



**Health care use, social burden  
and costs of children with  
and without ADHD in Flanders\***

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B E R I C H T E N

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## Nederlandse samenvatting

De doelstelling van voorliggende studie is om *kwantitatieve informatie* aan te leveren over de economische, sociale en mentale gevolgen die de gedragsstoornis ADHD bij een kind veroorzaakt in het gezin en voor het gezondheidszorgbudget.

Een geteste vragenlijst werd in februari 2003 verstuurd naar alle leden van de Vlaamse vereniging voor ADHD, 'Zit Stil'. Aan de ouders werd gevraagd om, zowel voor het kind met ADHD als voor een broer of zus wiens leeftijd het dichtste bij die van het ADHD-kind aansluit, het gebruik van gezondheidszorg en sociale zorg te registreren, het gedrag van het kind, en eventuele problemen. Aanvullend werd informatie gevraagd over de ernst van ADHD bij hun kind (IOWA-Conners Rating Scale) de inzet van andere middelen specifiek voor ADHD en over socio-demografische en economische karakteristieken van het gezin. Private en publieke jaarlijkse kosten werden berekend op basis van tarieven. De gegevens van de broertjes of zusjes worden gebruikt om de kinderen met ADHD mee te vergelijken. Gebruik makend van GLM schattingsmethodes, werden deze kosten verder vergeleken en gecorrigeerd voor meerdere beïnvloedende factoren.

Onze resultaten geven weer dat ADHD de schoolresultaten van het kind alsook de productiviteit van de ouders beïnvloedt. Bijna de helft van de ouders vermindert hun betaalde arbeidstijd vanwege hun kind met ADHD, en veel ouders veranderen van job om meer flexibiliteit te verwerven. Een kind met ADHD legt een extra last op de schouders van het gezin: Ouders maken veel ruzie over hun ADHD-kind, en er zijn ook meer ruzies met broertjes of zusjes.

ADHD kinderen gebruiken significant meer gezondheidszorg dan hun broertjes of zusjes zonder de aandoening: ADHD-kinderen hebben een hogere kans op een consultatie bij een huisarts (60.3 vs. 37.4%) en een specialist (50.9 vs. 12.9%); zij komen ook meer terecht op de spoedafdeling van een ziekenhuis (26 vs. 12.1%) en worden frequenter gehospitaliseerd (14 vs. 8.4%). Een kind met ADHD genereert als gevolg significant hogere medische kosten dan een kind zonder de aandoening; de kostenverschillen zijn frappant. Vergeleken met de eigen bijdrage van het gezin voor een kind zonder ADHD, is de eigen bijdrage voor de ouders ongeveer zes keer zo hoog (€588.3 vs. €91.5 op jaarbasis); publieke uitgaven zijn dubbel zo hoog (€779 vs. €371.3, eveneens op jaarbasis). Dit betekent dat het proportioneel aandeel van de ouders in de medische kosten groter is bij een ADHD-kind (31%) dan bij een kind zonder ADHD (18%).

De zorg voor een ADHD kind mag dus zeker niet onderschat worden, zowel mentaal als financieel betekent deze zorg een zware last voor het gezin.

## **1. Introduction**

ADHD is a mental health disorder that is estimated to occur in 3 to 5 percent of the school-aged population [1,2]. Children with ADHD suffer from developmentally inappropriate hyperactivity, inattention and/or impulsivity in a severe and persistent way [2]. These symptoms obviously make it exhausting to care for an affected child. ADHD-children are also confronted with poor academic performance and unsatisfactory family relations with many conflicts. These problems can be remedied by behavioural therapy and/or medication. Clearly, ADHD brings about important consequences for the affected children, their parents, family and for other people in their environment [4]. One of those consequences is that extra costs have to be made by the parents and the government to care for these children. Nevertheless, as the following literature review demonstrates, the literature seems bereft of economic studies concerning the costs of ADHD. We performed a Medline search with the search terms *ADHD* and *burden* or *cost* or *cost-effectiveness* or *economic evaluation* or *economics* or *cost of illness* for articles published between 1998 and September 2004. We found nine relevant studies, of which four are based on literature reviews [5,6,7,8]. The remaining five studies investigate the costs and burden of ADHD [9,10,11,12,13]. Two recently published reviews [14,15] confirm that there are no further relevant studies available. All of the retained studies are performed in the United States. The reported cost data in the five studies are divergent, in the sense that they observe children of different age and use different methods of diagnosing, types of costs and perspectives. Nevertheless they all point to ADHD-children having a higher cost profile than children without the disorder. As no European and consequently no Belgian cost data could be retrieved and no recent quantitative information on non-medical costs and burden is available, the objective of the present study is to provide quantitative information on the economic, social and mental burden borne by families of children with ADHD and the health care budget in Flanders (Flemish speaking part of Belgium) and to compare costs of ADHD-children with those of the siblings without the disorder. We gather detailed information on health care use and the social burden of children with ADHD and the siblings (without the disorder) through a parent questionnaire. In addition, costs of both groups of children are calculated using Belgian cost data and we explain these costs through GLM estimation. We discuss and analyze both public and private annual costs.

## **2. Methods**

### ***2.1. Study sample and design***

We gather information on children with ADHD through a questionnaire that is sent to a non-random sample of Flemish-speaking parents who are members of the Flemish ADHD society 'Zit Stil'. We did not have the budget to work with a random sample of the Belgian population. The questionnaire consists of 59 questions and was developed by the authors. The

questionnaire was pilot-tested and adjusted to stated comments. In February 2003 it was sent to the 1650 members of the Flemish ADHD society<sup>1</sup>.

To be able to compare costs between children with and without ADHD, we worked with a comparison group of siblings of the ADHD-children (if present). All children in the sample (children with ADHD and siblings) are younger than 16, if ADHD-children have more than one sibling without the disorder, the sibling most comparable in age is chosen. The questionnaire consists of three main parts. First there are some specific questions on ADHD (disease severity, medication, etc.). Then information on the use of medical, paramedical and other support is obtained for both the children with ADHD and the siblings. Finally some questions on socio-demographic and economic characteristics of the parents are included.

Disease severity is measured by the IOWA-Conners Rating Scale (IOWA-CRS). The IOWA-CRS is a 10-item parent rating scale developed by Loney and Milich [16] which focuses on the core symptoms of ADHD. The cut-off rule for the determination of ADHD is 15 [17]. In our survey parents have to fill in the IOWA-CRS, keeping in mind a drug-free period. If the child with ADHD never has a drug-free period, parents were asked to skip these questions.

## ***2.2. Measurement of service utilization and costs***

In order to cope with their disorder, children with ADHD can follow different types of behavioural therapy, can get help for learning difficulties, and can be followed by a general practitioner (GP) or a specialist. In addition, they can be admitted to the emergency department (ED) or the hospital as a result of getting hurt due to their hyperactive and impulsive behaviour. They often need extra support from parents, teachers, etcetera. Children without the disorder can also need this kind of care and support. Because data are gathered on both children with ADHD and the siblings without the disorder, this support can be compared between the two groups of children. In this way we can distinguish to what extent children with ADHD receive additional care and support.

Consumption of medical, paramedical and other support was measured retrospectively. For therapy, drug consumption and information on non-medical support a recall period of two weeks is used. For less frequent events we extend the recall period (two months for GP and specialist visits, and 1 year for ED-visits and hospitalizations). We have extrapolated all costs to yearly costs. Costs with a recall period of 2 weeks were multiplied by 26, except for medication and extra lessons. For medication costs we took into account that some children do not take their medication during weekends and school holidays. (Mean number of days that children take their medication is 324 per year); for the costs of extra lessons we took into account that most children do not follow extra lessons during summer holidays (we restricted lessons to 44 weeks per year). GP and specialist costs, which were measured in 2 months, were multiplied by 6.

In order to get insight in the cost generated by the ADHD-child and its sibling we also collect reimbursement and cost information.

<sup>1</sup> Not all members of the ADHD society were households with ADHD-children, the member list also contains GP's, specialists and other persons interested. We were not able to distinguish between these members, that is why we asked them to send back the questionnaire empty. We received 126 empty questionnaires.

### 2.3. *Study hypothesis*

The focus of this paper is on the calculation and explanation of the costs that children with ADHD incur. We hypothesize that children with ADHD incur significantly higher costs than unaffected peers. In performing regression analyses we point out that the main part of the cost difference between the children is due to the disorder and only a small part to other covariates.

### 2.4. *Statistical analysis*

We report descriptive statistics as well as results of statistical tests and regression analyses. Calculations are performed using STATA 7. We compare the data of ADHD-children with those of the siblings using t-tests for continuous variables, Wilcoxon Signed Rank tests for ordinal variables and Z-tests for proportion for categorical variables.

We calculate the average annual costs of children with ADHD and the siblings. Resource use is obtained from the detailed patient questionnaire and the costs of medical services are calculated on the basis of the official fees and charges for these services [18]. We consider the private as well as the public share (costs paid by the families and those covered by the national health insurance respectively), taking into account the insurance status of the patient. For the drugs used to treat ADHD, official prices are used, for service items not covered by the national health insurance, parents are asked to state the prices paid. We base our calculations on 2002 prices, with the exception of non-covered items, for which 2003 prices are used because parents were asked to state these prices when the questionnaire was sent to them, in 2003. For some cost items we do not have official fees, neither parent's statements. We solve this problem by using external information of the costs, e.g. for the cost of an ED visit, therapy and hospitalization cost<sup>2</sup>. For all of the cost items and for the total average costs, t-tests are used to test whether they are significantly different among children with ADHD and the siblings without the disorder.

Because the two groups of children are quite divergent we control for a number of covariates by performing regression analysis using cost as the dependent variable. A list of the independent variables can be found in appendix 2. Because of two peculiarities in the dataset we will not perform OLS regression. A first peculiarity that we encounter is that the dataset consists of pairs of siblings. The fact that these children belong to the same household could influence the regression results. We wanted to control for this effect by using a fixed effects model [19]. The family (fixed) effect is however not significant and it is therefore decided not to work with fixed effects after all. A second peculiarity with the data is that they are highly skewed as is usually the case with cost data. Therefore we can not use OLS. We consulted the extensive literature on the analysis of cost data; none of the papers that we read gives a clear cut answer to the question which model should be used when analyzing cost data. Several estimators are suggested. Transformation of cost onto a logarithmic scale is the most frequently suggested solution for skewed cost data. [20, 21, 22, 23]. However, in order to incur arithmetic means results have to be retransformed and when heteroskedasticity is present the retransformation is very complicated [21, 24]. An alternative is to work with one or two part Generalised Linear Models (GLM), for which the best link and variance function

<sup>2</sup> Detailed information on the cost calculations and approximations made can be retrieved with the authors.

have to be determined. [ 22, 23, 25, 26] The majority of the papers on cost data analysis encourage researchers to consider a variety of candidate models rather than to start data analysis with one regression model selected a priori. Some authors suggested algorithms to choose the most appropriate model for the data [20, 22, 23, 25, 27]. Using these algorithms we found that a GLM model fits our data best. We have tried several possible combinations of link and variance functions but by plotting the residuals against the independent variables and comparing the AIC's we concluded that a log link and a gamma distribution function result in the best fit. We used robust variance estimates and controlled for the fact that observations might be dependent within groups (households).

### **3. Results**

#### ***3.1. Socio-demographic and clinical characteristics***

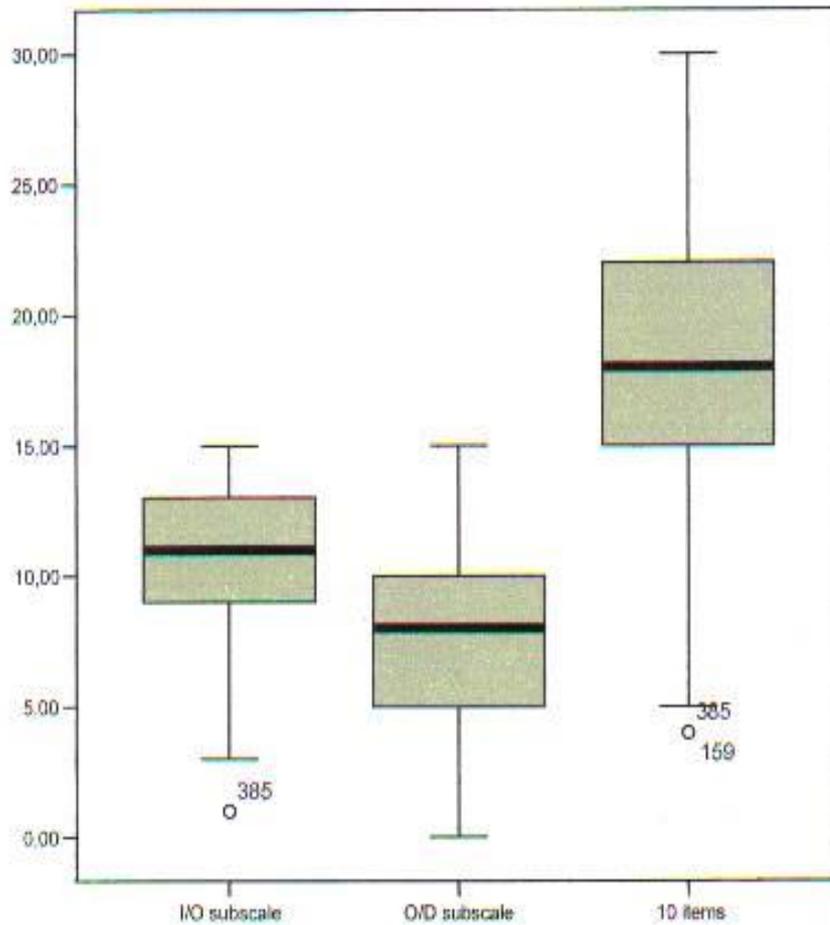
We dispose of 537 usable questionnaires<sup>3</sup> (response rate 40.18%). Detailed descriptive results are reported in appendix 1; below we discuss the most important findings.

In our sample 87.2% of the ADHD-children are boys. This corresponds with overall findings that the prevalence of ADHD is much higher in boys than in girls [2]. The mean age of the ADHD-children is 11.1 years. In the sample 372 of the ADHD-children have a brother or sister younger than 16 years without the disorder. The sample of siblings consists of 44.3% boys, the mean age of the siblings is 10.2 years.

Results on the severity of the disorder, measured by the IOWA-CRS, are presented in figure 1. The mean score is 18.3, this means that, according to the IOWA-CRS, the majority of the ADHD-children in our sample scores above the cut-off score of 15 (78%).

<sup>3</sup> 1650 questionnaires were sent, 663 questionnaires were sent back to us, 126 of them were empty.

**Figure 1: Boxplots of the results on disease severity (IOWA Conners rating scale)**



### ***3.2. Utilization of health care, social care and other non-medical resources***

A vast majority (90.8%) of the children with ADHD takes medication continuously, 89.8% of those take Methylphenidate (4.1% take a combination of Methylphenidate and another drug). At the time of the survey, Methylphenidate was the only brand drug for ADHD registered on the Belgian market, but non-specific drugs or magisterial drugs could be taken as well. More detailed results on drug use are presented in table 1.

Detailed results on utilization of health care, social care and other non-medical resources are in appendix 1. Main findings are that children with ADHD follow significantly more therapy, have significantly more GP visits, specialist visits, ED visits and hospitalisations. For ADHD-children significantly more ED visits and hospitalisations are caused by an accident (as opposed to an illness). They also take significantly more non-ADHD-related drugs than the siblings (e.g. drugs for a cold, antibiotics). Our data indicate that the disorder adversely affects school attainments. ADHD-children follow significantly more special education, extra lessons and they demand more extra attention at school. Parents spend a lot of time on homework assistance. Despite all the help approximately one in four children with ADHD has to repeat a grade at school.

Previous studies state that a child with ADHD can cause many difficulties in a household [4, 7]. Clearly, a heavy burden lies on the parents. We reveal this burden by asking some questions about the time parents spend on their child and costs they make for their child. We find that a lot of parents reduce on working time (44.5%) or change to a more flexible job

(mothers: 22.4%, fathers: 12.4%) because of their child with ADHD. They also spend a lot of money on information about the disorder. Parents often quarrel about their child with ADHD, there are also a lot of quarrels between the siblings.

**Table 1: ADHD-related drug consumption**

Variable	Values	%
Medication for ADHD Valid n= 530	No	9.2
	Yes	90.8
Type of medication Valid n= 481	Only Methylphenidate	89.8
	Methylphenidate+ other drugs	4.1
	Only other drugs	6.1
# of Methylphenidate intakes/day	1	7.1
	2	60.4
	3	32.1
	4	0.4
	<b>mean # of Methylphenidate intakes/day</b>	<b>2.11</b>
Average dose per intake	10.02 mg	
Methylphenidate during weekend Valid n= 450	No	39.3
	Yes	60.7
Methylphenidate during school holidays Valid n=451	No	51.4
	Yes	48.6
Methylphenidate-free periods Valid n= 449	No	47.0
	Yes	53.01
Methylphenidate at school at noon Valid n= 449	No	13.6
	Yes	86.4
How often does the child miss a dose of Methylphenidate Valid n= 454	often	5.7
	sometimes	26.9
	seldom	54.2
	never	11.9
	don't know	1.1
<b>Mean # of missed intakes/2 weeks</b>	<b>1.36</b>	

### ***3.3. Private and public annual costs of children with ADHD and the siblings without the disorder***

We calculate average annual public and private costs of children with ADHD and compare these with the average costs of siblings without the disorder. Average amounts of every cost item and results of the statistical tests are reported in table 2.

The majority of the ADHD children in our sample take drugs. There are only detailed questions on the use of Methylphenidate, so medication costs can only be calculated for those children that take this drug. Parents are asked how many pills their child takes per day. One Methylphenidate pill costs €0.13 [28] (One packing costs €2.60 and contains 20 pills). In 2003 the price of Methylphenidate has however increased with a factor 2.5, (one packing now costs €6.5 and still contains 20 pills) one pill now costs €0.33. Average medication costs can be found in table 2, the new medication cost is indicated in brackets. Methylphenidate was not reimbursed by the government in Belgium at that time; the cost of the drug is therefore entirely borne by the parents.

Detailed information is also gathered on the use of therapy. The therapy costs are significantly higher for children with ADHD compared to the siblings, for both the parents and the government ( $p < 0.001$ ).

**Table 2: Private and public annual costs (€) per cost item for ADHD children and siblings: averages and statistical significance of difference**

	Parents (out-of-pocket costs)		Sig. t-test (1-tailed)	Government		Sig. t-test (1-tailed)
	ADHD	Siblings		ADHD	Siblings	
Medication cost <sup>1</sup>	74.5 (223.6)	/	/	/	/	/
Therapy cost	221.5	33.02	.000	431.6	75.4	.000
Costs of extra lessons <sup>2</sup>	43.3	2.9	.003	/	/	/
GP cost	26.8	19.1	.0003	69.7	50.04	.0003
Specialist cost	56.6	17.2	.000	94.3	26.6	.000
ED cost	5.8	2.4	.000	4.7	1.6	.000
Hospitalisation cost	42.7	32.6	.695	431.3	329.2	.695
<b>Total costs<sup>3</sup></b>	<b>459.89 (571.8)</b>	<b>85.4</b>	<b>.000</b>	<b>1003.2</b>	<b>407.8</b>	<b>.010</b>

<sup>1</sup> taking into account that some children do not take their medication during weekends and school holidays. (Mean number of days that children take their medication is 324 per year)

<sup>2</sup> taking into account that most children do not follow extra lessons during summer holidays (44 weeks per year)

<sup>3</sup> Total costs  $\neq$  sum of costs per item because of differences in item non-response

10.1% of the children with ADHD follow extra lessons, while only 2.5% of the siblings do. Parents indicated how much they pay for those extra lessons and we include these costs into the cost calculations. These costs are significantly higher for ADHD-children ( $p = 0.003$ ).

For the costs of a GP- and specialist visit we work with the amounts stated in the nomenclature and take into account whether the children are entitled to higher reimbursement. Private as well as public GP and specialist costs are significantly higher for children with ADHD (both  $p < 0.001$ ).

ED costs were also calculated, again the insurance status of the children is taken into account. The private as well as public ED costs are significantly higher for children with ADHD compared to the siblings ( $p < 0.001$ ).

Concerning hospitalisation costs we calculate an average cost per inpatient day. Calculations are based on data from the National institute for sickness and invalidity insurance (RIZIV) [18] and the Independent National Health Insurance (MLOZ) ], a distinction is made between general and psychiatric hospitals. As mean costs are not very different it is no surprise that the hospitalisation costs are not significantly different for both groups of children, for both the parents and the government ( $p = 0.348$ ).

Finally we calculate the total private and public average annual cost of ADHD-children and the siblings. Average annual costs are presented in table 2. Recall that the cost of Methylphenidate has risen; total average costs based on the new medication cost are indicated in brackets. Private as well as public costs are significantly higher for children with ADHD ( $p < 0.001$  and  $p = 0.010$  respectively).

### 3.4. Multivariate cost analyses

In the previous paragraph it is shown that almost all of the cost items and total annual costs are significantly higher for children with ADHD compared to the siblings. In the first part of the results section it is however indicated that there are quite some differences between the

two groups of children in our sample. Main difference is that 87.2% of the ADHD-children in our sample are boys while this is only 55.7% for the siblings. A way to control for these possibly confounding variables is to perform regression analysis with total annual costs as the dependent variable. As was justified in the methodology section we use GLM to fit our cost data. Several models were run and a GLM with a log link and a gamma distribution function fits the cost differences best. As explanatory variables we include household characteristics, characteristics of the child and disease characteristics. We will only discuss the final model, in previous analyses we also included interaction effects, squared variables (eg. age<sup>2</sup>) and other explanatory variables; since these did not add to the power of the model we do not include them in the final analysis. We perform separate analyses for the total annual private and public costs.

$$\ln E(\text{cost}_{par}) = X\beta + Y\delta + Z\phi; \quad \text{cost}_{par} \sim \text{Gamma}$$

$$\ln E(\text{cost}_{gov}) = X\varphi + Y\gamma + Z\eta; \quad \text{cost}_{gov} \sim \text{Gamma}$$

with X = household characteristics, Y = characteristics of the child, Z = disease characteristics

We will discuss the most important regression results and marginal effects, the latter were calculated using the sample means of the independent variables. Full results are reported in table 3, a list of the independent variables can be found in appendix 2. We will first discuss results on private and afterwards on public costs.

It is clear from the analysis that, as expected, presence of the disorder causes the greatest cost difference, children with ADHD incur significantly higher costs than the siblings without the disorder, the marginal effect indicates that a sibling without the disorder costs on average €496 less per year to its parents compared to a child with ADHD (with a score between 16 and 22 on IOWA-CRS). Counterintuitive is the fact that the severity of the disorder has no significant influence on the costs. Another unexpected result is the significant positive influence of the number of ADHD-children in a household. Children that take drugs (besides drugs for ADHD) have significantly higher costs, they cost on average €134 more per year compared to a child that takes no (non-ADHD related) drugs. This effect has the expected sign. Private costs are also influenced by the behaviour of the children, children that often exhibit dangerous behaviour incur, as expected, higher costs; annual costs are on average €44 higher.

The variables that significantly influence public costs are more numerous than those that influence private costs. Presence of the disorder again explains a great part of the cost difference; a child with ADHD costs on average €392 more per year to the government than a child without the disorder. Younger children and older parents incur higher costs. Children that take (non-ADHD related) drugs cost on average €264 more per year and children with dangerous behaviour cost €133 more per year to the government. For the government boys are more expensive than girls, boys cost on average €297 more per year. Another expected effect is that children that are entitled to higher reimbursement incur higher public costs (€1153 more). Parents that are married or live together spend on average €308 more on their child compared to single parents.

**Table 3: regression results and marginal effects**

	cost_parents		cost_government	
	Estimation results	Marginal effects	Estimation results	Marginal effects
<b>no_adhd</b>	-1.856 (8.49)**	-496,35	-0.700 (2.49)*	-392,29
<b>iowa_0</b>	-0.126 (0.71)	-32,5	-0.057 (0.31)	-32,52
<b>iowa_2</b>	0.222 (1.13)	65,78	0.254 (0.73)	163,66
<b>iowa_mis</b>	0,011 (0.07)	2,94	0,184 (0.74)	114,14
<b>nadhd</b>	0.479 (2.30)*	129,14	0.165 (0.81)	95,68
<b>sex</b>	0.170 (0.91)	44,45	0.560 (2.51)*	297,45
<b>age</b>	-0.078 (1.76)	-20,91	-0.223 (4.10)**	-129,45
<b>othdrug</b>	0.446 (2.65)**	134,26	0.411 (2.25)*	264,37
<b>agepar</b>	0.031 (1.62)	8,43	0.057 (2.28)*	32,91
<b>nhoushold</b>	-0,132 (1.61)	-35,71	-0,083 (0.84)	-48,36
<b>married</b>	0.532 (1.25)	111,89	0.746 (2.07)*	307,8
<b>job_mother</b>	0,014 (0.08)	3,81	0,267 (1.24)	142,11
<b>job_father</b>	0,061 (0.24)	15,89	-0,52 (1.32)	-385,73
<b>education_2</b>	-0,415 (1.16)	-101,75	0,454 (1.78)	296,66
<b>education_3</b>	-0,201 (0.55)	-56,22	0,037 (0.16)	21,38
<b>statute</b>	0.209 (0.98)	56,28	0.189 (0.75)	109,46
<b>high_reimb</b>	0,483 (1.18)	165,49	1,112 (2.73)**	1153,91
<b>income_eq</b>	0 (0.36)	0,026	0 (1.02)	0,26
<b>fight_sibl</b>	0,071 (0.63)	19,12	-0,05 (0.42)	-29,09
<b>fight_friend</b>	-0,029 (0.41)	-7,77	0,088 (1.00)	51,02
<b>reckless</b>	0,077 -1,26	20,71	-0,038 (0.53)	-21,93
<b>dangerous</b>	-0,164 (2.67)**	-44,3	-0,23 (2.77)**	-133,56
<b>Constant</b>	5,66 (6.15)**		6,233 (5.46)**	

Coefficient; absolute value of z statistics in parentheses;

\* significant at 5%; \*\* significant at 1%; 673 observations

Through these GLM estimations we find that the total cost difference between children with and without ADHD is €888 (€496 + €392), through our own calculations in the previous paragraph a cost difference of €1082 was found. It is now clear that this difference was partly due to a number of confounding variables, the true cost difference is however still striking. In order to have an idea of the average cost of a child corrected for these confounding covariates we estimated marginal effects around the values 0 and 1 for the presence of ADHD variable (`no_adhd`) and adjusted values for the disease severity variables (`iowa_...`). We find that the average cost of a child with ADHD is €588.3 for the parents and €779.02 for the government, private and public costs of the siblings amount to €91.5 and €371.3 respectively.

### **3.5. Limitations**

It is important to recall that this questionnaire was sent to the members of the ADHD society "Zit Stil" and that the use of this non-random sample can bias our results. For example, the average net monthly income in our sample is €2926. When we consider the average net monthly income of families with children in Flanders retrieved by a survey on a random sample (Health Survey of 2001) we learn that it amounts to €2440. The income in our sample is therefore biased upward, parents in this sample have a higher average income than average Flemish families. Through the GLM estimations we however found that income does not significantly influence the costs, therefore the bias will be negligible. It should however be kept in mind that we worked with a non-random sample and that results cannot be extrapolated to the general population. It is therefore better to consider the comparison of costs between children with ADHD and the siblings than to focus too much on the absolute amounts.

Concerning the cost calculations it should be taken into account that when cost information was not retrievable external sources are used. For example, we did not have detailed information on the hospitalisation cost of the ADHD child or its sibling. Instead we combined the information on hospital length of stay with external information on the average cost per hospital day to obtain the hospitalisation cost. Neither did we have information on the costs of ED visits. Although total costs are therefore only approximations, we do not believe this will change overall conclusions.

As a final remark to these cost calculations we want to remind the reader of the fact that the data are gathered through a questionnaire. It is always possible that parents have over- or underestimated the health care use and costs of their children.

## **4. Conclusion**

To our knowledge, the present study is the first to provide quantitative information on economic, social and mental burden borne by families of children with ADHD in Flanders. It is also the first study that compares costs of Belgian ADHD-children with those of the siblings.

As expected, the majority of the children with ADHD (90.8%) takes drugs in order to cope with their disorder and most of them take Methylphenidate. When the ADHD-children are compared with the siblings it is obvious that they consume much more medical and non-medical care and support, and consequently have significantly higher economic and social costs. It is striking that for ADHD-children the ED and hospital

admissions are significantly more often caused by accidents (as opposed to illnesses), which is probably due to their hyperactive and impulsive behaviour. It is also obvious from the data that ADHD adversely affects school attainments. ADHD-children also break or lose more things, they exhibit more reckless and dangerous behaviour and they cause more quarrels in the family. Having an ADHD-child puts a heavy burden on the parents. Almost half of the parents in our sample reduce on working time because of their child with ADHD and a lot of parents change to a more flexible job. Parents of an ADHD-child are also more often unable to go to work. ADHD adversely affects the parents' work productivity.

We learn that average total costs of Flemish children with ADHD are about €1500 a year, which is significantly higher than costs of about €550 of the siblings without the disorder. This also holds for total average public and private costs and for every cost item except for hospitalisations. These results are in line with those of the literature. In addition to the cost differences, there is also a difference in the relative share of the payers. Whereas parents pay on average 18% of the costs of their child without ADHD, this share increases to 31% for the child with ADHD. In fact, the cost of an ADHD-child to its parents is almost 7 times higher than the cost of a sibling without the disorder; government costs are 'only' twice as large for an ADHD-child. These results are confirmed by multivariate regression analyses. Cost differences can be mainly explained by the presence of ADHD. Some other covariates have a significant influence, most of those are intuitive and expected effects. After correction for these covariates cost differences in private costs are quite similar to our calculations, for public costs the cost differences diminish but are still striking.

Finally, we can conclude that childhood ADHD results in a significantly higher use of health care and in significantly higher costs and adversely affects school attainments and parents' productivity, which puts a heavy burden on the family. Nevertheless the use of a non-random sample and the use of siblings as a comparator group have to be taken into consideration.

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## Appendices

### Appendix 1: Detailed descriptive statistics of the results (proportions and p-values)

Variable	Values	ADHD	Non-ADHD	Sig.
Sex Valid n= 531	Female	12.8	44.3	.000
	Male	87.2	55.7	
Other medication Valid n= 526	No	71.9	79.0	.004
	Yes	28.1	21.0	
Therapy Valid n= 529	No	53.9	88.3	.000
	Yes	46.1	11.7	
* Physiotherapy Valid n= 537	No	85.1	97.3	.000
	Yes	14.9	2.7	
* Speech and language therapy Valid n= 537	No	79.9	92.5	.000
	Yes	20.1	7.5	
* Ergo therapy Valid n= 537	No	94.6	99.5	.000
	Yes	5.4	0.5	
* Psychotherapy Valid n= 537	No	77.8	97.6	.000
	Yes	22.2	2.4	
* Other therapies Valid n= 537	No	88.1	99.5	.000
	Yes	11.9	0.5	
Special education Valid n= 528	No	87.5	98.4	.000
	Yes	12.5	1.6	
Extra lessons Valid n= 523	No	89.9	97.5	.000
	Yes	10.1	2.5	
Special attention from teacher Valid n= 501	No	39.5	85.3	.000
	Yes	44.9	8.6	
	Don't know	15.6	6.1	
Special attention from help teacher Valid n= 442	No	69.0	89.7	.000
	Yes	23.1	6.6	
	Don't know	7.9	3.7	
Special attention from school speech and language therapist Valid n= 407	No	86.2	95.8	.000
	Yes	8.4	1.5	
	Don't know	5.4	2.7	
Special attention from school psychiatrist Valid n= 404	No	85.9	95.8	.000
	Yes	7.2	1.5	
	Don't know	6.9	2.7	
Missed year at school Valid n= 516	No	77.5	91.6	.000
	Yes	22.5	8.4	
Quarrels between parents Valid n= 529	Not applicable	5.7	3.8	.000
	Very often	14.0	1.9	
	Often	17.2	1.4	
	Sometimes	40.6	15.6	
	Seldom	16.6	47.3	
	Never	5.9	30.1	
Quarrels between siblings Valid n= 526	Not applicable	13.3	/	.000
	Very often	40.5	24.9	
	Often	28.3	28.6	
	Sometimes	13.9	35.1	
	Seldom	3.6	11.1	
	Never	.4	.3	
Quarrels with friends Valid n= 526	Very often	7.4	0	.000
	Often	22.8	2.4	
	Sometimes	41.1	23.7	
	Seldom	26.4	59.3	

Variable	Values	ADHD	Non-ADHD	Sig.
	Never	2.3	14.6	
Reckless behaviour Valid n= 526	Very often	19.6	.3	.000
	Often	28.7	3.5	
	Sometimes	32.9	17.0	
	Seldom	14.4	48.4	
	Never	4.4	30.8	
Dangerous behaviour Valid n= 529	Very often	7.2	0	.000
	Often	16.6	.8	
	Sometimes	33.8	6.7	
	Seldom	27.0	36.4	
	Never	15.3	56.1	
Lost/broken school material Valid n= 508	No	52.6	97.0	.000
	Yes	47.4	3.0	
Lost/torn clothes Valid n= 511	No	52.1	94.3	.000
	Yes	47.9	5.7	
Lost/broken toys Valid n= 503	No	73.0	97.3	.000
	Yes	27.0	2.7	
Lost/broken kitchen material Valid n= 506	No	75.3	97.0	.000
	Yes	24.7	3.0	
Lost/broken bike parts Valid n= 508	No	79.1	97.2	.000
	Yes	20.9	2.8	
Help with homework Valid n= 529	No	17.8	54.6	.000
	Yes	82.2	45.4	
Time spent on help with homework by parents	<b>Mean time</b>	53 min	26 min	.000
Unable to go to work Valid n= 522	No	86.4	95.4	.000
	Yes	13.6	4.6	
# of days unable to go to work	<b>Mean</b>	4.75	2.09	.010
Visits to health provider Valid n= 528	No	20.8	56.3	.000
	Yes	79.2	43.7	
Visits to GP Valid n= 534	No	39.7	62.6	.000
	Yes	60.3	37.4	
# of GP visits	<b>Mean</b>	1.58	1.52	.137
Visits to specialist Valid n= 532	No	49.1	87.1	.000
	Yes	50.9	12.9	
# of specialist visits	<b>Mean</b>	1.51	1.18	.011
Visits to ED Valid n= 527	No	74.0	87.9	.000
	Yes	26.0	12.1	
Cause of ED visit Valid n= 135	Accident	89.6	76.7	.008
	Illness	10.4	23.3	
# of ED visits	<b>Mean</b>	1.38	1.20	.0085
Hospitalisation Valid n= 528	No	86.0	91.6	.002
	Yes	14.0	8.4	
Cause of hospitalisation Valid n= 59	Accident	39.0	9.1	.002
	Illness	61.0	90.9	
# of hospitalisations	<b>Mean</b>	1.26	1.03	.0006

## **Appendix 2: List of variables used in the GLM estimations**

Dependent variables:

**cost\_par**: total annual private costs

**cost\_gov**: total annual public costs

Explanatory variables:

**no\_adhd**: dummy variable (1 if child is *not* diagnosed with ADHD, 0 if child is diagnosed with ADHD)

**iowa\_0**: dummy variable (1 if child is diagnosed with ADHD *and* has a score between 0-15 on IOWA, 0 otherwise)

**iowa\_1**: dummy variable (1 if child is diagnosed with ADHD *and* has a score between 16-22 on IOWA, 0 otherwise)

**iowa\_2**: dummy variable (1 if child is diagnosed with ADHD *and* has a score > 22 for IOWA, 0 otherwise)

**iowa\_mis**: dummy variable (1 if child is diagnosed with ADHD *and* has a missing value for IOWA because it always takes medication, 0 otherwise)

**nadhd**: # of children with ADHD in the household

**sex**: dummy variable (1 if male, 0 if female)

**age**: age of the child

**othdrug**: dummy variable (1 if child takes (non-ADHD related) drugs, 0 otherwise)

**agepar**: age of the parent that filled in the questionnaire

**nhousehold**: # of household members

**married**: marital status of the parents (1 if married or living together, 0 otherwise)

**job\_mother**: dummy variable (1 if mother has a job, 0 if mother is unemployed)

**job\_father**: dummy variable (1 if father has a job, 0 if father is unemployed)

**Ieducation\_2**: dummy variable, education of the parents (1 if secundair ...)

**Ieducation\_3**: dummy variable, education of the parents (1 if higher education ...)

**statute**: national health service statute of the parent that filled in the questionnaire (1 if general regulation, 0 if selfemployed regulation)

**high\_reimb**: dummy variable (1 if child is entitled to higher reimbursement, 0 otherwise)

**income\_eq**: equivalent income of the household

**fight\_sibl**: does the child often fight with its siblings (ordinal variable)

**fight\_friend**: does the child often fight with its friends (ordinal variable)

**reckless**: does the child often exhibit reckless behaviour (ordinal variable)

**dangerous**: does the child often exhibit dangerous behaviour (ordinal variable)