioning persist across adolescence and into adulthood (e.g., vocational underachievement, interpersonal problems, substance use, and criminal activity), even though their core symptomatology (e.g., inattention) may improve with age.3–6

Children and youth with ADHD use services across a range of child-serving systems. The disorder is among the most common referring problems in primary care settings.7 In the educational system, ADHD is among the most common diagnoses in special educational settings and is the major behavioral problem regular education teachers face.8 In addition, ADHD is one of the most common diagnoses in MH settings for children.9 Its high prevalence, chronicity, and substantial impact on daily life functioning for children, their parents, peers, and teachers has made ADHD a major public health concern.10

As a result, ADHD is arguably the most well-researched MH disorder of childhood. As detailed in
other papers in this issue, many hundreds of papers, reviews, and texts have focused on the diagnosis, etiology, psychopathology, presentation, treatment, and outcome of the condition over the last 3 decades.11–13 Surprisingly, this voluminous body of research generally has ignored the economic impact of ADHD. Studies of the economic impact to society (or so-called costs of illness) have reported a long history for physical diseases, with prominent analytic models existing, for example, for coronary heart disease.14 Among adults, it is well established that MH disorders are important determinants of disability and related costs.15

In contrast, relatively little is known about the economic cost of disability resulting from childhood MH disorders.16 Most of the extant work has focused on the economic costs associated with conduct disorder, presumably because of the clear link to later crime and substance use—two of the mostly costly social ills of western society. A handful of studies document that childhood conduct disorder produce very large costs for the family and society during childhood and into adulthood.17–19 In one longitudinal study in London, by age 28, children with childhood conduct problems had cost society 3.5 to 10 times more than a comparison group, mainly for costs associated with crime and education.19

An accurate understanding of the societal costs of conditions such as ADHD is critically important for policy makers. Information about costs of illness is the necessary prerequisite for justifying and planning prevention and intervention. This paper considers the economic impact of ADHD. It describes a framework for thinking about the costs of ADHD and describes the extant, though small, literature. We conclude by identifying needs for future research in this crucial area.

Costs of Illness as a Framework for Understanding Economic Impact

In addressing the economic consequences of an illness or disorder, economists have developed 2 main approaches: willingness to pay and cost of illness (COI). COI generally focuses on tangible resource consequences on an illness, whereas willingness to pay methodology typically estimates subjective costs. COI estimates are generally lower than willingness to pay estimates,20,21 and the difference reflects intangible effects such as pain and suffering. In their analysis of the costs of violence, Cook and Ludwig22 illustrate this point well. The COI estimate of a crime like rape captures the related medical costs and lost work experienced by the victim as well as the costs of incarcerating the perpetrator. Of course, this estimate is many, many times lower than what a woman would be willing to pay to avoid experiencing this crime. That estimate would reflect intangible effects, such as the pain and suffering stemming from being violated. Another alternative is to use jury verdicts to capture these intangible costs.23 This practice is controversial within economics because such verdicts do not reflect market forces nor are they solicited from jurors in a structured process.

The analyses presented below reflect a COI approach. COI estimates have been generated for a wide range of illnesses, conditions, and disorders, including substance abuse,24 epilepsy,25 and diabetes.26

Framing the COI

The first step in estimating the costs of illness is to frame the scope of the analysis. Doing so involves specifying several key dimensions of the analysis: the perspectives included, the categories or types of costs included, and the time frame.

A first dimension of the scope of analysis involves perspectives from which costs will be assessed.27,28 This step is critical—the value of an input used in delivering a program may depend on the perspective from which that value is assessed. For example, the parents of a youth in trouble may be called to the principal's office. From the perspective of the school, the relevant costs involve the time of school personnel. From a social perspective, the time parents spend away from work or home to respond to school-related issues represents additional costs.29 The costs to that particular parent may involve lost pay.

Economists generally focus their analyses on the societal perspective. Assessed from this perspective, the costs of an activity represent the net or total effect of an activity on all members of society. The standard texts in this area recommend the societal perspective as the perspective for an economic analysis. For example, the “gold standard” for economic analysis in health is the report of the panel on cost effectiveness.30,31 This perspective is complemented by other perspectives, which can identify who bear the costs of the program or service. In addition, such analyses can illumine the incentives shaping the behavior of key agents such as participating families.

In our COI application below, in an effort to most accurately capture the societal perspective, we include the perspective of health care providers or insurers,
education, other nonhealth systems in the public sector (such as juvenile justice), and other members of society (e.g., victims of crime, children in the same classroom, and taxpayers). There is clearly a cost associated with ADHD for the individual families (e.g., parental work loss, parental stress-related illnesses, and increased childcare expenses) that fall under the general rubric of quality of life. However, there are no data currently available that quantify and enable monetization of these issues. This is a major limitation in the literature, which we discuss below.

The second dimension of the scope of a COI analysis involves the types or categories included. Economists typically group costs into 3 categories: health-sector costs, productivity-related costs, and other costs, such as costs borne by other public systems (e.g., education and juvenile justice). Economists sometimes refer to these costs as “indirect”, but this practice is confusing for several reasons. These include the use of the term by accountants to describe overhead.30 Our analysis below will attempt to identify and measure all categories of costs currently available within the literature. This dimension of the study’s scope is separate from that of the study’s perspective. In particular, costs in each sector can be estimated from each of the study’s perspectives.

The third and final dimension of a COI study involves specifying a time frame. One could estimate the costs of illness for a single year or for a cohort of individuals over a lifetime. This issue is especially important in considering a chronic condition such as ADHD. A longer time frame raises a key issue involving discounting, or the conversion of future costs into today’s dollars.32 For this study, our time frame is childhood and adolescence. We do not capture the costs of ADHD extending into adulthood. We summarize costs annually for individuals with ADHD, and we compute costs associated with the entire cohort of children and adolescents with ADHD by using commonly accepted prevalence estimates.

**Required Information**

For each of the affected sectors (e.g., health care costs) and the timing of the effects, estimating the costs of illness requires 2 types of information. The first involves the quantity of the behavior or outcome that creates the costs (e.g., number of special education placements). The second involves the per-unit costs of that behavior or outcome. The distinction is important because the information often is derived from rather different sources (e.g., school budgets vs the records of specific students).

As noted above, these per-unit costs could vary depending on the perspective involved.

**Costs of illness for ADHD**

A review of literature was conducted using combined key word searches from the following list: cost, cost of illness, cost benefit, cost effectiveness, attention-deficit disorder, attention-deficit hyperactivity disorder, education, substance use, health care, MH care, education, discipline, pharmacotherapy, medication, and pharmaceuticals. Additionally, a review of references as well as cited reference searches were conducted. Further, researchers in the field of ADHD were contacted and asked about studies in progress of cost data for ADHD and its associated domains, including our own laboratories. Studies were included if they utilized an identified attention-deficit disorder or ADHD sample and included outcome domains that were monetized.

To our knowledge, only 13 studies have been conducted which met the aforementioned criteria. The 13 relevant studies are presented in Tables I and II. Table I describes study characteristics, including sample characteristics, ages, comorbidities, cost outcomes assessed, and estimated total costs per year. Table II breaks down the costs into several categories representing the different sectors where costs are incurred: health costs (medication for ADHD and emergency room care/routine physician costs), educational costs, and other resource use.

The studies vary considerably, from those utilizing large databases from which ADHD cases and associated costs were obtained33 to those that involved diagnosed clinic cases of ADHD in treatment outcome studies or longitudinal studies.34 As is clear from examining Tables I and II, the range of cost sectors assessed and the ways costs were obtained similarly varied considerably. In the following sections, we shall summarize the key domains listed in Tables I and II. For purposes of comparison, all costs discussed below have been inflated to 2005 prices by using the Consumer Price Index (www.bls.gov) to enable comparison across studies.

**Health and Mental Health Systems**

**Costs of Pharmacological Treatment**

As shown in the Tables, 5 studies have assessed the cost of medication separately from total or general medical costs. Primarily, the per-unit cost (for all studies but Jones et al34 and Jensen et al35) are based upon health insurance claims data. In Jones et al,34 the per-unit cost...
<table>
<thead>
<tr>
<th>Study</th>
<th>Sample Characteristics</th>
<th>Ages</th>
<th>Comorbidity</th>
<th>Cost Outcomes</th>
<th>Estimated Total Cost (year of dollar)</th>
<th>Estimated Total Cost (2005 dollar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guevara et al., 2001</td>
<td>Through diagnosis codes; based on at least one ambulatory visit or hospitalization (n=2992)</td>
<td>Combines ages 3 through 17 (mean age 11.7)</td>
<td>Externalizing condition, internalizing condition, SUD</td>
<td>Primary care; MH; ED; Pharmacy; Hospitalizations</td>
<td>$1465 total health care cost, per patient (1997 dollars)</td>
<td>$1783 total health care cost, per patient</td>
</tr>
<tr>
<td>Leibson et al., 2001</td>
<td>Through observer review of school and medical records for evidence of ADD diagnosis (n=309)</td>
<td>Combines children born between 1976 and 1982 (mean age=7.3)</td>
<td>[Total medical care costs]</td>
<td></td>
<td>$4306 (9-year median cost; per patient)</td>
<td>$5518 (9-year median cost; per patient)</td>
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<tr>
<td>Chan et al., 2002</td>
<td>Through MEPS HC (Household component); self-report coded by interviewer (weighted n=2,175,155)</td>
<td>Combines ages 5 through 20</td>
<td>Anx, tics, Dep, CD, emotional disturbance, LD.</td>
<td>OP; ED; Prescriptions; Home visits; Hospital stay; Out-of-pocket</td>
<td>$1151, per patient (1996 dollars)</td>
<td>$1433, per patient</td>
</tr>
<tr>
<td>Kelleher, Child and Harman, 2001</td>
<td>Through Medicaid diagnosis code or stimulant prescription fills (n=1602)</td>
<td>Combines ages 7–20, from 1994–1995</td>
<td>None; ADHD v. asthmatics</td>
<td>IP, OP, prescriptions</td>
<td>$1795 per patient (1995 dollars)</td>
<td>$2300 per patient</td>
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<tr>
<td>Burd et al., 2003a,b</td>
<td>a,b Through North Dakota Department of Health, identified based on ICD-9 code (n=3872a) (n=7745b)</td>
<td>Combines ages 0–21 (mean age 10) from 1996–1997</td>
<td>a, none b, health related (vision, epilepsy) &amp; mental health related (Dep, ODD, bipolar, CD, adjustment disorder, LD, Anx, nondependent drug use, tics, personality disorder</td>
<td>a, Health care (non-prescription), IP, OP b, Total health mean cost difference to $653 nondependent drug use.</td>
<td>a, $649 per patient (1997 dollars)</td>
<td>a, $790 per patient (1997 dollars) b, from low $181 (tics) to $795 nondependent drug use.</td>
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<tr>
<td>Mandell et al., 2003</td>
<td>Through Medicaid claims data between year 1993–1996</td>
<td>Combines ages 3 through 15 (mean age 7.7)</td>
<td>ED; IP; MH</td>
<td></td>
<td>$1895 for total health care, per patient (1998 dollars)</td>
<td>$2271 for total health care, per patient</td>
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<tr>
<td>Swensen et al., 2003</td>
<td>Identified based on at least one medical or disability insurance claim related to ADD (n=1175)</td>
<td>Children (18 and under) observed between 1996 and 1998 (mean age 12.4)</td>
<td>Dep, adjustment reaction, disturbances of childhood, other psychoses, ODD, CD substance use, Anx.</td>
<td>Medical office; IP; OP; Pharmacy; Indirect costs to family members of ADHD patient. (1998 dollars)</td>
<td>$1574 healthcare costs to patient; $2728 for other costs (health care utilization and work loss) to family members of ADHD patient. (1998 dollars)</td>
<td>$1886 healthcare costs to patient; $3269 for other costs (health care utilization and work loss) to family members of ADHD patient.</td>
</tr>
<tr>
<td>Swensen et al., 2004</td>
<td>Identified based on at least one medical or disability insurance claim related to ADD note: sample same as Swensen et al. (2003)</td>
<td>Patients 0–64 (mean age 16) observed between 1996–1998</td>
<td>Medical claims due to accidents</td>
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<td>$209 per patient (accident-specific cost)</td>
<td>$230 per patient (accident-specific cost)</td>
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<table>
<thead>
<tr>
<th>Study</th>
<th>Sample Characteristics</th>
<th>Ages</th>
<th>Comorbidity</th>
<th>Cost Outcomes</th>
<th>Estimated Total Cost (year of dollar)</th>
<th>Estimated Total Cost (2005 dollar)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birnbaum et al., 2005</td>
<td>Administrative health insurance claims, Identified based on at least one medical claim for ADHD (ICD-9) (n=1219)</td>
<td>Patients (between ages 7–44) observed between 1996–1998</td>
<td>Medical claims, prescription drug claims, all other healthcare costs, medically related work absence time for ADHD patients and family members</td>
<td>Children with ADHD and adults and family members $31.6 billion (total cost reported) (2000 dollars)</td>
<td>Children with ADHD and adults and family members $35.8 billion (total cost reported)</td>
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<tr>
<td>Secnick et al. (2005)</td>
<td>Diagnosed with ADHD and entered into medical claim database (n=2252)</td>
<td>Patients over age of 18 (mean age 31.8 years) diagnosed between 1999–2001 and continuously insured.</td>
<td>SUD; bipolar; Dep.; Anx; antisocial disorder; social phobia; ODD</td>
<td>Direct medical cost (IP, OP, prescription drug service); Productivity costs (absenteeism, short-term disability, worker’s compensation)</td>
<td>$5651 per patient (2001 dollar)</td>
<td>$6232, per patient</td>
</tr>
<tr>
<td>Jensen et al. (2005)</td>
<td>Identified with ADHD as part of Multimodal Treatment of ADHD (MTA) study from 7 cites around the country (MTA, 1994) (n=144)</td>
<td>Patient between ages of 7–9.9 years (Community Control (CC) group only)</td>
<td>Internalizing disorder; externalizing disorder</td>
<td>Medical management cost (i.e. medication cost and medication visits); mental health cost</td>
<td>$1071 per patient (2000 dollar) for all ADHD and comorbid; $1131 ADHD only; $718 ADHD plus internalizing; $1204 ADHD plus externalizing; $976 ADHD plus both.</td>
<td>$1215 per patient for all ADHD and comorbid; $1283 ADHD only; $814 ADHD plus internalizing; $1366 ADHD plus externalizing; $1107 ADHD plus both.</td>
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<tr>
<td>Jones, Foster &amp; Gottschall, under review</td>
<td>Subset of FastTrack Project data (n=84)</td>
<td>Between ages 12–15</td>
<td>CD</td>
<td>IP; OP; General health (ED, general practice, hospital); JJ (detention center, arrest cost); School (grade retention, special education, counseling)</td>
<td>$7600 annually, per patient (2000 dollars)</td>
<td>$8620 annually, per patient</td>
</tr>
<tr>
<td>Robb, Pelham, Foster, Molina &amp; Gnagy, in preparation</td>
<td>Children with ADHD identified in childhood and treated in clinic, followed into adolescence as part of PALS; controls recruited separately (n=364)</td>
<td>Between ages 5–17 at recruitment, and between 14–30 at follow-up</td>
<td>CD, ODD, LD, internalizing</td>
<td>School (acts of discipline, grade retention, special education); Juvenile delinquency (self-report)</td>
<td>$4900 for incremental costs of education</td>
<td>$4900</td>
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</tbody>
</table>

IP = Inpatient care; OP = Outpatient care; MH = Mental Health care; ODD = Oppositional Defiant Disorder; CD = Conduct Disorder; Dep = Depression; Anx = Anxiety; LD = Learning Disorder/Disability; JJ = Juvenile Justice; ED = Emergency Department.
<table>
<thead>
<tr>
<th>Study</th>
<th>Medication</th>
<th>Work Loss</th>
<th>ER/ED/IP/OP/Urgent Care/Physician Contact</th>
<th>Education</th>
<th>Other Resource Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guevara et al., 2001</td>
<td>Prescription: $335</td>
<td>—</td>
<td>Primary Care: $427 $ (520)</td>
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<tr>
<td>(1997 dollars)</td>
<td>($408)</td>
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<td>OP mental health: $222 ($270)</td>
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<td>ED: $38 ($46)</td>
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<td>IP: $115 ($140)</td>
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<td>By comorbidity type</td>
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<td>ADHD alone: $375 ($456)</td>
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<td>ADHD alone: $375 ($456)</td>
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<td>Internalizing: $1012 ($1231)</td>
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<td>Internalizing: $1012 ($1231)</td>
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<td>Externalizing: $898 ($1093)</td>
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<td>Subtance use: $847 ($1031)</td>
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<td>Kelleher, Childs &amp; Harman, 2001</td>
<td>Pharmacy use: $508</td>
<td>—</td>
<td>Other services: $1287 ($1649)</td>
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<tr>
<td>(1995 dollars)</td>
<td>($651)</td>
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<td>Psychiatric services: $1135 ($1455)</td>
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<tr>
<td>Leibson et al., 2001</td>
<td>—</td>
<td>—</td>
<td>Total Cost = physician billed, expense, hospital care: $4306 (9-year median cost) ($5518)</td>
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<td>(1995 dollars)</td>
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<tr>
<td>Chan et al., 2002</td>
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<td>Total Cost (collapsed across all expenses) = $1151 ($1433); Comorbid $2367 ($2946) v. ADHD alone $997 ($1241)</td>
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<td>(1996 dollars)</td>
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<td>Burd et al., 2003a,b</td>
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<td>—</td>
<td>a. Health Care $649 ($790)</td>
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<td>(1997 dollars)</td>
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<td>IP $8861 ($10782)</td>
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<td>OP $1597 ($1943)</td>
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<td>b. Dep $1330 ($1618);</td>
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<td>ODD $1451 ($1766);</td>
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<td>CD $1576 ($1918);</td>
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<td>bipolar $1733 ($2109)</td>
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<td>Adjustment $1280 ($1558);</td>
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<td>Anx $1399 ($1702);</td>
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<td>Tics $848 ($1032);</td>
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<td>Personality $1943 ($2364);</td>
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<td>Study</td>
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<td>Mandell et al., 2003 (1998 dollars)</td>
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<td>Nondependent drug use $1866 ($2271)</td>
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<td></td>
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<td>Absenteeism: $233, ($279)</td>
<td>Ambulatory: $167 ($167)</td>
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<td>Disability: $435 ($521)</td>
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<tr>
<td>Swensen et al., 2004 (1998 dollars)</td>
<td>Prescription: $551 ($660)</td>
<td>Absenteeism: CAD $30 (0)</td>
<td>IP: $388 ($465)</td>
<td>—</td>
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<tr>
<td>Children and Adolescents combined (CAD)</td>
<td>CAD: $787 (0)</td>
<td>Disability: CAD $30 (0)</td>
<td>OP: $433 ($519)</td>
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<td></td>
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<td>Provider: $286 ($343)</td>
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<td>Other: $66 ($79)</td>
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<td>Birnbaum et al., 2005 (2000 dollars)</td>
<td>—</td>
<td>Work loss cost to ADHD</td>
<td>Treatment of ADHD (combined medical claim and prescription drug claim): $1013.78 ($1149)</td>
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<td>family members:</td>
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<td>$112 ($127)</td>
<td>$1013.78 ($1149)</td>
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<tr>
<td>Jones, Foster &amp; Gottschall, under review** (2000 dollars)</td>
<td>Prescription: $84 ($96)</td>
<td>—</td>
<td>Treatment of ADHD (combined medical claim and prescription drug claim): $1013.78 ($1149)</td>
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<td>All other healthcare costs:</td>
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<td>$1393 ($1580)</td>
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<td>$603 to family members</td>
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<td>($684)</td>
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<td>Schooling (special education and retention): $3681 $4175)</td>
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<td>General Health: $385.50 ($438)</td>
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<td>Juvenile Delinquency: $6597.35</td>
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IP-Inpatient care; OP-Outpatient care; MH-Mental Health care; ODD-Oppositional Defiant Disorder; CD-Conduct Disorder; Dep-Depression; Anx-Anxiety; JJ-Juvenile Justice

*Cost presented in year of dollar reported (2005 dollar)

**Cost computed for each year of child’s age. For reporting purposes, costs were averaged across each of the five reported years.
was based upon parental report of annual medication use, and the Multimodal Treatment Study of Children with ADHD (MTA) costs were computed using medication costs for children in the community comparison group. Estimated annual cost has ranged from a low of $96 (Jones et al34) to a high of $1283 (Jensen et al35), with a mean of $459. As we discuss below, the variation of costs across studies is likely due to a number of factors, including age of sample, comorbidities, source of sample, Socioeconomic Status (SES) of families, physician costs, and medication regimen and brand. For example, only 2 studies described “physician” in such a way that they could be considered a portion of pharmacological treatment.

Costs of Psychosocial Mental Health Treatments

Only a few studies have evaluated the costs of psychosocial MH treatments. Across their 4 waves of young adolescents, Jones et al34 reported that the use of outpatient MH services—$500 to $800 per year, depending on age—was relatively low. Through age 15, slightly more was spent on inpatient MH, where the cost of inpatient treatment increased dramatically to more than $6000 per child (mean $3036), with the bulk of this being spent on a small percentage of the children. Similar increased costs are apparent in other studies for inpatient treatment.36,37 These estimates are based on parental reports of service use. Per-unit costs were based on reports from the facilities where individuals were treated; those costs represent the costs of those services from the payor perspective. Notably, in Jones et al34 comorbid Conduct Disorder (CD) did not noticeably increase cost of MH services in this sample, and the cost of MH services for children with ADHD met or exceeded service costs for children with CD only. Two other studies estimate nonpharmacological MH costs. Guevara et al38 reported a mean of $270, with incrementally higher MH costs for children with ADHD (even higher for comorbid children with ADHD), and Kelleher et al33 reported a mean of $1455. Per-unit costs were based upon insurance diagnostic code reimbursements and represent the employer perspective.

Use of Other Health Services

Treatment for conditions other than ADHD varied across studies, both in terms of reporting categories and in terms of cost. Several studies reported on total health care cost,39–42 while others differentiated cost by type (inpatient, outpatient, emergency department, etc.)33,34,36,38,42–44 and still others differentiated cost based on comorbidity status.34,37,38 These reporting differences make it difficult to separate MH from other health services. When studies that separated MH and pharmacotherapy from other health care costs are examined, the estimates for all other health care range from $438 (Jones et al34) to $1580 (Birnbaum et al41).

Summary

Averaging these estimates for ADHD treatment and other health care costs across studies yields an annual per child cost of $2636, with a range from $790 to $5518. As can be seen in Tables I and II, the range is due to a number of factors, including the types of services that were included in the estimates, whether the ADHD child had comorbid disorders, and the nature of the database utilized.

Educational Costs

The incremental costs of education accrue from a variety of sources that mirror the educational system’s response to the children’s dysfunctional outcomes. Thus, many children with ADHD are eligible for special education services under Section 504 of the Rehabilitation Act of 1973 or the Individuals with Disabilities Education Act (IDEA) and receive related services at rates higher than those for children without ADHD.43 Factors contributing to cost include whether the child has an individualized education plan and is in a part-time or full-time special education classroom or a more restrictive setting (e.g., a special school), as well as whether the child is receiving accommodations in a regular setting (e.g., through a section 504 plan).

Only 2 studies have examined samples in which education costs can be computed for children with ADHD by using information regarding their school placements. In one study reported by our group, Jones et al34 examined existing data from the Fast Track study46 for education services utilization. They used standard parent interview data to make diagnoses of ADHD (and CD) in children from the original sample (across both normative and at-risk groups), and they examined parental report of special education utilization, school counseling, and retention over a 4-year period (ages 12–15). They used national estimates of cost of special education services and computed educational costs for their ADHD, CD, comorbid, and comparison groups. Collapsing across costs for grade retention, school counseling, and special education use, average school expenditures were significantly higher for ADHD—averaging $4175 per ADHD child annually.

The other study is also one that has just been completed by our group.47 The cost analysis relies on
a prospective longitudinal study, the Pittsburgh ADHD Longitudinal Study (PALS), of individuals with and without diagnosed ADHD in childhood (and comparison children). In this sample, a substantial number of individuals have completed their educational careers, and the remainder is in midadolescence to late adolescence. Measures included parental annual reports of special education services, retention, and disciplinary referrals. Costs associated with the utilization of special education were derived from national estimates from the US Department of Education. The average incremental annual cost to educate a child with ADHD from kindergarten through grade 12 is approximately $4900 annually over that of regular education, as compared with $265 annually for control children. The bulk of this amount was due to special educational placement and retention.

Crime, Delinquency, and Substance Use

Only a single study to date has examined the nonvictim cost of delinquency and/or criminal behavior in ADHD samples. Jones et al again examined existing data from the Fast Track study for juvenile justice system utilization and costs. Juvenile justice use was derived from the Service Assessment for Children and Adolescents, and per-unit cost estimates were computed by combining the cost of arrest and the cost of placement in a juvenile justice center. For ADHD individuals regardless of comorbidity, the annual cost in 2005 dollars ranged from $11 to $935, with a mean of $440.

A broader analysis included cost to victims, which is a major portion of crime-related costs. We computed victimization costs for the 14 to 17-year-olds in the PALS ADHD sample by using self-reported acts of delinquency. Applying Cohen’s victim costs for different acts, nearly $6600 annually in costs is incurred by victims of crime for each ADHD youth in the PALS sample.

Only a single study addressed each perspective (perpetrator and victim) and it is inappropriate to average across perspectives. Therefore, the appropriate estimate is the sum of the two studies, yielding an estimate for the cost of delinquency of $7040.

To date, no COI studies on the cost of alcohol abuse and/or drug abuse by ADHD youth (e.g., the cost of treatment in a sample) were identified. Given the high costs of drug and alcohol abuse and the increased risk for these outcomes in ADHD individuals, it is reasonable to expect an increase in COI from substance use/abuse in ADHD adolescents.

Total COI for ADHD

Table III shows the total COI for an ADHD child based on the studies and cost sectors reviewed in Tables I and II. The mean estimated annual cost for a child/adolescent with ADHD is $14,576, with a range from a low estimate of $12,005 to a high estimate of $17,458 by using the lowest and highest estimates from the review. Using the 2000 census of 60 million school-aged children in the US and assuming a commonly accepted prevalence rate of 5%, these individual estimates translate to an annual aggregate COI of $42.5 billion for the school-aged ADHD cohort in the United States (range, $36–$52.4 billion). The range of prevalence estimates for ADHD is 2% to 9%, so the cohort annual aggregate could range from 60% less to 80% more than our estimate of $42.5 billion.

Discussion

Although the number of studies is small and most have evaluated only a few domains, this review provides a preliminary estimate of the COI for ADHD—particularly in the areas of treatment costs, other health care costs, education, and juvenile justice. The review also highlights the areas in which little information is available and provides direction for future research needed to more comprehensively quantify the COI of ADHD.

Notably, the COI estimate we derived is considerably higher than that reported in any one of the articles reviewed. That difference is a result of the fact that most studies examined only a single sector COI, for example,
health care or education—but not both. As Table III illustrates, the COI of ADHD is distributed across at least the 3 sectors we examined, with substantial costs in each. Further, there are important cost sectors that have yet to be examined—most notably the cost to families of ADHD (e.g., parental work loss, parental stress and substance use, and extra child-care costs). There are no estimates of the costs of substance abuse associated with ADHD despite the fact that problems in this domain begin early and intensify through adolescence.4–6 Further, as we discuss below, it is likely that the estimates in 2 of these sectors—health care (specifically treatment) costs and educational costs are substantial understimates of the COI of ADHD in childhood and adolescence.

Costs of Health and Mental Health Systems

Let us first consider the most common treatment for ADHD—pharmacotherapy. At an aggregate level, current cost of pharmacotherapy for ADHD will depend primarily on1 how many children are medicated,2 whether they take a patented long-acting formulation,3 how many days per year they take medication,4 whether they are medicated for school hours only or for evening hours also, and for how many years they take medication.5 The costs for pharmacological treatment of ADHD reported in the studies reviewed herein are a substantial underestimate of current pharmacological practices. The main reason for this is that all extant studies were conducted a) before the new wave of patented ADHD formulations began in 1999/2000 with the FDA approval of Concerta and Adderall XR and (b) before guidelines that call for more frequent prescribing physician contact with ADHD families.7,51 The vast majority (80%) of children with ADHD and adolescents who are medicated currently receive 1 of these 2 long-acting (12-hour) formulations of methylphenidate/amphetamine.52 Still under patent protection, these formulations have substantially higher costs ($1440 annually for typical dosing at 2005 retail pricing) than the generic formulations that were most prevalent when the medication cost data in all of the published studies were gathered (mean prescription cost of $459). For example, twice-daily generic methylphenidate costs only one fourth as much as Concerta or Adderall XR at 2005 retail prices. If a prescribing physician (e.g., family practitioner) sees the child quarterly, the cost of physician time will be $332 annually.34 Thus, the annual cost of medication for ADHD currently is likely to be nearly $1775 to $1316 more annually than the estimate that we used in Table III. Assuming that 70% of children with ADHD are medicated at any one point in time,51,53 aggregate costs for pharmacotherapy for children with ADHD is likely to be $5.3 billion.54

Because pharmacological treatment is the most commonly used evidence-based treatment for ADHD, more information on the cost of this intervention is sorely needed. Given the dramatic difference in cost between short-acting generics and long-acting patented formulations, studies that compare the cost effectiveness of the 2 formulations in practice settings is needed. Although industry marketing argues that the newer long-acting stimulants produce better effects than short-acting generics, head-to-head comparisons suggest that the effects are similar.55 Further, longitudinal studies that relate lifetime costs to long-term benefits of stimulants are needed.

The other approach to intervening with ADHD involves behavioral interventions.56 The cost estimates for psychosocial treatments in the studies we reviewed are quite low, especially when compared with current recommendations for such interventions.7 Bussing et al57 and Hoagwood et al58 have shown that children with ADHD are woefully underserved with respect to MH treatments, and that is reflected in these costs. One possible contributor to this fact is that payor policies restrict access to mental health services.59 For example, in the Guevara HMO sample (Table I), the average ADHD child had only 1.3 mental health visits per year56 with a median of zero. Since the evidence-based behavioral treatments for ADHD involve numerous sessions (e.g., 12 for group parenting training and 12 separate ones for child social skills training), these low numbers suggest that evidence-based practices were not being offered or covered by the plan, or that plan physicians were not recommending them. Only 1 study has reported the cost of evidence-based behavioral treatment for ADHD; the mean cost of the comprehensive behavioral treatment (a year’s worth of parent training, teacher consultation, and a summer treatment program) for the children in the MTA study was reported as a cost of $6988 for a year of treatment.35 Thus, the extant literature on the cost of psychosocial treatments for ADHD is not informative regarding what the cost would be if evidence-based behavioral treatments were as widely used as is medication.

As with different medication formulations, COI research in this domain needs to focus on the cost effectiveness of evidence-based behavioral approaches versus and in combination with medication. In addition, analysis of the costs of different models of service
provision of evidence-based interventions need to be conducted (e.g., clinic-provided vs school-provided services). Finally, studies are needed of the impact of clinic-provided interventions on the school-based COI noted above.

As Tables I and II illustrate, nontreatment-related health care costs for ADHD have been most widely studied. At the same time, additional research is needed to fully describe the health-related COI of ADHD. For example, it is difficult to discern from the published studies whether physician visits are for ADHD medication prescription or for other purposes. It would also be useful for future studies to differentiate costs associated with various types of health care use (e.g., emergency room visit or outpatient pediatric visit).

**Educational Costs**

The incremental costs of education noted in the 2 studies reviewed are remarkable. In the only previous estimate of educational costs of ADHD, Forness and Kavale45 used a variety of national prevalence estimates and standard national cost data to derive an annual estimated cost of special education for ADHD of $3.2 billion (in 1995 dollars; $4.1 billion in 2005 dollars); Robb et al47 and Jones et al34 followed actual samples of children with ADHD and reported annual costs more than 4 times higher—$13.6 billion. Robb et al report that the educational costs for ADHD were not a result of a few severely disturbed children; 48% of the sample had at least 1 year of special education, and 80% of the sample had at least 1 serious disciplinary infraction each quarter. Clearly, the incremental cost of educating a child with ADHD is enormous. Based on this number, the lifetime incremental cost of educating a cohort of children with ADHD through high school would be $176.8 billion.

Despite their enormity, there are several reasons that these educational costs may be underestimates. The Foster et al34 sample was young adolescents followed through the middle school years where special education utilization is less than in elementary school. Further, the PALS sample that Robb et al37 analyzed had half of its collective education after 1992, when ADHD was first officially recognized under the IDEA as eligible for special education. Forness and Kavale45 estimated that there was a 68% increase in the number of children with ADHD by using special educational services in the 4 years after 1992. Thus, the Robb et al37 reports of special educational services may well be dramatic underestimates.

Future research needs to study a sample in which the education of the subjects has been entirely since the 1992 change in the IDEA began to be widely implemented. Additionally, neither Foster et al29 nor Robb et al47 had data regarding 504 plan implementation and associated costs. Future research should obtain such estimates, as well as more precise estimates of the costs of disciplinary infractions (e.g., lost instructional time and school administrator time). Finally, since the bulk of incremental educational cost is due to special education, research is needed that examines whether evidence-based treatments (both pharmacological and behavioral) influence subsequent special education utilization (see discussion below).

**Crime, Delinquency, and Substance Use**

Crime and delinquency contributed substantial cost to the COI of ADHD. However, only 2 studies were identified. More research is clearly needed in the COI of these domains. Foster et al29 reported useful treatment costs for young adolescents; information regarding treatment/incarceration costs for older adolescents is needed. A broader analysis in future studies would also include both the cost of treatment and the cost to victims, as noted above. Replication of the analysis of the victim costs of the PALS study is needed in other studies with comparable data that can be used to compute victim costs. Finally, studies of COI of substance abuse in ADHD samples are needed.

**Psychiatric Comorbidity**

It was evident in several studies reviewed that children with ADHD with comorbidities might incur greater COI. This was evident in treatment and health cost studies that reported on comorbidities.40 Similarly, Jones et al34 reported that the crime/delinquency-related costs were greater for children with ADHD with comorbid CD than for children with ADHD who were not comorbid (Robb et al47 did not report victim costs by comorbidity). Forness and Kavale45 speculated that children with ADHD with comorbid learning disabilities would have higher educational COI due to higher rates of special education, but this has not yet been systematically evaluated. Jensen et al35 reported that costs for medication treatment were lowered by comorbid anxiety and raised by comorbid aggression. ADHD adolescents with comorbid aggression are at greater risk for substance abuse and thus should have higher associated costs. Future research—particularly longitudinal studies that follow children with ADHD into the teen years when
delinquency is evident—should routinely examine COI in ADHD as a function of psychiatric comorbidity.

Limitations and Extensions

This study is limited by the small amount of literature on which our estimates are based. The variability in methods, outcomes, and estimates across the studies we reviewed make it clear that work on COI is difficult if one relies on a single source for data. For example, our cost estimates for education and crime are based on only 2 studies, and psychosocial treatment on a similarly small number. These studies are methodologically sound, but estimates may change with larger, more geographically or socioeconomically diverse samples, and more studies in each cost sector as well as neglected sectors are needed.

Existing methodology developed in the field of medical decision-making offers the potential to combine different data sources of different types to develop improved estimates of the costs of illness. These methods also provide a comprehensive assessment of the uncertainty associated with the estimated costs of illness—something that we cannot do with this small number of studies.

The estimate of impact of children with ADHD on their parental and family function represents the area with the greatest need of further study. Existing studies have shown little direct estimated cost, but there are arguably large indirect costs. Indeed, a considerable literature shows that parents of children with ADHD suffer very high levels of distress, depressed affect, and substance use caused by their children’s behavior, but these outcomes have not been monetized. For example, although a few of the studies in Tables I and II examined parental work loss, they did not provide enough information to separate work loss incurred by parents of children with ADHD from that of ADHD adults. Furthermore, they relied on official absenteeism and disability claims. As is the case with other MH disorders, official records are unlikely to reflect the main source of work loss for the parent of an ADHD child. Instead, family members likely incur unexcused and nonmedically related absences due to factors such as school suspension or difficulty obtaining after-school care or day care, as well as lost time at work due to phone calls from teachers or principals and anxiety-related inefficiency. Future research investigating this domain should include instruments designed to gather the kind of information that is used in workplace studies to facilitate accurate monetization of this component of COI. In addition, because the parents of children with ADHD are more likely to be depressed, anxious, and to have marital and alcohol problems relative to control groups, the economic impact of ADHD on these parental outcomes needs to be measured and included in COI (e.g., reports of parental MH services). Similarly, the impact of ADHD individuals on these domains has not been studied in their siblings.

There are many other domains that have not yet been evaluated, including whether ADHD families include individuals on disability or welfare at a differential rate. We noted above that information on increased substance use and abuse and associated costs needs to be monetized. In addition, one recent study shows that ADHD teens are more likely to engage in risky sexual activity and cause early pregnancies, and these data, as well as other data regarding risky activities with associated costs (e.g., risky driving) need to be included in a COI of ADHD.

We noted at the outset that our analysis focuses only on children and adolescents. It is clear that ADHD is a chronic condition and that ADHD individuals continue to have a host of difficulties that have associated costs in adulthood. Two of the studies in Table I involved mostly, or exclusively, adults. Birnbaum et al provided the only estimate of the COI of ADHD in adults of which we are aware (although their study included some children and adolescents), at $31.6 billion. Those studies are also limited by the breadth of sectors evaluated (e.g., no assessment of the cost of substance abuse or criminal activity) and the work-loss assessment issues noted above. Extension of COI work into the field of adult ADHD is clearly indicated. When combined, our estimate and that of Birnbaum et al—albeit preliminary and incomplete—suggest that the cost of ADHD across the lifespan is at least $74.1 billion.

It is instructive to put this COI for ADHD in the context of other conditions. For example, a recent analysis suggests that the annual COI for major depressive disorder in the US is $44 billion. The annual aggregate cost of substance abuse in the United States has been estimated to be $180 billion. The annual aggregate COI of stroke in the US was $53.6 billion in 2004. Kelleher et al reported that the annual health care costs of children with ADHD were comparable to those of children with asthma, and a recent report on the COI of asthma in the European Union reported an annual per child health care cost of $820 (2004 dollars)—similar to the health care costs for ADHD shown in Table II,
reinforcing the conclusion of Kelleher et al. It is clear that the COI of ADHD is of a similar magnitude as these other conditions—some of the most prominent in the professional literature and the public consciousness.

Finally, consider the fact that we employed a prevalence rate of 5% in our estimates. The upper bound of prevalence rates for ADHD is 9%.\textsuperscript{31} If the true prevalence rate of ADHD or children with ADHD symptoms and/or impairments were 9%, then the societal costs of our estimates would increase substantially.

**Implications for the Cost-Effectiveness of Treatment and Prevention**

These high costs of illness have important implications for treatment and prevention of ADHD. It is crucial to note that when costs of ADHD are computed, a relatively small amount is for direct medication or psychosocial treatment for ADHD, compared with much higher costs for education, crime, and costs to others. Therefore, any analysis of cost-effectiveness of treatments should prioritize these costs, both direct and indirect.

Additional research is needed on variation among children with ADHD and various comorbidities. The calculations provided here indicate that some behaviors are very costly, and we know from research in other areas (such as aggression) that a few youth account for a disproportionate share of costly behaviors and costs.\textsuperscript{34} On the other hand, as noted above, the costs of educational problems for children with ADHD applies to the majority of individuals. Additional studies that are comprehensive, have large sample sizes, and are longitudinal could provide information on whether the children and youth who are mostly costly in education are also more costly in other sectors such as juvenile justice. Once identified, such children could be the focus of early identification and prevention efforts or later intensive—though costly—intervention. Similarly, children whose characteristics suggest that they are the least costly might be treated with low-intensity treatments (e.g., low-cost classroom management tips for teachers and/or low-dose medication) before more costly treatments are implemented.\textsuperscript{68}

One can think of the costs of illness as an upper limit for what society might save through intervention. How much of the costs would be recouped, even by an effective program, may depend on the mediating mechanism targeted. For example, medications for ADHD have very large acute effects on symptoms but may generate a smaller reduction in COI than behavioral interventions that target the mechanisms (e.g., peer relationships, parenting, school functioning) linked most closely to costly outcomes and behaviors.\textsuperscript{69–72} Similarly, medication must be continued chronically, while behavioral treatments are applied over a limited period with subsequent adaptations designed to maintain initial gains.\textsuperscript{56} Though more expensive acutely than medication in the MTA—nearly 3 times as much—the effects of the behavioral treatments appeared to maintain better than medication, which required continuation.\textsuperscript{35} Over a 3-year period, the costs of the 2 modalities would become roughly comparable. Notably, a cost-effective treatment likely only has to capture a portion of the costs of illness demonstrated here. Even a relatively expensive treatment like the behavioral therapy offered in the MTA study might be cost effective because the costs of illness for ADHD are clearly several orders of magnitude larger than even the cost of the behavioral treatment.\textsuperscript{35} Which would be more cost effective in the long run is a key empirical question that has not yet been answered.

**Summary**

A preliminary, incomplete, and conservative estimate of the annual COI of ADHD is $14,576 per child in 2005 dollars, with a very wide range across a small number of studies. Using an ADHD prevalence of 5%, this translates into a minimum annual aggregate COI of $42.5 billion, with a more likely estimate being twice that amount. These costs are staggering and comparable in magnitude to other serious medical and MH problems in both children and adults. It is noteworthy that ADHD is somewhat unique among chronic childhood conditions because its impact, and therefore COI, cuts across a broader range of sectors than other conditions. For example, learning disabilities affect primarily the educational domain, while conduct problems impact the juvenile justice domain, and asthma primarily the health care and family domains. The functional difficulties for children with ADHD occur in all of these domains,\textsuperscript{11–13} so the COI would arguably be expected to be higher than many other conditions. The fact that multiple sectors are involved also highlights the need for interdisciplinary cooperative in the research and management of ADHD.

The magnitude of this COI estimate highlights the public health importance of ADHD for families, schools, and health care providers. Thus, this COI analysis not only justifies—but argues for—an expansion of evidence-based services for ADHD\textsuperscript{56} and an NIH commitment to growth both in research that compares the relative costs and effectiveness of evidence-based interventions and in
major public health initiatives focused on this common and refractory condition.68,69

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