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Mothers of Children Diagnosed with Attention-Deficit/ Hyperactivity Disorder: Health Conditions and Medical Care Utilization in Periods Before and After Birth of the Child

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Abstract

Background—Analyzing health conditions and medical utilization of mothers of children with attention-deficit/hyperactivity disorder (ADHD) can shed light on biological, environmental, and psychosocial factors relating to ADHD.

Objective—To examine health conditions, health care utilization, and costs of mothers of children with ADHD in periods before the child was diagnosed.

Methods—Using automated data from Northern California Kaiser Permanente we identified mothers of children with ADHD, mothers of children without ADHD, and mothers of children with asthma. Mothers' diagnostic clusters, health care utilization, and costs were compared. Mothers of children with ADHD were compared to mothers of children without ADHD and, separately, to mothers of children with asthma.

Results—Compared to mothers of children without ADHD, mothers of children with ADHD were more likely to be diagnosed with numerous medical and mental health problems in the two years after birth of their child, including depression (Odds Ratio (OR): 1.88), anxiety neuroses (OR: 1.64), obesity (OR: 1.70), and musculoskeletal symptoms (OR: 1.51). Results were similar for the year before delivery. Mothers of children with ADHD also had higher total health care costs per person in the year before ($1003) and the two years after ($953) the birth of their child. Mothers of children with ADHD also were diagnosed with more health conditions and had higher health care costs than mothers of children with asthma.

Conclusions—Our findings suggest that the likelihood of being diagnosed with ADHD is related to maternal conditions and use of health services that precede the child's diagnosis. Future studies are needed to clarify whether this is due to biologic, psychosocial, or environmental factors, or a combination.

Keywords

cost; ADHD; attention deficit; hyperactivity; asthma; ethnicity

Introduction

Attention-deficit/hyperactivity disorder (ADHD) is one of the most common psychiatric disorders of childhood, with an estimated prevalence of nearly 8% in U.S. children aged 4 to

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17 years.[1] There is evidence of both a genetic and environmental component to ADHD.[2-5] Studies have shown that health care costs and utilization of children with ADHD is higher than those of the general pediatric population.[6-13] A number of studies have addressed the relationship between ADHD in children and family psychosocial environment[14,15], prenatal exposure to tobacco and alcohol[16-22], and birth weight.[21-26] However, few recent studies have analyzed the medical and mental health conditions[15,27,28], and health services use[27], of the mothers of childrenwith ADHD. Most of these studies have relied on information obtained from self-reports or interviews conducted with mothers after their child was diagnosed with ADHD. These methods are susceptible to recall bias (if they ask about a time prior to the diagnosis of the ADHD child) and allow the possibility that having a child with ADHD may influence the medical conditions and utilization reported by the mother. No study, to our knowledge, has used claims data to investigate pre-existing conditions and patterns of health services utilization of mothers before the initial diagnosis of ADHD in their children.

In this study, we address the following questions: 1) Are mothers of children with ADHD more likely than mothers of children without ADHD to be diagnosed with certain health conditions in the year before and two years after the birth of their child; 2) Do mothers of children with ADHD have higher health care costs and utilization in the year before and two years after the birth of their child. The answers to these questions can shed light on potential maternal biologic factors that might be associated with having a child who is later diagnosed with ADHD. As importantly, they may indicate a relationship between maternal propensity to use services and seek diagnoses and the likelihood of the child being diagnosed with ADHD. The latter is particularly important given the inherently subjective nature of the ADHD diagnosis.[29] Mothers more likely to seek care and diagnoses for themselves may be more likely to seek care and diagnoses for their children.

We analyze the year before and two years after birth of the child in order to identify health conditions and patterns of utilization in mothers prior to the diagnosis (and likely manifestation) of ADHD in their children. In addition to comparing the mothers of children with ADHD to mothers of children without ADHD, we also compare the mothers of children with ADHD to the mothers of children with asthma to evaluate the specificity of our results to ADHD.

Methods

Setting

Kaiser Permanente of Northern California (KPNC) is a nonprofit, integrated health care delivery system providing care to over 3 million members. The KPNC membership represents approximately 30% of the insured population in the region and is demographically similar to the residents of the counties served by KPNC, except that the very poor and very wealthy are underrepresented.[30]

Selection of study population

Using KPNC electronic clinical databases, which contain information on interactions of members with the health system, we selected all children born in a KPNC hospital between January 1, 1996 and December 31, 1999. We then identified those children who, between January 1, 1996 and December 31, 2006, had a visit at a KPNC facility that included the diagnosis or management of ADHD (International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) code 314.0), and who were at least 2 years of age when their first ADHD diagnosis was made (all children selected were between 2 and 11 years of age when diagnosed with ADHD). Each child had to be a KPNC member from birth until receipt of their first ADHD diagnosis. On average, these children were 7.1 years old when first diagnosed with ADHD. The guideline for providers at KPNC is to use the Diagnostic and

Statistical Manual of Mental Disorders (DSM-IV) criteria for diagnosing ADHD. An assessment should take place, but there is variability with respect to the tools used. Generally, an ADHD-specific questionnaire is filled out by parents and the child's teacher(s) and a developmental history questionnaire (usually with a KPNC-developed tool) is filled out by the parents, and the parents and children are interviewed.

We selected two comparison groups, matched at approximately a 3:1 ratio to the children with ADHD (cases) on birth month, birth facility, and months of continuous enrollment in the health plan. The first group was defined as children who were not diagnosed with or treated for ADHD between 1996 and 2006 (non-ADHD group). Treatment was defined as being dispensed a psychostimulant or atomoxetine from a KPNC outpatient pharmacy. The second group was defined as children with a diagnosis of asthma (ICD-9-CM code 493) between 1996 and 2006. Only the subgroup of children with ADHD for whom a match to both comparison groups was found were included in the sample. The children without ADHD may have had asthma (or any other condition except ADHD), and children with asthma may have had ADHD (or any other condition) in addition to asthma. Thus, a woman could be in both the "mothers of children without ADHD" comparison group, and the "mothers of children with asthma" comparison group. A small number of mothers of children with ADHD (n=33) had one index child with ADHD and a different index child with asthma. Because these introduce definitional and analytical complexities, we excluded them from analyses where mothers of children with ADHD were compared to mothers of children with asthma.

Mothers were identified from the Admission, Discharge and Transfer system, which records information regarding every delivery in a KPNC hospital. The mother's index date was the day after she was discharged from the hospitalization during which the index child was born. We only included mothers who were between 15 and 45 years of age on their index date and were continuous members of the health plan for at least 24 months after their index date.

Maternal Medical conditions

We extracted from KPNC automated databases all diagnoses (whether primary or not) received by each mother in the year before, and two years after, her index date. Similar to prior studies[31], we used the Johns Hopkins ACG Case-Mix system (version 7.1) to group diagnoses into Expanded Diagnosis Clusters (EDCs). The EDC methodology assigns ICD9 codes to one of 264 EDCs. To focus on relatively common conditions, and have sufficient numbers of persons in the analyses, we only included EDCs having at least 5% prevalence (for the combined two year period after the index date) among either the mothers of children with ADHD or the comparison mothers. We also determined which mothers received a specific diagnosis of ADHD between 1996 and 2006 (complete diagnosis information was not available prior to 1996).

Maternal characteristics

We used the health plan automated hospitalization databases and the California State Vital Statistics Birth Data to determine the length of the maternal hospital stay, maternal educational level at delivery, and the total number of children the mother had given birth to as of the index date.

Cost and Utilization Data

Costs for services provided by KPNC were obtained from the Cost Management Information System, an automated system that integrates utilization and financial databases. Costs (including program and facility overhead) are generated for services using standard accounting methods and program-specific relative value units. From these data we estimated the average cost of: (1) hospitalizations by Diagnosis Related Group (DRG) and within DRG, by length

of stay; (2) emergency department (ED) visits; (3) outpatient office visits by department and provider type (e.g., “physician”, “registered nurse”). Hospitalizations, ED visits, and office visits were extracted from the health plan’s automated databases and were assigned the costs described earlier.

Pharmacy costs were obtained from KPNC’s Pharmacy Information Management System, which records information on all prescription drugs dispensed at KPNC outpatient pharmacies including acquisition cost of the medications dispensed. For services covered by KPNC, but provided by non-KPNC vendors, we used the payments made to those vendors as the cost of those services.

The Consumer Price Index was used to adjust all costs to 2006 dollars. Two measures of utilization were also included in the analyses: number of inpatient hospital days and number of outpatient visits to KP providers.

Analyses

To test for differences between mothers of children with and without ADHD in the prevalence of specific medical conditions (EDCs) diagnosed in the 2 years after the index date, we ran a separate logistic regression model for each condition, controlling for race/ethnicity (white, black, Hispanic, Asian, and other, based on self-report at the time of admission for the index delivery), age at delivery (categorical in five-year age groups), income (in quintiles based on median family income by census block group from the 2000 US census), mother’s education (categorical: <high school graduate, high school graduate, any college, any post-graduate) primary medical facility used by the mother (15-level categorical), and the number of children the mother had given birth to prior to the birth of the index child (categorical: 0, 1, 2, 3+). Census block group (and thus estimated income) was based on the member’s home address as of the index date. In order to remove the possible effect of having other, older, children with ADHD in the family, we performed a sensitivity analysis in which we analyzed maternal health conditions only for the subset of women for whom the index child was their first born. To control for the possible effect of early development and behavior (prior to the age of 2 and the initial diagnosis of ADHD) on maternal healthcare utilization, we performed a secondary analysis in which we analyzed the diagnostic clusters in the year before the birth of the index child for the subgroup of women who were health plan members continuously during this time period. Due to the smaller sample sizes available for these two subsequent analyses, these models did not include as a covariate the 15-level primary facility used by the mother.

For our cost analysis, we constructed a dataset consisting of one observation per mother, with cost and utilization summarized over the two years after the index date. To estimate the excess costs to the health plan of the mothers of children with ADHD compared to the mothers of children without ADHD, we ran an ordinary least squares (OLS) model (using SAS software PROC MIXED with an identity link function and a Gaussian distribution assumption) in which untransformed cost was the dependent variable. (In preliminary analyses using a split-sample testing approach, we found that OLS regression predicted costs as well or better than models involving log-transformed costs or log-links with gamma distribution functions — findings similar to those of a recent study comparing cost modeling techniques).[32] We also adjusted for race/ethnicity, age at delivery, income, mother’s education, primary medical facility used by the mother, and the number of children the mother had given birth to prior to the index child. The cost subgroups separately assessed were: hospital, emergency department, outpatient primary care (which includes all visits to the departments of medicine, family practice, pediatrics and gynecology), outpatient psychiatry department, pharmacy, and other outpatient services (e.g., specialty department visits like optometry or neurology, as well as covered outpatient services provided by non-KP providers). In order to test how sensitive the cost results were to outliers, we reran the model excluding mothers with total costs over $50,000 (the 14

mothers with the highest cost). In another sensitivity analysis, we included only those mothers for whom the index child was the first-born. In a secondary analysis we analyzed costs in the year before the index date.

The primary analyses of medical conditions and costs were also performed to compare the mothers of children with ADHD to the mothers of children with asthma. Because many of the children with ADHD also had asthma (~25%), we created three mutually exclusive groups: 1) mothers of children with ADHD but not asthma; 2) mothers of children with both ADHD and asthma, and; 3) mothers of children with asthma but not ADHD. We then separately compared each of the first two groups to the third group.

Results

Subject characteristics

We identified 1,869 mothers of children with ADHD and 5,538 mothers of children without ADHD who met the study criteria (Table 1). The mothers of children with ADHD were much more likely to be white Americans, have longer delivery hospital stays, and have a diagnosis of ADHD than mothers of children without ADHD.

We identified 1,379 mothers of children with ADHD but not asthma, 457 mothers of children with ADHD and asthma, and 4,973 mothers of children with asthma but not ADHD (Table 2). Mothers of children with ADHD only, or ADHD and asthma, were much more likely to be white Americans than mothers of children with asthma only, and were also much more likely themselves to have received a diagnosis of ADHD between 1996 and 2006.

Prevalence of diagnosed medical conditions

In the two years after the index date, mothers of children with ADHD were significantly more likely than mothers of children without ADHD to be diagnosed with most of the 35 EDCs examined (Table 3), representing a wide variety of medical conditions with varying etiologies and affecting multiple organ systems. These included psychiatric conditions (e.g., depression, anxiety neuroses), musculoskeletal problems (e.g., musculoskeletal symptoms, lower back pain, acute sprains), immune-related conditions (e.g., respiratory and other infections, asthma, allergic rhinitis, viral syndromes), as well as a variety of other diagnostic clusters (e.g., obesity, female genital symptoms, abdominal pain, headaches, diarrhea).

When we restricted the cohort to those women for whom the index child was their first child (863 (46%) mothers of children with ADHD and 2582 (47%) non-ADHD comparison mothers), we still found that mothers of children with ADHD were more often diagnosed with virtually all the conditions, and continued to be significantly more likely to be diagnosed with nineteen of the conditions, including depression (OR: 2.09, CI: 1.52 to 2.87), anxiety neurosis (OR: 1.85, CI: 1.49 to 2.29), contusions/abrasion (OR: 1.63, CI: 1.10 to 2.40) and abdominal pain (OR: 1.64, CI: 1.32 to 2.05).

We analyzed the health conditions in the year before the birth of the index child for the subset of mothers for whom we had complete diagnostic data in that year (1113 mothers of children with ADHD, 3167 comparison mothers). In the year before the birth of the index child, mothers of children with ADHD were significantly more likely to be diagnosed with depression (OR: 1.94, CI: 1.29 to 2.91), musculoskeletal symptoms (OR: 1.93, CI: 1.38 to 2.68), conjunctive keratitis (OR: 1.70, CI: 1.16 to 2.47), acute sprains (OR: 1.65, CI: 1.23 to 2.22), obesity (OR: 1.44, CI: 1.10 to 1.86), anxiety neuroses (OR: 1.37, CI: 1.05 to 1.78) and eight other conditions.

In the two years after the index date, the mothers of children with ADHD but not asthma were significantly more likely to be diagnosed with depression (OR: 2.09, CI: 1.62 to 2.69), obesity

(OR: 1.71, CI: 1.36 to 2.15), contusions/abrasions (OR: 1.42, CI: 1.05 to 1.89), anxiety neuroses (OR: 1.38, CI: 1.17 to 1.62), and acute sprains (OR: 1.19, CI: 1.02 to 1.40) compared to mothers of children with asthma only (Table 4). The mothers of children with ADHD and asthma were significantly more likely to be diagnosed with depression (OR: 2.01, CI: 1.34 to 2.91), anxiety neuroses (OR: 1.69, CI: 1.33 to 2.14), female genital symptoms (OR: 1.67, CI: 1.23 to 2.25), lower back pain (OR: 1.49, CI: 1.18 to 1.86), acute upper respiratory infection (OR: 1.41, CI: 1.16 to 1.71) and five other conditions than mothers of children with asthma only (Table 4). No conditions were significantly more likely to be diagnosed in the mothers of children with asthma only.

Excess cost and utilization

After adjusting for all co-variables, mothers of children with ADHD cost on average $953 (CI: $619 to $1287) more than mothers of children without ADHD (Table 5) in the two years after the index date. Mothers of children with ADHD had higher emergency, primary care, and psychiatric department costs, as well as higher pharmacy costs and more outpatient visits. After excluding the 14 mothers with costs greater than $50,000, excess costs in the two years after the index date were $941 (CI: $695 to $1188). Results were similar among the subgroup of mothers for whom the index child was their first child (excess costs of $625 (CI: $82 to $1167)). Mothers of children with ADHD also had much higher costs than mothers of children without ADHD in the single year before the index date ($1003, CI: $621 to $1386).

The costs of mothers of children with ADHD (alone or with asthma), were also higher than those of the mothers of children with asthma alone. In the two years after the index date, the mothers of children with ADHD and not asthma were $467 (CI: $102 to $832) more costly than the mothers of children with asthma alone. The mothers of children with ADHD and asthma were $746 (CI: $166 to $1326) more costly than the mothers of children with asthma alone.

Discussion

To our knowledge, ours is the first study to examine a wide range of maternal conditions, and health services utilization and cost, in the year before and two years after the birth of a child subsequently diagnosed with ADHD. We found that mothers of children with ADHD were more likely to be diagnosed with a number of medical and mental health problems, covering a wide range of etiologies and organ systems compared with mothers of children without ADHD or mothers of children with asthma. We also found that mothers of children with ADHD had higher medical costs and utilization during that time.

The two year period following the birth of the affected child corresponded to the period prior to the child's initial ADHD diagnosis and thus maternal diagnoses made during this period are much less likely to be the result of the child's condition, although it is possible that the child manifested certain behaviors prior to the initial ADHD diagnosis and that these affected the mother. However, we found that even during the year before the birth of the child, mothers of children with ADHD were diagnosed more frequently with a wide variety of health conditions and had higher overall health care costs than comparison mothers.

Our finding that the mothers of children with ADHD were more likely to be diagnosed with depression and anxiety disorder is consistent with that of Lesesne et al., who estimated that children of mothers with activity-limiting mental health conditions were about 4 times more likely to have been identified by a health provider as having ADHD (by parental report).[27] The latter study, however, was based on self-report and could not address the temporal order of the maternal health condition and the child's ADHD. More consistent with our methodology (though based on parent surveys), Whitaker et al. found that maternal health conditions

(broadly defined as mental health, substance use and domestic violence) in the year after delivery were associated with child behavioral problems at three years of age, including inattention/hyperactivity.[33]

There are a number of ways in which to view the relationship between maternal medical conditions and health care utilization and having a child with ADHD. (1) The mother may be genetically predisposed to ADHD and conditions relating to it, which lead to higher utilization of services, and which are inherited by the child and manifest as ADHD in the child; (2) The mother's general health status may adversely affect the developing fetus and predispose the child to ADHD; (3) The mother's medical conditions and psychopathology may, after the birth of the child, contribute to adverse family environment which in turn is related to a child developing ADHD; (4) The mother's medical conditions and utilization may be related to her increased propensity to seek services and diagnoses, both for herself her child.

Disentangling these putative causal pathways is extremely challenging. The genetic basis for ADHD is well established[3,4], and a number of studies suggest that pregnancy and delivery complications, maternal stress during pregnancy, and chronic exposure of the fetus to alcohol or tobacco, may be risk factors for ADHD.[18] In addition, there is evidence that adverse family-environment is also predictive of ADHD in children.[14,34]

Few studies have investigated the factors that influence referrals for ADHD evaluation, including maternal propensity to use services. Schneider and Eisenberg note that the inherent subjectivity of the DSM-IV criteria for diagnosing ADHD allows for a range of individuals to influence the diagnosis process.[29] Based on a survey of practicing physicians, Sax and Kautz estimated that the diagnosis of ADHD is most often initially suggested by teachers (46% of the time), followed by parents (30% of the time), and least often by a primary care physician or MD consultant (14% of the time).[35] There is evidence - confirmed in the current study - that non-white Americans are less likely to be diagnosed with, and treated for, ADHD.[29,36,37] Race may, in part, be a proxy for cultural variations in help-seeking patterns.[38,39] In our study, mothers of children with ADHD were more likely to be diagnosed with both psychiatric and non-psychiatric conditions. Although conditions such as depression are known to be independent risk factors for a number of medical illnesses[40], it is also possible that mothers of children with ADHD may have a higher propensity to use services and seek medical attention — both for themselves and for their children. Our results of increased health care costs and utilization among mothers of children with ADHD in comparison to mothers of children with asthma lend support to this hypothesis. These results suggest that explanatory models of childhood ADHD (or the diagnosing of childhood ADHD) should take into account maternal health, health-seeking behavior, and propensity to use services.

Limitations

We did not independently assess the validity of the ADHD diagnoses made by providers; thus, there may be some misclassification. Nevertheless, the children with ADHD were considered by the health system to have ADHD. Diagnosis of ADHD is likely to drive physician prescribing patterns and behavioral treatments and thus be important from the health system perspective. Because women can be diagnosed with multiple conditions and these diagnoses can be repeated in different time periods, the results from one diagnosis cluster to another, or one time period to another, are not independent of each other. We did not adjust for multiple comparisons (a procedure we view as problematic[41]) and, given the large number of conditions we analyzed, there is an increased possibility that some differences were significant due to random variation. However, that mothers of children with ADHD were more commonly diagnosed with nearly every condition (whether significantly or not) is unlikely to be due to chance alone. Because of limitations in the availability of historical data, the study population

was limited to mothers of children diagnosed with ADHD between 2 and 11 years of age. Our results cannot strictly be applied to mothers of children diagnosed with ADHD at later ages.

Conclusion

Compared to mothers of children without ADHD, and to mothers of children with asthma, the mothers of children with ADHD are more likely to be diagnosed with a number of medical and mental health conditions, and have higher health care costs and utilization in the year before, and the two years after, the birth of a child subsequently diagnosed with ADHD. The reasons for these differences are likely explained by a combination of biological, environmental, and psychosocial factors (including propensity to use services and seek diagnoses), and future studies are needed to clarify their contributions.

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Table 1

Demographic characteristics of mothers of children with ADHD and mothers of children without ADHD.[†]

Characteristic	Mothers of children with ADHD (N=1869)	Mothers of children without ADHD (N=5538)
Age at delivery (%)		
15-<20 years old	84 (4)	204 (4)
20-<25 years old	227 (12)	665 (12)
25-<30 years old	542 (29)	1586 (29)
30-<35 years old	576 (31)	1845 (33)
35-<40 years old	359 (19)	1012 (18)
40-<45 years old	81 (4)	226 (4)
Mean age (years) at delivery	30.5	30.7
Race [*]		
Asian-American	140 (7)	934 (17)
African-American	147 (8)	351 (6)
Hispanic-American	359 (19)	1086 (20)
White American	1171 (63)	2883 (52)
Other/Unknown	52 (3)	284 (5)
Income based on census block group[§]		
1st (bottom) quintile	338 (18)	992 (18)
2nd quintile	332 (18)	1020 (18)
3rd quintile	352 (19)	1045 (19)
4th quintile	422 (23)	1176 (21)
5th (top) quintile	352 (19)	1038 (19)
Unknown	73 (4)	267 (5)
Education [*]		
< High school graduate	105 (6)	410 (7)
High school graduate	574 (31)	154 5 (28)
Undergraduate college	929 (50)	2671 (48)
Postgraduate	258 (14)	875 (16)
Unknown	3 (0)	37 (1)
Diagnosed with ADHD between 1996 and 2006 [*]	110 (6)	34 (1)
Mean hospital length of stay of mother during delivery of index child (hours) [*]	56.3	51.8
Mean number of children mother had given birth to before the birth of the index child	0.86	0.93

[†] Mothers of children without ADHD were the mothers of children (matched to an index ADHD child) who were not diagnosed with ADHD between 1996 and 2006. “Index child” refers to the ADHD child or non-ADHD comparison child through which the mother was included in the study.

[§] Income quintile cut-points were based on a larger sample than included in this analysis.

[*] Mothers of ADHD children were significantly different from mothers of children without ADHD at p<=0.05.

Table 2

Demographic characteristics of mothers of children with ADHD and not asthma, mothers of children with ADHD and asthma, and mothers of children with asthma and not ADHD.[†]

Characteristic	Mothers of children with ADHD and not asthma (N=1379)	Mothers of children with ADHD and asthma (N=457)	Mothers of children with asthma and not ADHD (N=4973)
Age at delivery (%)			
15-<20 years old	62 (4)	22 (5)	175 (4)
20-<25 years old	169 (12)	56 (12)	625 (13)
25-<30 years old	376 (27)	159 (35)	1519 (31)
30-<35 years old	441 (32)	122 (27)	1604 (32)
35-<40 years old	270 (20)	78 (17)	845 (17)
40-<45 years old	61 (4)	20 (4)	205 (4)
Mean age (years) at delivery	30.7	30.0	30.4
Race [*,//]			
Asian-American	97 (7)	39 (9)	872 (18)
African-American	104 (8)	41 (9)	408 (8)
Hispanic-American	266 (19)	86 (19)	1058 (21)
White American	871 (63)	280 (61)	2402 (48)
Other/Unknown	41 (3)	11 (2)	233 (5)
Income based on census block group [§]			
1st (bottom) quintile	235 (17)	95 (21)	910 (18)
2nd quintile	254 (18)	74 (16)	918 (18)
3rd quintile	256 (19)	88 (19)	961 (19)
4th quintile	317 (23)	97 (21)	1067 (21)
5th (top) quintile	265 (19)	83 (18)	1067 (21)
Unknown	52 (4)	20 (4)	238 (5)
Education [*]			
< High school graduate	72 (5)	30 (7)	353 (7)
High school graduate	403 (29)	160 (35)	1500 (30)
Undergraduate college	695 (50)	217 (47)	2463 (49)
Postgraduate	207 (15)	49 (11)	655 (13)
Unknown	2 (0)	1 (0)	29 (1)
Diagnosed with ADHD between 1996 and 2006 [*,//]	78 (6)	31 (7)	52 (1)
Mean hospital length of stay of mother during delivery of index child (hours)	56.1	56.8	55.1
Mean number of children mother had given birth to before the birth of the index child	0.88	0.73	0.94

[†] Classification of mothers was based on the diagnoses received by the index child. “Index child” refers to the child through which the mother was included in the study. 33 mothers of children with ADHD and asthm a who were included in Table 1 have been excluded here because the child with asthma was adifferent child than the child with ADHD.

[§] Income quintile cut-points were based on a larger sample than included in this analysis.

[*] Mothers of children with ADHD only were significantly different from mothers of children with asthma only at p<=0.05.

[//] Mothers of children with ADHD and asthma were significantly different from mothers of children with asthma only at p<=0.05.

Table 3

Prevalence of medical and mental health conditions in the 2 years after the index date, for mothers of children with ADHD and mothers of children without ADHD.[†]

Diagnostic Clusters[‡]	Mothers of children with ADHD (N=1869)	Mothers of children without ADHD (N=5538)	Number (Percent) of persons receiving medical diagnoses during the period and odds ratio Odds Ratio (95% CI): Mothers of mothers of children with ADHD to mothers of children without ADHD [§]
Depression (PSY09)	148 (8)	213 (4)	1.88 (1.51 to 2.35)*
Obesity (NUT03)	166 (9)	291 (5)	1.70 (1.39 to 2.09)*
Anxiety neuroses (PSY01)	367 (20)	669 (12)	1.64 (1.42 to 1.89)*
Contusion/abrasions (SKN01)	96 (5)	175 (3)	1.59 (1.22 to 2.06)*
Musculoskeletal symptoms (MUS01)	224 (12)	46 (8)	1.51 (1.26 to 1.79)*
Acute lower respiratory infection (RES02)	282 (15)	589 (11)	1.47 (1.26 to 1.72)*
Lower back pain (MUS14)	392 (21)	834 (15)	1.45 (1.27 to 1.66)*
Asthma without asthmaticus (ALL04)	171 (9)	347 (6)	1.45 (1.19 to 1.76)*
Female genital symptoms (FRE02)	175 (9)	370 (7)	1.43 (1.18 to 1.73)*
Acute sprains (MUS02)	357 (19)	776 (14)	1.41 (1.22 to 1.62)*
Abdominal pain (GSU10)	295 (16)	646 (12)	1.41 (1.21 to 1.64)*
Acne (SKN04)	123 (7)	249 (4)	1.41 (1.12 to 1.77)*
Vertiginous syndromes (NUR04)	98 (5)	216 (4)	1.36 (1.05 to1.74)*
Viral syndomes (INF06)	154 (8)	342 (6)	1.33 (1.08 to 1.62)*
Acute upper respiratory infection (EAR11)	753 (40)	1822 (33)	1.32 (1.18 to 1.47)*
Diarrhea (GAS07)	151 (8)	348 (6)	1.32 (1.08 to 1.62)*
Headaches (NUR02)	255 (14)	591 (11)	1.27 (1.08 to 1.49)*
Nonfungal infections of skin/tissue (GSU09)	158 (8)	364 (7)	1.27 (1.04 to 1.55)*
Sinusitis (RES07)	339 (18)	797 (14)	1.26 (1.09 to 1.45)*
Allergic rhinitis (ALL03)	272 (15)	672 (12)	1.25 (1.07 to 1.46)*
Peripheral neuropathy, neuritis (NUR03)	123 (7)	287 (5)	1.25 (1.00 to 1.56)
Cough (RES05)	105 (6)	254 (5)	1.25 (0.98 to 1.58)
Otitis media (EAR01)	252 (13)	606 (11)	1.20 (1.02 to 1.40)*
Chest pain (GSI02)	95 (5)	237 (4)	1.20 (0.93 to 1.54)
Other breast disorders (GSU07)	203 (11)	506 (9)	1.17 (0.98 to 1.40)
Refractive errors (EYE05)	553 (30)	1470 (27)	1.16 (1.03 to 1.30)*
Benign and unspecified neoplasm (GSU03)	180 (10)	460 (8)	1.16 (0.96 to 1.39)
Menstrual disorders (FRE09)	203 (11)	513 (9)	1.15 (0.97 to 1.37)
Conjuctivitis/Keratitis (EYE07)	174 (9)	445 (8)	1.14 (0.94 to 1.38)
Urinary tract infection (GUR08)	220 (12)	582 (11)	1.12 (0.94 to 1.33)
Vaginitis/vulvitis/cervicitis (FRE08)	297 (16)	771 (14)	1.11 (0.96 to 1.29)
Dermatitis/eczema (SKN02)	289 (15)	798 (14)	1.10 (0.95 to 1.28)
Cervical pain syndromes (MUS13)	141 (8)	380 (7)	1.10 (0.89 to 1.35)
Anorectal conditions (GSU01)	102 (5)	290 (5)	1.06 (0.83 to 1.34)
Bursitis, synovitis, tenosynovitis (MUS15)	166 (9)	473 (9)	1.01 (0.84 to 1.22)
Pigmented nevus (SKN14)	102 (5)	271 (5)	1.00 (0.78 to 1.26)
Other skin disorders (SKN17)	147 (8)	439 (8)	0.97 (0.79 to 1.18)

[†] The index date was the discharge date of the hospitalization in which the index child was born. “Index child” refers to the ADHD child or non-ADHD comparison child through which the mother was included in the study. All index children with ADHD were diagnosed with ADHD between ages two and eleven.

[‡] All diagnoses during the two years after the index date were grouped into Expanded Diagnosis Clusters (EDCs) using the Johns Hopkins Case-Mix software. Those EDCs that were associated with at least 5% of either them others of children with ADHD or the mothers of children without ADHD in the two years after the index date were included in the analysis (excepting EDCs related to administration, non-specific signs or symptoms, preventive care, laboratory results, infertility, contraception and pregnancy). EDCs are listed in parentheses. Numbers represent the number of mothers receiving at least one diagnosis in the diagnostic cluster over the two year span.

[§] Odds ratio from logistic regression adjusting for race/ethnicity, age, census block income, mother’s education, primary medical facility used by mother, and number of children to whom mother had given birth.

* Mothers of ADHD children were more likely to be diagnosed with condition compared to mothers of chidlren without ADHD at p<=0.05, after adjusting for covariables.

Table 4

Prevalence of medical and mental health conditions in the 2 years after the index date, for mothers of children with ADHD only, mothers of children with ADHD and asthma, and mothers of children with asthma only. †

	Number (Percent) of persons receiving medical diagnoses during the period and odds ratio				
Diagnostic Clusters‡	**Mothers of children with ADHD only (N=1379)**	**Mothers of children with ADHD and astma (N=457)**	**Mothers of children with astma only (N=4973)**	**Odds Ratio (95% CI): mothers of children with ADHD only compared to mothers of children with astma only§**	**Odds Ratio (95% CI): mothers of children with ADHD and asthma compared to mothers of children with asthma only §**
Depression (PSY09)	110 (8)	34 (7)	177 (4)	2.09 (1.62 to 2.69)*	2.01 (1.34 to 2.91)*
Obesity (NUT03)	127 (9)	36 (8)	269 (5)	1.71 (1.36 to 2.15)*	1.42 (0.97 to 2.02)
Contusion/abrasions (SKN01)	70 (5)	25 (5)	174 (3)	1.42 (1.05 to 1.89)*	1.49 (0.94 to 2.26)
Anxiety neuroses (PSY01)	257 (19)	101 (22)	671 (13)	1.38 (1.17 to 1.62)*	1.69 (1.33 to 2.14)*
Musculoskeletal symptoms (MUS01)	159 (12)	61 (13)	480 (10)	1.21 (0.99 to 1.46)	1.40 (1.04 to 1.85)*
Other breast disorders (GSU07)	149 (11)	49 (11)	425 (9)	1.20 (0.98 to 1.47)	1.26 (0.91 to 1.71)
Acute sprains (MUS02)	257 (19)	92 (20)	796 (16)	1.19 (1.02 to 1.40)*	1.29 (1.01 to 1.65)*
Acne (SKN04)	91 (7)	29 (6)	264 (5)	1.19 (0.92 to 1.53)	1.14 (0.75 to 1.67)
Lower back pain (MUS14)	276 (20)	113 (25)	889 (18)	1.16 (0.99 to 1.35)	1.49 (1.18 to 1.86)*
Abdominal pain (GSU10)	211 (15)	78 (17)	679 (14)	1.16 (0.97 to 1.38)	1.30 (0.99 to 1.67)
Nonfungal infections of skin/tissue (GSU09)	119 (9)	37 (8)	375 (8)	1.13 (0.90 to 1.41)	1.03 (0.71 to 1.46)
Benign and unspecified neoplasm (GSU03)	138 (10)	39 (9)	434 (9)	1.11 (0.90 to 1.36)	0.93 (0.65 to 1.30)
Diarrhea (GAS07)	110 (8)	40 (9)	363 (7)	1.10 (0.87 to 1.38)	1.16 (0.81 to 1.62)
Female genital symptoms (FRE02)	115 (8)	56 (12)	368 (7)	1.10 (0.87 to 1.37)	1.67 (1.23 to 2.25)*
Cough (RES05)	73 (5)	29 (6)	257 (5)	1.10 (0.83 to 1.44)	1.28 (0.84 to 1.88)
Acute lower respiratory infection (RES02)	197 (14)	80 (18)	661 (13)	1.06 (0.89 to 1.27)	1.34 (1.03 to 1.73)*
Refractive errors (EYE05)	410 (30)	131 (29)	1388 (28)	1.05 (0.92 to 1.20)	1.04 (0.84 to 1.29)
Acute upper respiratory infection (EAR11)	524 (38)	210 (46)	1834 (37)	1.01 (0.89 to 1.14)	1.41 (1.16 to 1.71)*
Vaginitis/vulvitis/cervicitis (FRE08)	214 (16)	79 (17)	769 (15)	1.00 (0.84 to 1.18)	1.07 (0.82 to 1.38)
Conjuctivitis/Keratitis (EYE07)	124 (9)	46 (10)	431 (9)	1.00 (0.80 to 1.23)	1.16 (0.83 to 1.58)
Pigmented nevus (SKN14)	78 (6)	20 (4)	241 (5)	0.97 (0.74 to 1.27)	0.78 (0.47 to 1.22)
Sinusitis (RES07)	239 (17)	97 (21)	832 (17)	0.96 (0.81 to 1.12)	1.23 (0.97 to 1.56)
Otitis media (EAR01)	187 (14)	59 (13)	661 (13)	0.96 (0.80 to 1.15)	0.90 (0.67 to 1.19)
Allergic rhinitis (ALL03)	190 (14)	78 (17)	723 (15)	0.96 (0.80 to 1.14)	1.23 (0.94 to 1.58)
Peripheral neuropathy, neuritis (NUR03)	85 (6)	34 (7)	313 (6)	0.96 (0.74 to 1.23)	1.16 (0.79 to 1.67)
Vertiginous syndromes (NUR04)	71 (5)	24 (5)	271 (5)	0.96 (0.73 to 1.26)	0.99 (0.63 to 1.49)
Chest pain (GSI02)	64 (5)	28 (6)	250 (5)	0.96 (0.72 to 1.28)	1.28 (0.83 to 1.89)
Dermatitis/eczema (SKN02)	201 (15)	82 (18)	763 (15)	0.94 (0.79 to 1.11)	1.23 (0.95 to 1.58)
Other skin disorders (SKN17)	115 (8)	29 (6)	417 (8)	0.94 (0.75 to 1.16)	0.72 (0.48 to 1.05)
Urinary tract infection (GUR08)	154 (11)	58 (13)	580 (12)	0.93 (0.77 to 1.13)	1.06 (0.78 to 1.41)
Headaches (NUR02)	169 (12)	79 (17)	634 (13)	0.93 (0.77 to 1.12)	1.38 (1.06 to 1.78)*
Menstrual disorders (FRE09)	140 (10)	61 (13)	538 (11)	0.93 (0.75 to 1.13)	1.27 (0.94 to 1.68)
Asthma without asthmaticus (ALL04)	111 (8)	54 (12)	430 (9)	0.89 (0.71 to 1.10)	1.37 (1.00 to 1.84)*
Viral syndomes (INF06)	102 (7)	48 (11)	400 (8)	0.89 (0.70 to 1.11)	1.27 (0.92 to 1.74)
Cervical pain syndromes (MUS13)	104 (8)	35 (8)	430 (9)	0.87 (0.69 to 1.09)	0.87 (0.60 to 1.23)
Anorectal conditions (GSU01)	73 (5)	27 (6)	299 (6)	0.85 (0.65 to 1.11)	0.97 (0.63 to 1.43)

Diagnostic Clusters[‡]	Number (Percent) of persons receiving medical diagnoses during the period and odds ratio				
	Mothers of children with ADHD only (N=1379)	Mothers of children with ADHD and astma (N=457)	Mothers of children with astma only (N=4973)	Odds Ratio (95% CI): mothers of children with ADHD only compared to mothers of children with astma only[§]	Odds Ratio (95% CI): mothers of children with ADHD and asthma compared to mothers of children with asthma only [§]
Bursitis, synovitis, tenosynovitis (MUS15)	118 (9)	48 (11)	485 (10)	0.83 (0.66 to 1.02)	1.07 (0.77 to 1.46)

[†]The index date was the discharge date of the hospitalization in which the index child was born. “Index child” refers to the child through which the mother was included in the study. All index children with ADHD or asthma were diagnosed with their condition between ages two and eleven.

[‡]All diagnoses during the two years after the index date were grouped into Expanded Diagnosis Clusters (EDCs) using the Johns Hopkins Case-Mix software. Those EDCs that were associated with at least 5% of either them others of children with ADHD or the mothers of children without ADHD in the two years after the index date were included in the analysis (except EDCs related to administration, non-specific signs or symptoms, preventive care, laboratory results, infertility, contraception and pregnancy). EDCs are listed in parentheses. Numbers represent the number of mothers receiving at least one diagnosis in the diagnostic cluster over the two year span.

[§]Odds ratio from logistic regression adjusting for race/ethnicity, age, census block income, mother’s education, primary medical facility used by mother, and number of children to whom mother had given birth.

[*]Mothers of children with ADHD only, or ADHD and asthma, were more likely to be diagnosed with condition compared to mothers of children with asthma only at p<=0.05, after adjusting for covariables.

Table 5

Adjusted excess costs and utilization of mothers of children with ADHD compared to comparison mothers in the 2 years after the index date.‡

Variable	Mothers of children with ADHD compared to mothers of children without ADHD	Mothers of children with ADHD only compared to mothers of children with asthma only	Mothers of children with ADHD and asthma compared to mothers of children with asthma only
Adjusted excess costs of mothers of children with ADHD only, or ADHD and asthma, compared to mothers of children with asthma only, mean (95% CI), $			
All hospital-related costs	100 (−123 to 323)	97 (−124 to 319)	−36 (−388 to 316)
ED-related costs	99 (62 to 137)*	26 (−22 to 74)	96 (20 to 172)*
Outpatient primary care visit costs	334 (242 to 425)*	114 (3 to 225)*	351 (175 to 528)*
Outpatient psychiatry department visit costs	154 (117 to 192)*	138 (92 to 184)*	127 (53 to 200)*
Other outpatient-related costs	159 (91 to 227)*	5 (−85 to 94)	122 (−19 to 264)
Outpatient pharmacy costs	106 (57 to 155)*	87 (47 to 128)*	85 (20 to 150)*
Total excess costs	953 (619 to 1287)*	467 (102 to 832)*	746 (166 to 1326)*
Adjusted excess utilization of mothers of children with ADHD only, or ADHD and asthma, compared to mothers of children with asthma only, mean (95% CI), $			
Hospital days	0.02 (−0.08 to 0.11)	0.05 (−.04 to .14)	−0.02 (−0.16 to 0.13)
Outpatient visits	2.68 (2.13 to 3.23)*	1.23 (0.54 to 1.92)	2.48 (1.39 to 3.58)*

‡Index date is the date the mother was discharged from the hospitalization in which the index ADHD child was born. Excess costs were estimated using an ordinary least squares models with untransformed costs as the dependent variable. Results have been adjusted forrace/ethnicity, age, census block income, mother's education, primary medical facility used by mother, and number of children to whom the mother had given birth. Excess costs are for the two years combined. Numbers in parentheses represent lower and upper bounds of 95% confidence interval. Costs are reported in 2006 US dollars.

*Excess costs for mothers of children with ADHD, or mothers of children with ADHD and asthma, were significantly different from those of mothers of children with asthma only at p<=0.05.