Health Complaints, Bullying and Predictors of Attention-Deficit/Hyperactivity Disorder (ADHD) in 10-year-olds in a Swedish Community

KIRSTEN HOLMBERG
Dissertation presented at Uppsala University to be publicly examined in Rosénsalen, Akademiska barnsjukhuset, ing 95, Uppsala, Thursday, May 7, 2009 at 09:15 for the degree of Doctor of Philosophy (Faculty of Medicine). The examination will be conducted in Swedish.

Abstract


Attention-deficit/hyperactivity disorder (ADHD) is one of the most common behavioural disturbances in school children. The aims of this thesis were to explore the association of ADHD with recurrent health complaints and bullying behaviour in children in grade four, and to evaluate whether it is possible to predict ADHD in grade four by screening before or at school entry.

Cohort study in a population of 577 fourth graders (10-year-olds) in Sigtuna, a municipality in Stockholm County. All children were screened for attention and behaviour problems by parents and teachers in fourth grade. In a second step children with high scores underwent further clinical and cognitive assessments. Information about health complaints and bullying was collected from the children themselves in a classroom questionnaire. Hypotheses were tested in multivariate analyses with adjustment for sex and parental education. Screening with developmental indicators and Conners scale from routine child health services was performed. Sensitivity, specificity and positive predictive value for being diagnosed with ADHD in fourth grade was calculated.

Recurrent abdominal pain, sleeping problems, and tiredness were associated with ADHD (adjusted relative risks: 2.2 [1.4-3.4], 1.7 [1.1-2.7], and 2.7 [1.7-4.1] respectively). ADHD was associated with bullying others students (adjusted odds ratios; 3.8 [95% CI: 2.0-7.2]) as well as being bullied (often 10.8 [4.0-29.0] and sometimes 2.9 [1.5-5.7]). The predictive value of developmental deviations for ADHD was no more than 20% and 50% when combining a Conner score of at least 10 from both parents and teachers.

This thesis demonstrates a connection between ADHD in one as well as two settings (home and school), health complaints, and bullying in school children. Treatment strategies for ADHD need to include an effective evaluation and treatment of health complaints and effective interventions for bullying. Evaluation of ADHD should be considered in children with recurrent health complaints and in children involved in bullying. Screening does not identify children who are diagnosed with ADHD in grade four with a high degree of selectivity. It may be more important for schools to have an effective strategy for identifying and dealing with children who develop ADHD when these problems evolve, rather than before school entry.

Keywords: ADHD, health complaints, psychosomatic, bullying, developmental screening, preschool children, school children, behavioural screening, Conners 10-item scale, Wilson and Jungner criteria

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To Patrik and Caroline
List of Papers

This thesis is based on the following papers, which are referred to in the text by their Roman numerals.


III Holmberg K, Sundelin C, Hjern A. Routine developmental screening at 5.5 and 7 years of age is not an efficient predictor of attention-deficit/hyperactivity disorder at age 10. (Submitted).

IV Holmberg K, Sundelin C, Hjern A. Screening for attention-deficit/hyperactivity disorder: can high-risk children be identified in first grade? (Manuscript).

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## Abbreviations

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<th>Description</th>
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<tr>
<td>ADHD</td>
<td>Attention-deficit/hyperactivity disorder</td>
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<tr>
<td>CD</td>
<td>Conduct disorder</td>
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<tr>
<td>CGAS</td>
<td>Children's Global Assessment Scale</td>
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<tr>
<td>CH record</td>
<td>child health record</td>
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<tr>
<td>CHC</td>
<td>child health centre</td>
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<tr>
<td>DAMP</td>
<td>Deficits in attention, motor control and perception</td>
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<td>DCD</td>
<td>Developmental coordination disorder</td>
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<td>DSM-IV</td>
<td>Diagnostic and Statistical Manual of Mental Disorders 4th ed</td>
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<tr>
<td>EF</td>
<td>Executive Function</td>
</tr>
<tr>
<td>EFSS</td>
<td>Executive Functions Screening Scale</td>
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<tr>
<td>GAF</td>
<td>Global Assessment of Functioning Scale</td>
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<tr>
<td>HBSC</td>
<td>Health Behaviour of School-aged Children</td>
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<tr>
<td>HKD</td>
<td>Hyperkinetic disorder</td>
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<td>ICH-10</td>
<td>International Classification of Diseases 10th edition</td>
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<tr>
<td>MBD</td>
<td>Minimal brain dysfunction</td>
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<td>MMR</td>
<td>Mild mental retardation</td>
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<tr>
<td>ODD</td>
<td>Oppositional defiant disorder</td>
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<tr>
<td>SHS</td>
<td>School Health Service</td>
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<tr>
<td>SPSS</td>
<td>Statistical Package for the Social Sciences</td>
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<tr>
<td>WHO</td>
<td>World Health Organisation</td>
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<tr>
<td>WISC III</td>
<td>Wechsler intelligence scale for children 3rd ed</td>
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Introduction

Parenting should be one of life's enriching experiences, but for some parents it is frustrating, exhausting and disappointing. Puzzled and distressed by their child's behaviour they may turn to health care or educational personnel for help to understand their children's problems, a task which may require qualified skills and considerable resources. The child's behaviour often needs to be understood as a variation of the normal – temper tantrums in 3-year-olds or resistance to parental rules in 14-year-olds – but for a significant number, the “difficult behaviour” is a symptom of an underlying issue to be identified and addressed.

Attention deficit/hyperactivity disorder (ADHD) (APA, 1994) is one of the most common behavioural disturbances in children (Spencer et al., 2007). The inattentive, hyperactive and impulsive behaviour is associated with troublesome relationships with family members and peers (Hoza, 2007; Klassen et al., 2004). Learning difficulties may further complicate the situation in school and everyday life (Gillberg et al., 2004). ADHD seems to be one of the most common reasons, both among boys and girls, for seeking help in a child and adolescent psychiatric out-patient clinic (Kopp and Gillberg, 2003).

During my work as a paediatrician in primary care and as a child neurologist at a university hospital, I have experienced the effect of underidentification of ADHD symptoms and of children being referred for evaluation far too late. The child's behaviour has already become associated with family stress, peer rejection and school failure. Some parents describe their “struggle” to obtain a diagnosis of ADHD.

I have also observed that the ADHD diagnosis may lead to a relatively good life for some children while others still seem to experience insufficient support and understanding, resulting in further stress and impairment. Parents seem to invest considerable time “fighting the support system,” to ensure educational and psychosocial resources for their child and family.

There is a lack of population-based studies in these domains. Population-based epidemiological studies may contribute to improving our understanding of ADHD, its natural history, its treatment and its consequences.
It has been recommended to ask children themselves about their perceptions of problems in school and family (Flay et al., 2005; Hart and Chesson, 1998; Klassen et al., 2006). One boy in this study with attention problems presented his perspective as follows:

Many children are put under stress because of school
I am one of them
I can't concentrate and the teacher says I work too slowly
For me school has always been a problem
I always feel rushed – for any reason
Just because I know I won't be able to handle it
That makes me a person feeling stressed – every day
I have always wondered
What can I do to get away from the stress monster inside of me?
Nothing
I can't do anything about myself!
I feel as if the monster is slowly eating me up

A.K., Sigtuna

In this thesis I have explored subjective health complaints and bullying associated with school-age ADHD, and the possibility to predict ADHD in school children by screening before school entry.

My wish is that the results will add to a better understanding of the ADHD syndrome. I hope this thesis will contribute to constructive discussion and further progress in the field, leading to improvement in the quality of care.

According to The United Nations Convention on the Rights of the Child (UNCRC), our devotion should be to the best interests of the disabled child who

“...should enjoy a full and decent life, in conditions which ensure dignity, promote self-reliance and facilitate the child's active participation in the community” (Article 23:1, (U.N. 1989).

Let that be our goal!

Kirsten Holmberg
Background

Attention Deficit Hyperactivity Disorder (ADHD)

Attention-deficit/hyperactivity disorder (ADHD) (APA, 1994) is one of the most common behavioural disturbances in children with an onset in early childhood, continuing through adolescence into adulthood (Biederman, 2005; DuPaul et al., 2001; Gillberg and Hellgren, 1996; Kadesjö, 2002; Larsson et al., 2004b). The disorder affects 3 to 5% of school-age children in Swedish population-based studies, and 7 to 12% if children with less severe symptoms are included (Biederman and Faraone, 2005; Kadesjö and Gillberg, 1998; Landgren et al., 1996). The aetiology is considered to be multifactorial with interaction of genetic and environmental factors (Biederman, 2005).

The main clinical symptoms are inattention, hyperactivity and impulsivity, causing impairment to school performance, social skills and interpersonal relationships (APA, 1994; Biederman, 2005). ADHD is a clinically heterogeneous condition with variability in symptom expression, functional impairment and comorbid features related to age, sex and psychosocial context (Biederman, 2005; Scahill et al., 1999; Wåhlstedt et al., 2008). Childhood ADHD is associated with financial burden, stress to families, individual suffering, and adverse academic and occupational functioning (Polanczyk et al., 2007).

ADHD is a major clinical and public health problem (Spencer et al., 2007; Wåhlstedt et al., 2008), requiring extensive efforts to develop primary and secondary interventions to improve both short-term and long-term outcome. These programmes should be based on reliable and valid assessment data (DuPaul et al., 2001). Research regarding the disorder in childhood in the general population is important in order to identify risk factors related to the aetiology and prognosis (Biederman, 2005).
Table 1. Diagnostic criteria for Attention-Deficit/Hyperactivity Disorder (DSM-IV)

A. Either (1) or (2):

(1) six (or more) of the following symptoms of inattention have persisted for at least 6 months to a degree that is maladaptive and inconsistent with developmental level:
   (a) often fails to give close attention to details or makes careless mistakes in schoolwork, work, or other activities
   (b) often has difficulty sustaining attention in tasks or play activities
   (c) often does not seem to listen when spoken to directly
   (d) often does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace (not due to oppositional behaviour or failure to understand instructions)
   (e) often has difficulty organizing tasks and activities
   (f) often avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort (such as schoolwork or homework)
   (g) often loses things necessary for tasks or activities (e.g., toys, school assignments, pencils, books, or tools)
   (h) is often easily distracted by extraneous stimuli
   (i) is often forgetful in daily activities

(2) six (or more) of the following symptoms of hyperactivity-impulsivity have persisted for at least 6 months to a degree that is maladaptive and inconsistent with developmental level:

Hyperactivity
   (a) often fidgets with hands or feet or squirms in seat
   (b) often leaves seat in classroom or in other situations in which remaining seated is expected
   (c) often runs about or climbs excessively in situations in which it is inappropriate
      (in adolescents or adults, may be limited to subjective feelings of restlessness)
   (d) often has difficulty playing or engaging in leisure activities quietly
   (e) is often "on the go" or often acts as if "driven by a motor"
   (f) often talks excessively

Impulsivity
   (g) often blurts out answers before questions have been completed
   (h) often has difficulty awaiting turn
   (i) often interrupts or intrudes on others (e.g., butts into conversations or games)

B. Some hyperactive-impulsive or inattentive symptoms that caused impairment were present before age 7 years.

C. Some impairment from the symptoms is present in two or more settings (e.g., at school [or work] and at home).

D. There must be clear evidence of clinically significant impairment in social, academic, or occupational functioning.

E. The symptoms do not occur exclusively during the course of a Pervasive Developmental Disorder, Schizophrenia, or other Psychotic Disorder and are not better accounted for by another mental disorder (e.g., Mood Disorder, Anxiety Disorder, Dissociative Disorders, or a Personality Disorder).

DSM-IV, Diagnostic and Statistical Manual of Mental Disorders 4th ed (APA, 1994)
Classification

Diagnostic criteria

Childhood hyperactivity may be classified according to the diagnostic criteria for a) hyperkinetic disorder (HKD), as defined by the International Classification of Diseases (10th edition; ICD-10) (WHO, 1992), or b) attention-deficit/hyperactivity disorder (ADHD) as defined by the Diagnostic and Statistical Manual of Mental Disorders of the American Psychiatric Association (4th edition; DSM-IV; Table 1) (APA, 1994). HKD has been used in many countries in Europe, while in Sweden, as in the US, ADHD is most commonly used.

Both classifications include children displaying developmentally inappropriate levels of inattention, hyperactivity, and impulsivity that begin in early childhood and cause impairment of school performance, intellectual functioning and social skills at home and at school. The disorders comprise 2 separate dimensions of symptoms (hyperactive/impulsive and inattentive) and the same list of these symptoms (A1 or A2, Table 1). The DSM-IV allows for three subtypes, based on which symptoms are predominant: mainly inattentive, or mainly hyperactive-impulsive, or both combined (Table 2).

Direct observation of this behaviour by the clinician is not required.

Table 2. Subtypes of ADHD (DSM-IV)

<table>
<thead>
<tr>
<th>Subtypes</th>
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<tr>
<td></td>
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<tr>
<td><strong>Combined Type.</strong> This subtype should be used if six (or more) symptoms of inattention and six (or more) symptoms of hyperactivity-impulsivity have persisted for at least 6 months. Most children and adolescents with the disorder have the Combined Type. It is not known whether the same is true for adults with the disorder.</td>
</tr>
<tr>
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<tr>
<td><strong>Predominantly Inattentive Type.</strong> This subtype should be used if six (or more) symptoms of inattention (but fewer than six symptoms of hyperactivity-impulsivity) have persisted for at least 6 months. Hyperactivity may still be a significant clinical feature in many such cases, whereas other cases are more purely inattentive.</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>Predominantly Hyperactive-Impulsive Type.</strong> This subtype should be used if six (or more) symptoms of hyperactivity-impulsivity (but fewer than six symptoms of inattention) have persisted for at least 6 months. Inattention may often still be a significant clinical feature in such cases.</td>
</tr>
</tbody>
</table>

DSM-IV, Diagnostic and Statistical Manual of Mental Disorders 4th ed (APA, 1994)

The HKD criteria are more restrictive than the DSM-IV diagnosis of ADHD because HKD requires a greater degree of symptom expression (Table 3) (Biederman and Faraone, 2005). The ICD-10 definition requires the presence of abnormal levels of inattention and overactivity in two settings, together with direct observation of these symptoms.
Table 3. Differences between DSM-IV and ICD-10 criteria of ADHD or HKD

<table>
<thead>
<tr>
<th>DSM-IV ADHD</th>
<th>ICD-10 HKD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptoms</td>
<td></td>
</tr>
<tr>
<td>- Either or both of the following:</td>
<td>- All of the following:</td>
</tr>
<tr>
<td>- At least six of nine inattentive symptoms</td>
<td>- At least six of eight inattentive symptoms</td>
</tr>
<tr>
<td>- At least six of nine hyperactive or impulsive symptoms</td>
<td>- At least three of five hyperactive symptoms</td>
</tr>
<tr>
<td></td>
<td>- At least one of four impulsive symptoms</td>
</tr>
<tr>
<td>Pervasiveness</td>
<td>Criteria are met for more than one setting</td>
</tr>
<tr>
<td>- Some impairment from symptoms is present in more than one setting</td>
<td></td>
</tr>
</tbody>
</table>

ADHD, attention-deficit/hyperactivity disorder. HKD, hyperkinetic disorder. (Biederman and Faraone, 2005)

ADHD is more prevalent than HKD, as the DSM-IV criteria identify a broader group of children than those identified by the ICD-10 (Biederman and Faraone, 2005; Polanczyk et al., 2007). An overlap between the ADHD combined type and HKD has been reported, while the inattentive or hyperactive-impulsive type ADHD may go undiagnosed by the HKD diagnostic criteria (Lahey et al., 2006; Tripp et al., 1999).

In the present thesis the ADHD diagnosis according to the DSM-IV has been applied.

Situational vs. pervasive

Similar to ADHD being divided into three subtypes, questions have been raised concerning evidence of “situational” ADHD (diagnostic criteria fulfilled either at home, home only ADHD; or at school, school only ADHD) as an independent syndrome (Buitelaar and Engeland, 1996). Epidemiological studies have claimed that pervasive hyperactivity is qualitatively different from situational hyperactivity. Pervasiveness has been reported to be associated with earlier age of onset, more cognitive difficulties, delayed language and motor development and poorer achievement at school, suggesting stronger genetic underpinning for pervasive disorder than for situational (Buitelaar and Engeland, 1996; Ho et al., 1996). The evidence is not wholly convincing. The difference in outcome may depend on comorbid aggressive behaviour as ADHD in combination with conduct problems is associated with worse outcome (Spencer et al., 2007).

There are still unresolved questions concerning the validity, reliability and utility of the situational-pervasive distinction (Buitelaar and Engeland, 1996). It has been argued that the distinction between pervasive or situational hyperactivity is not the main issue, but rather the setting of the behaviour problems (e.g., home or school). According to population-based research the degree of hyperactivity has been reported to increase progressively from home only to school only to pervasive symptoms indicating that school only ADHD may be more similar to pervasive ADHD than the
home only type. Teacher ratings of hyperactivity seem to be better correlated with cognitive deficits and attentional impairment than parent ratings (Ho et al., 1996; Szatmari et al., 1990). Mannuzza et al. demonstrated that school only ADHD, unlike home only ADHD, was associated with similar elevated risks of impaired psychosocial functioning and academic underachievement as clinical ADHD at long-term follow-up (Mannuzza et al., 2002).

Whether it is appropriate to keep the situational and pervasive categories apart or to merge school only and pervasive ADHD into one group is still a matter that requires further research (Buitelaar and Engeland, 1996; Wolraich et al., 2004). Studies with longer follow-up may clarify whether pervasiveness is synonymous with severe ADHD and causes persistence, or whether persistence leads to pervasiveness, or excessive school hyperactivity is the core problem.

Categorical vs. dimensional approach
ADHD is clinically defined as a categorical disorder with a discrete threshold for diagnosis (APA, 1994). Several researchers has suggested that ADHD should best be viewed as a dimension rather than strictly dichotomously (Kadesjö and Gillberg, 1998; Kraemer et al., 2004; Scahill et al., 1999). The disorder may be conceived as the extreme end of inattentive and/or hyperactive symptoms that are continuously distributed throughout the entire population (Buitelaar, 2002; Levy et al., 1997; Schachar and Tannock, 2006). Even “subclinical” or “subthreshold” ADHD patients (with symptoms not prominent enough to fulfil the diagnostic criteria; i.e., similar but milder ADHD problems) (AAP, 1997) may be at risk of developmental problems (Warner-Rogers et al., 2000) or impairment (e.g., peer rejection) (Hoza, 2007; Scahill et al., 1999). It has been suggested that the research should include examination of the whole range of severity of hyperactivity and inattention symptoms in the population. This may provide further information about the relationship between symptom severity and overall impairment, in order to further evaluate the relative risk of elevated ADHD symptoms (Warner-Rogers et al., 2000).

Associated impairment
ADHD is associated with social and cognitive impairments that extend beyond the three core symptoms accounted for by the diagnostic criteria (Diamantopoulou et al., 2007; Mares et al., 2007).

Executive functions
Neuropsychological assessment in ADHD has demonstrated problems in higher cognitive abilities or processes referred to as executive functions (EFs). These cognitive functions underlie self-regulation and goal-directed behaviour, including inhibitory and emotional control, behaviour regulation,
Effective planning and organising, working memory, and sustained attention (Doyle, 2006). Poor EFs in ADHD are independent of intelligence and seems to be the primary cognitive impairment underlying ADHD (Mares et al., 2007) causing some of the behavioural problems in ADHD not accounted for by the core symptoms (Doyle, 2006; Seidman et al., 1997).

However, EF weaknesses are neither necessary nor sufficient to cause all cases of ADHD (Doyle, 2006; Martinussen et al., 2005; Willcutt et al., 2005). A recent Swedish community-based study of 8-year-old children with high scores of ADHD symptoms suggested that 26% had no EF impairment (Wåhlstedt et al., 2008). Another study of 9-year-olds demonstrated that low EF was related to academic underachievement but not to poor social functioning. In combination with high levels of teacher-rated ADHD symptoms, low EF seemed to have an interactive effect causing more severe peer and school problems. High EF deficits may exacerbate ADHD-related problems at school (Diamantopoulou et al., 2007).

**Prevalence**

ADHD is a worldwide and highly prevalent disorder, estimated to affect 5 to 10% of children and 4% of adults (Faraone et al., 2003). ADHD is a difficult concept to define in a reliable way in epidemiological studies, because of the subjective and context-bound nature of the impairment criteria included in the existing diagnostic classifications (Polanczyk et al., 2007; Rowland et al., 2002). Environmental and cultural aspects influence the prevalence in a given population (Polanczyk et al., 2007). On the other hand, recent analyses of prevalence studies from different parts of the world suggest that most variations in the prevalence of ADHD are attributed to methodological differences among studies rather than the geographical location (Faraone et al., 2003).

There is no “gold standard” for measuring behaviour and development (Kenny et al., 1991; Marks et al., 2008), or for diagnosing ADHD (Kadesjö, 2000). Hence, it is of crucial importance in epidemiological research to state clearly how the diagnostic information is to be organised in order to arrive at a definition of caseness (Buitelaar, 2002). The prevalence depends, to a great extent, on: (A) the diagnostic measures used: (1) rating scales or structured interviews for epidemiological case definitions or clinical assessment for clinical case definition; (2) diagnostic systems (less restrictive criteria in DSM-IV than in ICD-10), and associated criteria (situational versus pervasive, degree of impairment); (3) sampling method (referred or population-based); (4) number of informants used (parents only, teachers only or both) and the method of combining parent and teacher reports (if deviation in at least one setting is required for epidemiological diagnosis: the “OR rule”; or if symptoms in both settings are required: the ”AND rule” - relying on information provided using the AND rule criterion results in lower prevalence estimates) (Polanczyk et al., 2007; Wolraich et al., 2004); and (5) handling
of comorbidity (exclusion of cases with comorbid diagnosis). (B) Epidemiological studies have demonstrated that socio-demographic characteristics of the population studied (age, sex, and ethnical background) also influence the prevalence (Biederman, 2005; Schachar and Tannock, 2006). Male sex, low socioeconomic status and young age are associated with a increased prevalence of ADHD (Biederman and Faraone, 2005).

Course and prognosis
The core symptoms of ADHD tend to decline from childhood and diminish in severity over time (Figure 1). Remission in 15 to 60% in childhood ADHD has been reported (Biederman et al., 1996; Biederman et al., 2000; Gillberg, 2003; Gillberg and Hellgren, 1996).

On the other hand, the stability of ADHD with preschool onset has been demonstrated by longitudinal studies with 6 to 8 years of follow-up (Gillberg, 1987; Hellgren, 1994; Kadesjö, 2002; Lahey et al., 2006; Lahey et al., 1998). The disorder persists into adolescence in half or more of childhood ADHD (Biederman et al., 1996; Gillberg and Hellgren, 1996) and adolescent disorder persists into adulthood in half or more of the cases (Rasmussen and Gillberg, 2000; Schachar and Tannock, 2006). School-age children display similar behaviours but usually with less frequency or intensity than preschoolers.
Both in remittent and persistent ADHD, hyperactive-impulsive symptoms tend to decline in late childhood and early adolescence (although fidgety behaviour and feelings of restlessness may persist), but inattentive symptoms and attention-related impairment, seem to remain relatively constant (Biederman and Faraone, 2005; Biederman et al., 2000; Langberg et al., 2008; Rowland et al., 2008; Seidman et al., 1997). Specific impairments, in particular problems with family and peer relationships and academic functioning, are better predictors of a negative long-term outcome than the core symptoms of ADHD (Pelham et al., 2005). A family history of ADHD, psychosocial adversity and comorbidity with conduct, mood, and anxiety disorders appear to predict persistence (August et al., 1999; Biederman, 2005; Biederman et al., 1996). The risk of ADHD has been found to increase with each increase in the number of adversity indicators (Biederman et al., 1995).

ADHD in adolescence and young adulthood is associated with an increased risk on school failure, frequent job changes, low socioeconomic status, emotional difficulties, early parenthood, peer problems and trouble with the law (Barkley et al., 2006; Mannuzza and Klein, 2000; Mannuzza et al., 2002; Spencer et al., 2007). There seems to be an approximately five times greater risk of substance abuse (tobacco, alcohol, illicit drugs), antiso-
cial behaviour (aggression), and other psychiatric disorders, such as depression and anxiety (Hellgren, 1994; Schachar and Tannock, 2006). Peer problems in childhood ADHD seem to have an additive effect, resulting in an increased risk of adjustment problems (Mikami and Hinshaw, 2006).

However, persistence of childhood ADHD into adolescence is not always associated with a bad prognosis, but rather a variety of emotional, educational and social outcomes. A follow-up study by Biederman et al. (Biederman et al., 1998) demonstrated that 20% of children functioned poorly at follow-up in all three domains, 20% did well in all three domains, and 60% had intermediate outcomes.

Comorbidity
Comorbid symptoms or disorders are common in ADHD, add to the functional impairment and complicate the diagnosis, treatment, and prognosis of ADHD (Spencer et al., 2007). Population-based research has reported that about 50 to 90% has at least one other DSM diagnosis (Gillberg et al., 2004; Seahill et al., 1999; Willcutt et al., 2007) and two in three meet the criteria for at least two comorbid diagnoses (Kadesjö and Gillberg, 1998). There appears to be a relationship between the severity of ADHD and the risk of comorbidity (Kadesjö and Gillberg, 1998; Seahill et al., 1999).

DCD – DAMP
ADHD has been reported to be associated with motor and perceptual problems (developmental coordination disorder, DCD) (APA, 1994). The diagnostic criteria for DCD are presented in Table 20, Appendix I. The descriptive term deficits in attention, motor control and perception (DAMP) was created by Gillberg et al. (Gillberg, 2003) to cover a combination of ADHD and DCD in children who have no severe learning disability or cerebral palsy (Gillberg, 2003; Gillberg et al., 1993; Kadesjö and Gillberg, 1998). DAMP is considered to be a subgroup of ADHD (Gillberg, 2003). In its more severe form it has been reported to affect 1.2 to 2.0% of the general population of Swedish school-age children, with 5 to 6% having more moderate difficulties (Gillberg, 2003; Gillberg et al., 1982; Kadesjö and Gillberg, 1998; Landgren et al., 1996). Comorbidity of ADHD with DCD has been estimated to be about 50% in 6 to 7-year-olds and is associated with more severe academic underachievement, learning and language disorders (Gillberg, 2003; Gillberg et al., 2004; Kadesjö and Gillberg, 1999; Landgren et al., 1996) than ADHD without motor problems. DCD in ADHD may signal a more severe variant of the disorder (Kadesjö and Gillberg, 1999) with stronger links to autism spectrum disorders (Gillberg, 2003).

Motor problems in DAMP have been reported to decline with age. Gillberg et al. demonstrated in a follow-up study of DAMP at 7 years of age that motor clumsiness was less obvious at the age of 10 and 13 (overlap reduced
from 50% to 25% at age 10) (Gillberg, 1985). On the other hand, Pitcher et al. demonstrated a concurrence of fine and gross motor problems in about 50% of ADHD in 10-year-olds (Pitcher et al., 2003). The attention, behavioural and academic achievement problems in DAMP tend to persist into adolescence (Gillberg, 1987) and adult age (Gillberg, 2003).

**Psychiatric comorbidity**

Figure 2 illustrates the prevalence rates of common comorbid diagnoses of childhood ADHD and how these diagnoses are affected with respect to gender (Biederman, 2005).

![Figure 2. Approximate prevalence of comorbid diagnoses in children with attention-deficit/hyperactivity disorder](image)

Oppositional defiant disorder (ODD; Table 21, Appendix I) (APA, 1994) is characterised by recurrent patterns of negativistic, defiant, disobedient and hostile behaviour toward authority figures. Conduct disorder (CD; Table 22, Appendix I) (APA, 1994) is characterised by norm violation and antisocial behaviour. ODD and CD are the most common comorbid conditions in childhood ADHD with prevalence rates estimated to be 30 to 60% (Figure 2) (Biederman, 2005; Gillberg et al 2004; Spencer et al 2007). ADHD and aggressive behaviours seem to interact by increasing the risk of substance use and more severe antisocial behaviour (Biederman et al., 2008; Dwyer et al., 2006; Jones et al., 2007; Kadesjö, 2002; Mrug et al., 2009).

Other prevalent psychiatric conditions are mood disorders (both unipolar and bipolar), depression and anxiety disorders, and tic disorders including
Tourette syndrome (Gillberg et al., 2004; Kadesjö and Gillberg, 2000; Khalifa and von Knorring, 2006). It is often difficult to differentiate between ADHD, depression, CD and juvenile mania because of overlapping symptoms and impairments such as hyperactivity, fatigue, irritability, aggression and school difficulties (Spencer et al., 2007).

**Neurological disorders**

ADHD can coexist with several neurological disorders in childhood. There is a high co-morbidity of epilepsy and attentional and behavioural problems including ADHD (Danielsson et al., 2009), and it has been estimated that at least 20% of patients with epilepsy may present with features of ADHD (Tan and Appleton, 2005). This may be an effect of the epilepsy (particularly as a secondary symptom of subtle seizures) or of the antiepileptic treatment (Aldenkamp et al., 2006).

Congenital syndromes, such as the 22q11 deletion syndrome and Down syndrome, have been reported to be associated with ADHD (Capone et al., 2006; Coe et al., 1999; Niklasson et al., 2008). Foetal alcohol spectrum disorders (FASDs), and cerebral palsy (Gross-Tsur et al., 2002) are other diagnoses with increased ADHD prevalence (Kodituwakku, 2007). Prematurity may cause cerebral palsy as well as ADHD (Gaddlin et al., 2007). The parent-reported prevalence of ADHD in males with Duchenne or Becker muscular dystrophy has been reported to be higher than in the general population (Hendriksen and Vles, 2008; Young et al., 2008). Other childhood illnesses associated with ADHD include virus infections, meningitis, encephalitis and head injury (Millichap, 2008). ADHD is associated with an increased risk of all kinds of accidents including brain concussion, but ADHD may also be secondary to traumatic brain injury (Gillberg et al., 2004; Levin et al., 2007).

**Impaired cognitive performance and Learning disabilities**

ADHD is associated with increased grade retention, and increased use of school-based services (Loe and Feldman, 2007; Spencer et al., 2007). Additional difficulties in overall cognitive functioning or in specific domains may further complicate the situation at school (Gillberg et al., 2004; Spencer et al., 2007).

**Cognitive difficulties**

Neuropsychological testing in clinical and community samples of referred individuals with ADHD symptoms has revealed that mean IQ is reduced by 3-7 points in ADHD (Buitelaar and Engeland, 1996; Gillberg et al., 2004; Landgren et al., 2000). There seems also to be great variability in test results including subaverage performance on various tasks (e.g., visual-spatial, verbal memory, and attention) resulting in uneven WISC profiles on individual
and on group level (Ek et al., 2007; Gillberg et al., 2004; Seidman et al., 1997).

Children with subnormal intelligence (IQ<85) may exhibit attention problems which may be mistakenly diagnosed as ADHD (Gillberg et al., 2004) (Nolan et al., 2001). An increase in ADHD symptoms has been reported to be associated with mild intellectual disability after accounting for mental age (Hastings et al 2005; Simonoff et al 2007). Mental retardation may be 5 to 10 times as common in ADHD as without ADHD in the general population (Gillberg et al 2004).

Learning disability
ADHD has been reported to be associated with difficulties in reading and mathematics, which are not merely directly associated with low IQ scores (Gillberg, 1987). Reading disorders and ADHD occur concomitantly in both clinic-referred and community samples, and have been reported to coexist in 25 to 40% of ADHD (Gillberg et al., 2004; Willcutt and Pennington, 2000). These disorders appear to be associated with inattentiveness (Buitelaar and Engeland, 1996; Massetti et al., 2008; Willcutt and Pennington, 2000) and may show an interactive effect causing more severe school failure (Gillberg et al., 2004).

Specific mathematical learning difficulty tends to be increased in school-age ADHD with prevalence rates estimated from 3% to 18% in non-clinical samples (Capano et al., 2008), and 10% to 60% in clinical samples (Gillberg et al., 2004). Arithmetic disability in ADHD is frequently associated with reading disorders (Capano et al., 2008) and may further complicate the school situation (Seidman et al., 2001).

Language disorders
Early language delay has been reported in about 50% of ADHD (Gillberg et al., 2004; Miniscalco et al., 2006; Tirosh and Cohen, 1998) and may predict further expressive language difficulties (Miniscalco et al., 2007; Snowling et al., 2006).

Aetiology
The aetiology of ADHD has not been clearly identified, although there is considerable evidence that both genetic and non-genetic factors contribute to the development of ADHD (Lasky-Su et al., 2007; Mick and Faraone, 2008).

Genetics of ADHD
Family, adoption, and twin studies have demonstrated that symptoms of ADHD are aggregated within families and that the familiarity is largely due to genetic factors. The estimated heritability is thought to be over 50% (Larsson et al., 2006), and some studies estimate it to be as high as 70 to
80% (Biederman and Faraone, 2005). Genes play a strong role in mediating susceptibility to ADHD and seem to be involved in the regulation of the dopaminergic and serotonergic systems that play important roles in the development of the core symptoms of ADHD (Faraone et al., 2005; Spencer et al., 2007). However, the specific genes involved have yet to be identified (Wallis et al., 2008).

Environmental factors

Biological adversity
An emerging literature documents that maternal smoking and alcohol exposure during pregnancy, low birth weight, pregnancy and delivery complications are risk factors for ADHD (Biederman, 2005).

Psychosocial adversity
Children from households with a disadvantaged socioeconomic situation are more often diagnosed with ADHD (Landgren et al., 1998; Scahill et al., 1999). Adverse family environment variables (e.g., low socioeconomic status, large family size, paternal criminality, maternal mental disorder, family conflicts) are independent risk factors for ADHD (Biederman and Faraone, 2005; Biederman et al., 2002a; Biederman et al., 1995). These findings were based on case control studies in comparatively small samples, and have recently been confirmed by a large Swedish population-based study (Hjern et al., 2009).

Gene - Environmental Interaction
Although there appears to be a relationship between low social class and ADHD, these findings must be interpreted with caution. It is possible that the observed relationship between low social class and ADHD is actually due to genetic factors. In addition, complex interactions between genes and the environment could be involved in the observed associations. Twin studies have explored how genes and environments contribute to the development of ADHD in children and adolescents and influence the continuity in ADHD over time (Larsson et al., 2004b). A recent study by Lasky-Su et al. (Lasky-Su et al., 2007) suggests a more direct interaction between environmental and genetic factors in the development of ADHD. In this study, the socioeconomic status of the family predicted the number of inattentive, but not hyperactive-impulsive, symptom counts in children exposed to the genetic risk factor brain-derived neurotrophic factor (BNDF), which is a possible candidate gene for ADHD.

Another recent study by Hjern et al. (Hjern et al., 2009) demonstrated that low maternal education, single parenthood and receiving social welfare are strong predictors of ADHD in school children. Considering that the heritability of ADHD is over 50%, the high predictive value of socioeconomic variables strongly suggest gene-environment interactions in the development of
ADHD symptoms. Effects of environmental factors like maternal education and need for social welfare may be genetically mediated to some degree: they may indicate expression of heritable personality characteristics of importance for the development of ADHD. They may even be expressions of parental ADHD.

Evidence-based parent training programmes in a community setting may reduce children's disruptive behaviour, including ADHD symptoms (Jones et al., 2007). This further suggests that environmental factors are involved in the aetiology of ADHD. According to the gene-environment interaction models, symptoms of ADHD may be differently expressed in different contexts. These gene-environment interaction models may provide a useful framework for future research into the aetiology of ADHD and subsequent development of preventive interventions (Beauchaine et al., 2008; Hjern et al., 2009).

Neurobiology of ADHD
The neurobiology of ADHD is not completely understood, although imbalances in dopaminergic and noradrenergic systems have been implicated in the core symptoms of this disorder (Biederman, 2005; Spencer et al., 2007). Structural and functional neuroimaging (Castellanos et al., 2002), and neuropsychological studies of ADHD support the hypothesis that deficits in frontal lobe function and the connections between the frontal lobe and key subcortical regions underlie this disorder. These prefrontal-subcortical circuits control executive functions including inhibition, organising, planning, working memory and sustained attention (Biederman and Faraone, 2005; Doyle, 2006).

The fronto-subcortical system pathways associated with ADHD are rich in catecholamines, which are involved in the mechanism of action of stimulant medications used to treat this disorder. Stimulants, such as methylphenidate, seem to reduce core ADHD symptoms by inhibiting the dopamine transporter and blocking dopamine and norepinephrine reuptake into the presynaptic neuron, thereby increasing the release of these monoamines into the extraneuronal space, which results in a greater inhibitory influence of frontal cortical activity on subcortical structures (Biederman, 2005).

Treatment
Multimodal treatment strategy
There is general agreement that a multimodal treatment strategy should be applied in treating ADHD at all ages. It is important to focus on impaired functioning in key domains (peer, family, school) when outlining the treatment plan (Pelham et al., 2005). Combinations of psychosocial treatments with parent training, school-based interventions (e.g., classroom behaviour management, peer interventions, and direct targeting of academic impairment), together with pharmacotherapy may improve areas of functional im-
pairment better than medication alone, according to the MTA study (Conners et al., 2001; Hinshaw et al., 2000; MTA, 1999).

According to the national guidelines for medication in ADHD issued by the Swedish National Board of Health and Welfare in 2002 (Swedish National Board of Health and Welfare, 2002), medication should be reserved for cases where other supportive interventions have failed. In Sweden, child neurologists, child psychiatrists, psychiatrists, and some developmental paediatricians are licensed to prescribe stimulants.

Associated psychosocial impairments and additional comorbid symptoms need to be assessed and treated at the same time as the ADHD in order to achieve an optimal treatment outcome (Gillberg, 2003; Langberg et al., 2008; Pelham et al., 2005; Turgay, 2004). Addressing several areas of functioning simultaneously and continuously over a long period of time seems to be necessary to achieve a good outcome (Chronis et al., 2006; Gillberg et al., 2004).

The International Classification of Functioning, Disability and Health

The International Classification of Functioning, Disability and Health (ICF) (WHO, 2001) provides a framework to understand the health of a child and how his or her environment interacts with other factors to hinder or promote a life lived to its full potential. According to the ICF concept, health depends on biological as well as psychosocial factors. The ICF classifies functioning into four broad domains: body structures, activities and participation, and environmental factors (Figure 3). The framework provides a possibility to organise and present information about different aspects (e.g., domain-specific functions) that influence a child's health status. Application of the model facilitates our understanding of how and to what extent problems experienced in daily life impact on functioning and health-related quality of life.
The ICF model may be applied when studying how ADHD or symptoms of ADHD with or without comorbid problems may influence a child's health.

Assessment of ADHD and comorbid behaviour or motor problems would fall within the mental function or body function section, which is a part of the body structure. Cognitive and learning difficulties would influence activities and participation as well as peer rejection and negative parent-child interaction. The impact of ADHD symptoms and their consequences on perceived health may vary with the degree of inappropriateness of the environment. Adverse family-related factors seem to increase the risk of distress by personal factors (genetically mediated) and environmental factors (Hjern et al., 2009).

Traditionally, research into the assessment of ADHD has focused largely on the core symptoms of inattention and hyperactivity/impulsivity rather than functional impairment (Mrug et al., 2009). However, impairment in functioning - not the core ADHD symptoms - is typically the main reason for referral (Pelham et al., 2005). Specific impairments, in particular problems with peer relationships, are better predictors of long-term outcome than the core symptoms of ADHD (Hoza, 2007). The relationship between ADHD symptom severity and impact on health and well-being needs to be further explored (Warner-Rogers et al., 2000). Because the impact of ADHD is not uniform, decisions about targeted psychosocial and educational interventions should incorporate a broader range of functional aspects affecting quality of life and relevant indicators of outcome (Klassen et al., 2004).

In future research, the use of a severity scale of ADHD symptoms has been suggested to explore pervasiveness, degree of situational deviance, age of onset, persistence and co-occurring functional problems (Fombonne, 2006).
Associated social and psychosomatic symptoms in ADHD

The core symptoms of ADHD and impaired executive functioning in ADHD may cause stress. Stress symptoms in children are commonly expressed as subjective health complaints. Social problems and peer rejection are associated with the spectrum of behaviour characterising ADHD. Involvement in bullying may cause further distress.

Health complaints

Subjective health complaints refer to symptoms experienced by the child with or without a defined diagnosis (Haugland and Wold, 2001). Common childhood health complaints include pain syndromes such as headaches, recurrent abdominal pain (RAP) and back pain (Alfven, 1993; Haugland and Wold, 2001; Perquin et al., 2000; Petersen et al., 2006), as well as symptoms of a more psychological nature—irritability, nervousness, sleeping difficulties and day-time tiredness (Danielsson, 2003; Haugland and Wold, 2001). Recurrent pain appears to have negative effects on the development of children with associated restriction in daily activities and school problems, and is frequently the cause of absence from school (Haugland and Wold, 2001; Ramchandani et al., 2007). Health-related quality of life (HRQOL) in young school children with recurrent pain tends to be impaired (Petersen, 2008). Children with frequent pain may constitute a risk group for future chronic pain (Brattberg, 1994; Brattberg, 2004). Previous studies have demonstrated that poor peer, teacher, and parental relations are associated with health complaints (Danielsson, 2003; Ghandour et al., 2004; Hjern et al., 2008). Maternal anxiety (Ramchandani et al., 2007), economic stress in the family, and schoolwork pressure seem to be other risk factors for psychosomatic symptoms (Hjern et al., 2008; Östberg, 2001a; Östberg et al., 2006).

Bullying

Bullying among children is a specific form of aggressive behaviour, which has been defined as the intentional, unprovoked abuse of power by one or more children to inflict pain on or cause distress to another child (Forero et al., 1999; Kumpulainen et al., 1998; Olweus, 1993; Olweus, 1994). It generally includes abusive behaviour by a child or group of children towards a weaker classmate, repeatedly and over time (Olweus, 1994). Bullying behaviour can be physical (e.g., hitting, pushing, kicking) or psychological with verbal bullying (e.g., calling names, making threats, slander) (Fekkes et al., 2005; Kumpulainen et al., 1998). Most bullying occurs at school, either in the playground or in the classroom (Fekkes et al., 2005; Olweus, 1991). Children involved in bullying as perpetrators as well as victims have been
reported to have an increased risk of mental and physical health problems of various kinds, as well as educational problems and school absenteeism (Fekkes et al., 2005; Forero et al., 1999; Hjern, 2006; Juvonen et al., 2003; Kumpulainen and Räsänen, 2000; Kumpulainen et al., 1998; Sourander et al., 2007; Östberg, 2001b). Bullying behaviour tends to persist (Kumpulainen and Räsänen, 2000). Aggression in school-age children is considered to be a risk factor for physical violence during adolescence and adulthood (Broidy et al., 2003; Sourander et al., 2006). Former victims are more likely to continue to have poor self-esteem (Olweus, 1994).

Single parenthood and parental low education tend to be risk factors for bullying (Kumpulainen et al., 1999; Nordhagen et al., 2005).

Being subjected to harassment is most commonly reported by younger school children (grade 3 to 6) and decreases in higher grades (Olweus, 1994). Boys seem to be more involved in bullying than girls (Danielsson, 2003; Kumpulainen et al., 1998) and they bully in a more direct way (e.g., hitting or kicking, whereas girls bully in a more indirect way (e.g., excluding others, spreading rumors). No major gender differences have been found for victimisation—boys are bullied as often as girls (Fekkes et al., 2005).

Screening

Routine screening of a child's health and developmental progress has been recommended for early detection of developmental problems or identification of children who are at risk of developmental deviation (AAP, 2006; Hall and Elliman, 2003; Swedish National Board of Health and Welfare 1991). Early identification and intervention are important as a part of secondary prevention in primary care (Sonnander, 2000).

Definition

Screening was defined by the American Commission on Chronic Illness in 1957 as “the presumptive identification of unrecognised disease or defect by the application of tests, examinations, or other procedures which can be applied rapidly. Screening tests sort out apparently well persons who probably have a disease from those who probably do not. A screening test is not intended to be diagnostic” (Wilson and Jungner, 1968). In essence, a screening procedure (which may be a test or a questionnaire) is applied to a population that has no manifestations of a disorder to separate out those at higher risk from those at lower risk.
Criteria and evaluation

It has been recognised that some screening activities are not merely useless but are potentially harmful, because of the unnecessary worry and referrals that may result (Hall and Elliman, 2003). Indeed, it is unethical to offer screening tests which cannot stand up to critical examinations (Cochrane and Holland, 1971; Hall and Elliman, 2003).

Wilson and Jungner (Wilson and Jungner, 1968) devised a set of criteria by which screening programmes could be evaluated. These have been adopted by WHO (Frankenburg, 1974) and modified by Hall to increase their relevance for paediatric practice (Hall and Elliman, 2003) (Table 4).

Table 4. **Wilson and Jungner’s criteria** for screening programmes

1. The condition to be sought should be an important public health problem as judged by the potential for health achievable by early diagnosis
2. There should be an accepted treatment or other beneficial intervention for patients with recognised or occult disease
3. Facilities for diagnosis and treatment should be available and shown to be working effectively for classic cases of the condition in question
4. There should be a latent or early symptomatic stage and the extent to which this can be recognised by parents and professionals should be known
5. There should be a suitable test or examination: it should be simple, valid for the condition in question, reasonably priced, repeatable in different trials or circumstances, sensitive and specific; the test should be acceptable to the majority of the population
6. The natural history of the condition and of conditions which may mimic it should be understood
7. There should be an agreed definition of what is meant by a case of the target disorder, and also an agreement as to (i) which other conditions are likely to be detected by the screening programme and (ii) whether their detection will be an advantage or a disadvantage
8. Treatment at the early, latent, or presymptomatic phase should favourably influence the prognosis, or improve the outcome for the family as a whole
9. The cost of screening should be economically balanced in relation to expenditure on the care and treatment of persons with the disorder and to medical care as a whole
10. Case finding may need to be a continuous process and not a once and for all project, but there should be explicit justification for repeated screening procedures or stages

Modifications proposed to increase the relevance for paediatric practice are shown in italics (Hall and Elliman, 2003)

When selecting an appropriate screening method as part of a screening programme, it is important to consider the psychometric properties of the instrument and to use screens only as they were designed to be used. The inappropriate uses of behavioural health measures can lead to high misclassification rates (Weitzman and Leventhal, 2006).
Cochrane and Holland (Cochrane and Holland, 1971) described the characteristics of the ideal screening test (which corresponds to the WHO criterion #5) as follows:

1. Simple, quick and easy to interpret; capable of being performed by paramedics or other personnel.
2. Acceptable to the public, as participation in screening programmes is voluntary.
3. Accurate or valid; i.e., giving a true measure of the domain or construct that it intended to measure.
4. Precise or repeatable (i.e., reliable): the test should be consistent between different assessors and over time. Reliability involves: (i) interrater reliability which measures the stability of results when the test is repeated by different evaluators on the same subject (e.g., two nurses at CHC performing a developmental test); (ii) test-retest reliability reports on how stable a test is when performed at different times by the same observer, employing the same testing methods.
5. Sensitive
6. Specific

Criteria for effectiveness

Sensitivity – Specificity – Predictive value

The effectiveness of a screening test is evaluated by its sensitivity and specificity (Ahlbom and Norell, 1987; Cochrane and Holland, 1971). This is also applicable when examining a screening method's performance in predicting children's mental health outcome (Dwyer et al., 2006) (Kenny et al., 1991). According to WHO criterion #5, the screening test should be sensitive and specific.
Table 5 and Figure 4 illustrate the relationship between screening test results and actual diagnosis (Ahlbom and Norell, 1987; Frankenburg, 1974; Wilson and Jungner, 1968). In this thesis, screening at 4, 5.5 and 7 years of age was evaluated for diagnosing ADHD in fourth grade. Screen-positive results indicated a high risk of ADHD in grade 4; screen-negative result indicated low risk of ADHD in grade four.

Table 5. The efficiency of a screening test (Frankenburg, 1974)

<table>
<thead>
<tr>
<th>Screening result</th>
<th>Disorder present</th>
<th>Disorder not present</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screening test positive</td>
<td>a With disorder and with positive test</td>
<td>b Without disorder but with positive test</td>
<td>a + b All persons with positive test</td>
</tr>
<tr>
<td>Screening test negative</td>
<td>c With disorder but with negative test</td>
<td>d Without disorder and with negative test</td>
<td>c + d All persons with negative test</td>
</tr>
<tr>
<td>Total</td>
<td>a + c Total unknown cases of disorder</td>
<td>b + d Total persons without disorder</td>
<td>a + b + c + d All persons in population</td>
</tr>
</tbody>
</table>

\[ a = \text{True positive, correct referral} \quad b = \text{False positive, over-referral} \quad c = \text{False negative, under-referral} \quad d = \text{True negative} \]

Sensitivity = \( \frac{a}{a + c} \)  \quad Specificity = \( \frac{d}{b + d} \)  \quad Positive predictive value = \( \frac{a}{a + b} \)
Sensitivity is the proportion of individuals with the disorder (e.g., ADHD in this thesis) who have a positive screening test result (e.g., hyperactive symptoms present) and equals \( a/a + c \). The ability of a test to identify correctly all individuals in a population with the disorder (e.g., all children with ADHD) is expressed by the sensitivity. Standards for sensitivity are the identification of at least 70 to 80% of children with developmental disabilities at a single administration (Glascoe, 2005; Marks et al., 2008).

Specificity is the proportion of individuals in a population without the disorder who have a negative screening test result (e.g., no developmental deviation or hyperactivity) and equals \( d/b + d \). The ability of a test to identify correctly all individuals without the disorder as healthy or normal is expressed by the specificity. Specificity is recommended to be closer to 80% in developmental paediatrics (Glascoe, 2005; Marks et al., 2008).

The positive predictive value is the proportion of individuals with a positive screening result (e.g., classified as high risk of developing ADHD) who develop the disorder and equals \( a/a + b \). This value reflects the probability that an individual with a screen-positive test has the disorder or will eventually develop the disorder. It is an important measure of a diagnostic method as it reflects the probability that a positive test reflects the underlying condition being tested for.

The three concepts are often expressed as percentages. The predictive value of a test is determined by the test's sensitivity and specificity. In contrast to sensitivity and specificity, the predictive value also depends on the prevalence of the disease or disorder in the population in which the test is applied (Ahlbom and Norell, 1987). The positive predictive value increases when the prevalence rate of the disorder being measured increases.

Screening or diagnostic tests in clinical research often reflect group differences. A common mistake in studies is to use a \( p \) value that indicates that differences or relationships between screen results and outcome will be only obtained by chance (e.g., preschool hyperactivity in relation to ADHD diagnosis in grade four). Instead, measures of sensitivity and specificity are more appropriate to the clinical application (Kenny et al., 1991).

It has been recommended that these measures of efficiency should be calculated before a new screening method is implemented (Cochrane and Holland, 1971), which applies to the The Child health surveillance programme (Swedish National Board of Health and Welfare, 1994) as well.

Early onset ADHD - Predictors of ADHD

Approximately 2% of children aged 2 through 5 years have been reported to meet the diagnostic criteria for ADHD (Lavigne et al., 1996; McGee et al., 1991). The onset of pervasive hyperactivity during the first few years of life has been suggested to be an indicator of poor educational (Masetti et al., 2008) and social outcome (Spencer et al., 2007) in school age, adolescence
and adulthood (Flanagan et al., 2003; Gillberg and Hellgren, 1996; McGee et al., 1991; McGee et al., 2002).

Developmental deviation as a precursor of ADHD
There is some evidence to support the concept that ADHD is a developmental and cognitive as well as a behavioural disorder (Loe et al., 2008). Population-based studies have demonstrated that early onset ADHD tends to have high rates of delayed speech and language problems, cognitive difficulties and motor problems, such as DCD (Gillberg and Hellgren, 1996; Ho et al., 1996; Kadesjö and Gillberg, 1998; Landgren et al., 1998; Landgren et al., 2000; Massetti et al., 2008; McGee et al., 1991). As early onset of pervasive hyperactivity seems to be characterised by more developmental problems than later onset ADHD, it has been suggested that preschool ADHD represents a distinct subgroup with a stronger biological, genetic underpinning than ADHD starting later during childhood (Buitelaar and Engeland, 1996). It may be a subgroup with an especially bad prognosis, which is important to identify as early as possible.

Behaviour problems as a precursor of ADHD
When evaluating behavioural symptoms in young children, normal developmental changes must be taken into consideration. Disruptive symptoms, such as hyperactive-inattentive and aggressive behaviour, are well recognised to be part of normal behaviour in young children (Bennett and Offord, 2001), particularly at the time of entry in primary school, and to diminish with increasing age (Nagin and Tremblay, 1999).

However, several studies have demonstrated that high levels of hyperactivity in early childhood are relatively stable and may lead to a clinical diagnosis of ADHD (Gillberg and Hellgren, 1996; Lahey et al., 2006; Lahey et al., 1998; McGee et al., 1991). Preschool children displaying high levels of opposition and externalising behaviour problems are at high risk of persistent physical aggression at school age (Biederman et al., 2008; Campbell et al., 2006). (Bennett and Offord, 2001; Campbell and Ewing, 1990; Nagin and Tremblay, 1999; Nagin and Tremblay, 2001). More than 50% will develop CD and antisocial behaviour in adolescence and adulthood (Campbell, 1995; Gillberg and Hellgren, 1996).

In preschool children, hyperactive and disruptive behaviour often occurs at the same time (Kadesjö, 2002; Larsson et al., 2004a; Lavigne et al., 1996; Sonuga-Barke et al., 1997) and increases the risk of early onset ADHD (Speltz et al., 1999), ODD or CD (Loeber et al., 1995). Screening procedures should therefore focus on children exhibiting aggressive as well as hyperactive-inattentive behaviour (van Lier et al., 2003).

Early recognition of these disorders followed by effective interventions has a potential to improve the psychosocial and educational development and prevent mental health problems in adulthood (Biederman and Faraone,
Prevention
High levels of externalising symptoms in young children are associated with parental stress (August et al., 1996; Kadesjö, 2002). Adverse parenting may increase the risk of persistence of ADHD and comorbid ODD (August et al., 1999). Secondary prevention through evidence-based family-centred interventions for young children at risk of ADHD and/or conduct problems in a community setting may benefit children, if the interventions are implemented early before the child's behaviour becomes associated with peer rejection and school failure (Bennett and Offord, 2001; Jones et al., 2007). Preliminary evaluations of a basic parenting skills programme for preschool children with conduct disorder and signs of ADHD suggest that interventions aimed at modifying parent-child interactions may be a successful road to prevent the development of ADHD and CD (Jones et al., 2008). The success of intervention programmes depends on the availability of an accurate early detection method that can be applied to normal populations to identify high-risk children (Dwyer et al., 2006; Flanagan et al., 2003).

Swedish Child Health Care
The Swedish health surveillance programme includes all children and adolescents up to 16 years of age. All examinations are free of charge and have a participation rate of almost 100% (Magnusson, 1997). Child Health Centres (CHCs) are responsible for health surveillance and health promotion of infants from birth up to school age (Swedish National Board of Health and Welfare, 1991). After starting school at the age of six to seven, the checkups are performed according to the school health surveillance programme by the school health care at the local school.

Child Health Surveillance Programme
There is an extensive network of about 3000 CHCs throughout Sweden. Each CHC consults once a week with a general practitioner or a paediatrician. The nurse at the CHC plays a central role in the preventive paediatrics and surveillance programmes for preschoolers.

In Sweden, as in many countries, children's development is followed by different surveillance programs. The local CHCs perform regular checkups at certain predetermined ages. Most developmental screening activities are performed by the nurse and the physician examines the child at 2, 6, 10 to 12 months and 5 to 6 years of age (www.growingpeople.se).
Developmental screening

Results from two of the routine developmental screenings at 4 and 5.5 years of age at CHCs are included in this thesis:

4 years of age

The Swedish National Board of Health and Welfare recommended in 1968 a health screening of 4-year-olds at CHCs to identify developmental delay and severe behaviour symptoms (Swedish National Board of Health and Welfare, 1968). The nurse performs a motor-perceptual test, language evaluation, and screening for hearing impairment and vision defects. Children with deviations are evaluated by a physician (general practitioner or paediatrician). Children with speech delay only are referred to a speech pathologist.

5 to 6 years of age

Gillberg and Rasmussen developed a screening method for minimal brain dysfunction (MBD), a condition characterised by attention deficit, major or minor neurological signs or perceptual abnormalities (Gillberg et al., 1982), and DAMP in 7-year-old children (Gillberg and Rasmussen, 1982b). The method comprised three measures: (i) a 6-item motor examination (Gillberg et al., 1983), (ii) information from parents using a questionnaire (Rasmussen and Gillberg, 1983), and (iii) a preschool teachers questionnaire (Gillberg and Rasmussen, 1982a). This method was introduced as a school entrance test for 5 to 6-year-olds in many regional CHC surveillance programmes in Sweden during the 1980s, and was formalised by the Swedish National Board of Health and Welfare in 1991 (Swedish National Board of Health and Welfare, 1991). Although not explicitly stated in the guidelines, this was considered to constitute screening to identify deficits in attention, motor and perceptual dysfunction (Blomquist, 2000; Landgren et al., 1996; Sundelin and Håkansson, 2000; Thunström, 2002). Children's need for extra support at school entry or in first grade should be evaluated. The design was supposed to be worked out on a local basis.

The developmental screening at five to six years of age has been a part of the Swedish surveillance programme offered by the CHSs since 1991 and was included in child health (CH) records from 1981 as a complementary measure (Swedish National Board of Health and Welfare, 1981). This screening method was in practice when the data analysed in this thesis were collected. The nurse performed the whole screening programme, with the exception of some motor tasks that were checked by a physician. Vision screening was also performed.

The developmental screening at five to six years of age is still part of the child health surveillance programme (Swedish National Board of Health and Welfare, 2000) (guidelines available on www.growingpeople). The purpose is to make an evaluation of the child's need for extra support at school entry.
or in first grade. Five of the six motor perceptual items validated in previous Swedish studies are included (Gillberg et al., 1983; Landgren et al., 1996), as is a parent interview (no questionnaire). Information from the preschool teacher may be obtained if the child has problems according to the parent.

The Swedish school system

In Sweden, children start school by attending a preschool class at the age of 6 (grade 0), and then continue into primary school from grade one to nine. All grades are compulsory. In most Swedish communities, there is a preponderance of community-run schools with mainstream teaching methods. According to the Swedish Education Act (Chapter 1 and 4; SFS, 1985), children with special educational needs are entitled to support and intervention. It is recommended that children with special needs primarily be integrated in mainstream schools (Skolverket, 1998) and that special education interventions be provided within the realm of the general school system.

Children with intellectual disabilities (i.e., mild mental retardation (MMR) with IQ $\leq 70$) are enrolled in special schools. At the time of the present study, the prevalence rate of school-age children in special education in Sweden was estimated to be just over 1% of all pupils in compulsory schools (Sonnander, 2000). However, in some communities, other children with subnormal cognitive abilities (“slow learners”) are enrolled in the same class. These classes are usually located within the regular school premises and the children share the same playground. However, it is not uncommon that mildly retarded children or children with severe learning difficulties are integrated in regular classes.

Children with learning disabilities, i.e., significant problems in one or more school subjects indicated by remedial education of some kind in the regular compulsory school, are estimated to comprise around 35% of all pupils in an age cohort (Sonnander, 2000). Landgren et al. (Landgren et al., 2003) estimated that 15% of children in fourth grade are in need of special education.

Children with severe behaviour problems, such as severe ADHD combined type, conduct disorder, or problems related to severe psychosocial difficulties, may be educated in special classes together with a small number of students. In recent years, special classes for autism spectrum disorders, including Asperger's syndrome, have been made available in many communities.

Swedish School Health Care

All children should have access to the School Health Service (SHS) according to the Swedish Education Act (Chapter 14; SFS, 1985). The objectives of the school health care are stated in the legislation as “monitoring the development of the child, maintaining and improving the child's physical and mental health, and promoting healthy habits of life,” in cooperation with
parents. Preventive interventions and counteracting bullying at school are included in the goals. The SHS should provide health examinations and simple treatment measures. A school physician and a school nurse must be provided for all children.

**School Health Surveillance Programme**

All pupils should be offered at least three health checkups during the first nine school years, and the first of these should take place during the first school year or preschool year (grade 0). The activities of the SHS are described by the Swedish National Board of Health and Welfare (Swedish National Board of Health and Welfare, 2004) and evidence-based methods are recommended. The three health checkups are performed at school entry, in fourth grade, and usually in seventh or eighth grade. It is important to penetrate any emotional, social or functional impairment that may interfere with the child's education. Usually the school nurse performs screening interviews with the child and a parent. The school physician performs a medical examination, usually at school entry and later only if requested.

**School entry examination**

All children and their parents are invited to see the school nurse, and the participation rate is high. When this study started in 1998, there was a routine health examination in first grade. Today, a school entry examination is recommended during the preschool year (6-year-olds) or in first grade (7-year-olds) (Swedish National Board of Health and Welfare, 2004). This examination includes screening for medical, developmental and behavioural problems by interviewing parents and teachers. Questionnaires about motor function, language performance, attention problems, and emotional, social or learning difficulties are completed (Swedish National Board of Health and Welfare, 2004). Information from teachers is collected with parental consent.

According to some local manuals for the SHS; for example, in the municipality of Sigtuna where this study was performed (Skolhälsovården, 2007), a motor-perceptual test similar to the one at five to six years of age at the CHC, should be performed by the nurse if developmental deviation is suspected.

**Health examination in fourth grade**

All children have individual health talks with the school nurse, including a simple evaluation of psychological problems and well-being, family situation, psychosomatic complaints, bullying and other peer problems. Factors affecting the child's educational achievements are discussed. Complementary information is gathered from parents and teachers when warranted.
Rationale for the present thesis

The studies in this thesis are important in relation both to research and to child health care in the clinical setting. Caring for children with attention problems and associated school problems is an area with potential for improvement, considering the evidence of poor long-term social and educational outcome.

Associated social and psychosomatic symptoms in ADHD

Research

When the work of the present thesis was initiated, there was no detailed information about the association of subclinical or clinical ADHD with health complaints and bullying including the child's perspective, based on population-based studies of school children. There is a great need for population-based controlled longitudinal follow-up studies of children who show early onset attention disorders (Gillberg et al., 2004). The relationship between ADHD symptom severity and the impact on health and well-being needs to be further explored to establish the contribution of these additional problems in ADHD (Warner-Rogers et al., 2000). New knowledge may improve the ability of clinicians to identify children with significant functional impairment, to decide in which domains intervention is needed, and to aid in the evaluation of treatment effectiveness (Pelham et al., 2005).

Health care

Mental health problems and psychosomatic stress symptoms are main areas of concern for the SHS (Swedish National Board of Health and Welfare, 2004). Attention or hyperactivity problems as well as health complaints have been reported to be a common reason for young Swedish school children to consult the school nurse (Clausson et al., 2008; Larsson and Zaluha, 2003). One way to improve early identification is to evaluate and further develop the methods used in the School health surveillance programme. Changes to screening practices from non-standardised methods to implementation of validated instruments has the potential to improve the effectiveness of the developmental and mental health surveillance (Sand et al., 2005).

Predictors of ADHD

The scientific basis for the activities at CHCs and the routine school health examinations is rather weak (Bremberg, 2000; Kadesjö, 2000; Sundelin and Häkansson, 2000). In a review, Sonnander concluded that there is little evidence of the effectiveness of developmental screening and few studies concerning long-term outcome have been performed in Sweden (Sonnander, 2000). Existing screening programmes should be followed up to ensure a
scientific basis for the activities included in the Child health surveillance programme (Sundelin and Håkansson, 2000).

The effectiveness of the preschool screening at five to six years of age at CHCs for predicting DAMP/ADHD in school children has been questioned (Bergström et al., 1988; Blomquist, 2000; Bondestam et al., 1992). The need for scientific evaluation was pointed out already in 2000 (Sundelin and Håkansson, 2000). Previous Swedish population-based studies have demonstrated group differences at follow-up using a case-control design (Gillberg, 1987; Hellgren, 1994), but evaluation of this screening according to the WHO criteria (Wilson and Jungner, 1968) for ADHD has not previously been carried out.

The developmental screening at five to six years of age is still a part of the Child health surveillance programme today (www.growingpeople), as well as a part of the school entrance test for six to seven-year-olds (Swedish National Board of Health and Welfare, 2004). The intention is to make an evaluation of the child's need for extra support at school entry or in first grade. Whether this screening predicts school-age ADHD or not remains unclear. Even if these examinations do not define any specific disorder to be discovered or predicted, it is of interest to evaluate whether the screening predicts school-age ADHD, as mental health problems are of major concern for the child health care (Swedish National Board of Health and Welfare, 2004).

Previous long-term studies of the CHC examination of four-year-olds have demonstrated that the screening has low predictive value in relation to school problems in seven-year-olds (Rydell et al., 1991) and ten-year-olds (Mellbin et al., 1982). To assess the efficiency of developmental screening at age four for ADHD at age ten may add to the scientific basis for the routine health screening of children.

In addition to developmental screening, the school entry examination includes screening for behavioural problems by parents and teachers interviews (open-ended questions) (Swedish National Board of Health and Welfare, 2004). Applying methods of structured interviews, such as a behavioural scale (e.g., the Conners scale), may be a possibility for early identification of children at risk of attention problems. This may be the first step in secondary prevention in terms of social and educational support and family-based intervention such as parent training programmes. However, the method needs to be evaluated according to the WHO criteria before it is recommended in the health surveillance programme.
Aims of the present study

General (overall) aims

- To explore the association between ADHD and recurrent health complaints and bullying behaviour in children in grade four.
- To evaluate whether ADHD in grade four may be predicted by screening before school entry or in first grade.

Specific aims

- To assess the association between ADHD and recurrent subjective health complaints in school children in grade four (Study I).
- To assess the association between ADHD and bullying (bullying others or being bullied) in the peer group in school children in grade four (Study II).
- To assess the efficiency of developmental screening for ADHD in grade four (Study III).
- To assess the efficiency of behavioural screening in first grade for ADHD in grade four (Study IV).
Material and Methods

Study design

**DESIGN**

**Longitudinal study**

- **Record study**
  - CHC
  - Grade 1: 453 children
  - Grade 4: 422 children

**Retrospective study in grade 4**

- Maternal country of birth
- Maternal level of education
- Hyperactive-inattentive behaviour before school entry
- Measured by CH record, school health record, study questionnaire

**Cross-sectional study**—all children in grade 4 (n=577)

- Measures: Conners scale, EFSS, DSM-IV, clinical assessment, WISC test
- **Children with ADHD symptoms**

**OUTCOME**

- Measured by HBSC:
  - Headache
  - Recurrent abdominal pain
  - Sleeping problems
  - Day tiredness
  - Bullying

*Figure 5. Overall study design*
Material

Study population
The study was carried out in Sigtuna, a municipality in Stockholm County with a total population of approximately 36,000 inhabitants.

**Longitudinal study**

**Record study**

<table>
<thead>
<tr>
<th>Year</th>
<th>Grade 1</th>
<th>Grade 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>453 children</td>
<td>422 children</td>
</tr>
<tr>
<td>CHC</td>
<td>4-year 5.5-year screening</td>
<td>442 children</td>
</tr>
</tbody>
</table>

**Cross-sectional study**

in grade 4 (n=577)

Figure 6. Study design and data collection

**First data collection (Studies II – IV)**

*7-year-olds in first grade*

The first data collection (Studies II – IV) was performed in first grade during the academic year 1998-1999 (Figure 5 and 6). The entire population of children born in 1991 comprised 536 children (265 girls, 271 boys). At school entry in first grade, the whole population was screened for developmental and behavioural problems by parent and teacher reporting in a questionnaire in connection with a routine health examination. Children from all schools in the municipality (17 community-run and 2 private schools comprising four special and 40 mainstream classes) participated in the screening programme. Questionnaires from 87% of the parents and 85% of the teachers were returned.

**Second data collection (Studies I – IV)**

*10-year-olds in grade 4 and grade 3*

The second data collection (Studies I – IV) was performed in grade four during the academic year 2001-2002. The entire population comprised all 577 children (282 girls, 295 boys) in fourth grade (20 born in 1990, 539 born
in 1991, 18 born in 1992). Another 14 children born in 1991 (2 girls, 12 boys) who had repeated one grade and; thus, were in third grade, had participated in the first data collection and were added to the cohort. In connection with the routine health examination in fourth grade the total population was screened for behaviour and attention problems using parent and teacher questionnaires. Information about health complaints and bullying was collected from the children themselves in a classroom study.

All community and private schools participated in the second data collection. The children attended 33 different classes, 5 of which were for children needing special education; 3 groups for children with learning difficulties (MMR or “slow learners”), one for children with externalising behavioural problems, and one for children diagnosed with autism spectrum disorders. All 37 teachers, (36 female, 1 male) participated in the data collection. Their mean age was 44 years (range 25–61) and they had long teaching experience (mean 16 years, range 1–40 years). Most of the teachers had worked for several years in the present school (mean 8 years, range 1-33 years).

Questionnaires from 92% of the parents, 94% of the children and from all teachers were returned. We thereby had complete ADHD screening data from two settings (home and school) for 92% (544/591) of the whole population.

One hundred and seventy-four children were screen-positive (Figure 7 and Table 6). Of these, 159 (91%) agreed to participate in a further clinical diagnostic assessment for ADHD based on DSM-IV (APA, 1994). Psychological examinations were performed in 137 children (79% of all screen-positives).

Third data collection (Study III)
5.5-year-olds at CHC

Results from developmental examinations at 4 and 5.5 years of age were collected retrospectively from the child's health (CH) record from CHCs for the whole population (all children in grade 4 and the 14 children in grade 3) in connection with the routine health examination in fourth grade. The CHC records had been sent to the school nurse at the time of the child's school start with parental consent. The children had been assessed at five different CHCs by 11 different nurses and 11 general practitioners in the municipality.
Final study populations

**Studies I and II**

The entire study population comprised all 577 children (282 girls, 295 boys) in fourth grade (20 born in 1990, 539 born in 1991, 18 born in 1992) during the academic year 2001–2002. Complete screening information was obtained from teachers and parents for 530 children. The 516 children (89.4% of all fourth-graders), 252 girls and 264 boys, for whom there was information from all three data sources: parent, teacher and child, were included in the final study population. The 14 children who had repeated one grade were not included in these studies. One hundred and sixty children were screen-positive (Figure 8 and Table 6). Of these, 145 (91%) agreed to participate in the clinical diagnostic assessments for ADHD and cognitive assessment was performed in 124 children (78% of all screen-positives).

In Study II, ratings of hyperactive behaviour by parents collected at the first data collection in 1998 at school entry early in first grade were available for 382 of the 516 children in the study population and were added to the data set for part of the analyses.
Study III

5.5-year-olds

The entire population of children born in 1991 comprised 553 children during the academic year 2001–2002; 539 children (272 boys, 276 girls) in grade four, and 14 children (12 boys, 2 girls) in grade three. Children in grade four born in 1990 or 1992 were not included. Complete screening information was obtained from teachers and parents for 506 children. Test results from 5.5 years of age (range 63-75 months) were available for 92% (466/506) of the children; 11 were not living in Sweden at 5.5 years of age, 18 CHC records were missing, 5 parents declined examination and 6 children were never invited for assessment at the CHC. In order to minimise the effect of age variance on the screening result, only records with test results from 5.5 years (66 months) ± 3 months of age were included. Thereby, 442 children (80% of the entire population; 213 girls, 229 boys) for whom there was information from all three data sources were included in the final study population for analysis of the screening result. Results from the language screening at 4 years +/- 3 months were available for 419 children.

In the study population of 442 children, 126 were screen-positive (Figure 9 and Table 6), 118 (94%) were clinically assessed and 101 (80% of the screen-positives) participated in the cognitive examination.

Data from screening in first grade (the first data collection during the academic year 1998–1999) were included in Study III. The final study population for this part of the analysis is the same as the study population in Study IV (Figure 10).
Studies III and IV

7- year-olds

Study IV started by the first data collection during the academic year 1998–1999. The entire population of children born 1991 comprised 536 children, 265 girls, 271 boys, in first grade. Complete screening information was obtained from parents and teachers for 453 children (84.5%). The study population was followed up during the academic year 2001–2002 in grade four. Nine children had repeated one grade and were in grade three. Thirty-one children had moved from the municipality and were not included in the study population in grade four. Thereby, 422 children (76% of the entire population born in 1991; 204 girls, 218 boys) for whom there was information from parents and teachers in grade one and grade four were included in the final study population for the analysis of the screening result for first-graders in Studies III and IV.

In grade four, 126 children were screen-positive (Figure 10 and Table 6). Of these, 118 (94%) agreed to participate in the clinical diagnostic assessments for ADHD and 94 children (75% of all screen-positives) were examined by the psychologist.
Table 6 provides an overview of the study populations, results of screening for ADHD symptoms and clinical assessment in grade four in the different studies.

Table 6. Study populations and ADHD-categories in fourth grade in Studies I-IV

<table>
<thead>
<tr>
<th>Study</th>
<th>Total N</th>
<th>Screen Positive n (%</th>
<th>Clinically assessed n (%)</th>
<th>No ADHD n (%)</th>
<th>Subthresh ADHD n (%)</th>
<th>Situational ADHD n (%)</th>
<th>Pervasive ADHD n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study I and II</td>
<td>516</td>
<td>160 (31)</td>
<td>145 (28)</td>
<td>420 (81)</td>
<td>35 (7)</td>
<td>32 (6)</td>
<td>29 (6)</td>
</tr>
<tr>
<td>Study III 5.5-year-olds</td>
<td>442</td>
<td>126 (29)</td>
<td>118 (27)</td>
<td>356 (81)</td>
<td>30 (7)</td>
<td>31 (7)</td>
<td>25 (5)</td>
</tr>
<tr>
<td>Study III 7-year-olds</td>
<td>422</td>
<td>117 (28)</td>
<td>108 (26)</td>
<td>344 (82)</td>
<td>29 (7)</td>
<td>25 (6)</td>
<td>24 (5)</td>
</tr>
<tr>
<td>Study IV</td>
<td>422</td>
<td>117 (28)</td>
<td>108 (26)</td>
<td>344 (82)</td>
<td>29 (7)</td>
<td>25 (6)</td>
<td>24 (5)</td>
</tr>
</tbody>
</table>

Procedures

Implementation

This study was launched within a routine School Health framework. The research project was initiated by presenting the purpose, background and aims to local school politicians, school leaders, headmasters, and administrators responsible for the funding of educational support. According to the project plan, about 500 children would be screened for behaviour and school problems in grade one and four, and there might be a possibility that the
project would reveal an increased need for educational adjustment and support. On the other hand, through the study, many children would be offered evaluation by a paediatrician with experience of developmental disorders and psychological assessment, without any cost to the school. The whole project was sanctioned by the school authorities. The fact that ethical approval for the study was granted by the ethics committee at Karolinska Institutet, Stockholm, was interpreted as a “guarantee” of the qualification and significance of this research.

In the second step, information about the project was given to and approval sought from all class teachers who would be involved, school health personnel, school psychologists and school social workers, staff at the CHCs and other health staff in the community working with children. Most of the information was provided orally through personal contacts. The class teachers also received written information about the project at the same time as the teachers’ questionnaires were distributed.

Finally, all parents were invited to participate through information letters. In connection with the second round of data collection, the project leader participated in a school meeting for parents in the low-income area of the community with a high prevalence of foreign-born parents and low Swedish reading skills. This was a good opportunity to give complementary oral information and to answer questions.

During the academic year 2001/2002, when the screening and clinical assessment of ADHD in grade four was carried out, KH was working as a school physician for all children in fourth grade in the municipality and handled all medical problems revealed in connection with the routine health examination in grade four that was carried out by the school nurse.

Case-finding procedure (Studies I – IV)

10-year-olds in fourth grade

Step 1. Screening

The school nurse at each school distributed letters of information and study questionnaires together with an information letter about the child's health examination in grade four to the parents through the class teachers. Parents were informed that the teachers would complete a questionnaire similar to the parent's version about the child's behaviour and attention capacity. The school nurse also distributed written information to all teachers and the teachers' questionnaires. All completed questionnaires were sent directly to the project leader (KH).

Parent questionnaire

The parent questionnaire included (a) the Conners 10-item scale (Conners, 1973), (b) the executive functions screening scale (EFSS) (the scales are
presented in Appendix II and III), and (c) some questions about the socio-demographic characteristics of the household.

The EFSS consisted of 17 items pertaining to slow behaviour, learning difficulties and problems related to concentration and problem-solving (Ek et al., 2004). A cut-off score of 17 was used on this scale, which has a range of 0 to 51, to obtain a total of 30% of screen-positive children in the study population. Parent questionnaires were returned for 91.9% of the children.

**Teacher questionnaire**
The questionnaire comprised (a) The Conners 10-item scale, (b) the EFSS, and (c) the ADHD rating scale—IV according to DSM-IV (APA, 1994; DuPaul et al., 1998). All teachers were also interviewed by KH regarding the children’s learning and behaviour problems. Information from the teachers was received for all children in the study.

**Step 2. Clinical assessment**
A score of at least 10 (possible range of scores 0–30) on the Conners scale was used as the cut-off point indicating behavioural problems, as suggested by earlier studies (Kadesjö and Gillberg, 1998; Landgren et al., 1996). In the grade four cohort, 10.2% scored above the cut-off point in the parent reports and 13.4% in the teacher reports.

In the EFSS a score of at least 17 (possible range of scores 0–51) indicated behavioural problems, learning problems, or both (Ek et al., 2004). At this cut-off point, 10.5% and 16.8% of the children had such problems according to the assessments by the parents and teachers, respectively.

Children were considered for inclusion in the clinical part of the study according to the following criteria: 1) ratings above the cut-off points on at least two questionnaires, 2) a rating above the cut-off point on at least one questionnaire in combination with significant problems reported by the teacher, such as a known developmental disorder or if the child had had to repeat a grade. Pervasiveness of symptoms was not required for being screen-positive.

On the basis of these inclusion criteria, 160 children were screen-positive. Of these, 145 (91%) agreed to participate in a clinical assessment by KH at the school health office. All parents were interviewed using the same semi-structured diagnostic interview about their children (with the child present), including medical, developmental and behavioural history; duration, severity and pervasiveness of ADHD core symptoms, impairment caused by symptoms, associated functional difficulties (e.g., educational and social difficulties), and symptoms of comorbidity. The parent completed the ADHD rating scale—IV (DuPaul et al., 1998) towards the end of the interview.

A child was considered socially or academically impaired by ADHD if the symptoms interfered with daily life activities according to the teacher and parent interviews. Information about ADHD-related symptoms present before the age of 7 was collected from CHC records and parent interviews.
If medical need or developmental deviations were present, the child was examined.

The parents were offered a psychological examination of their child, including a cognitive assessment according to the WISC III (Wechsler, 1999). Psychological examinations were performed in 112 children. Another 12 children had previously (within the past 2 years) been assessed by a psychologist and were therefore not re-tested. These results were retrieved with parental consent. Twenty-one children did not participate in the examination by the psychologist. The reason for this attrition was either the parents’ language problems or that the parent could not be motivated to let their child participate in the cognitive assessment. Thus, cognitive data from 124 children were available. All parents were later invited back to receive feedback on their child’s test results and to discuss possible further interventions.

Clinical outcomes
ADHD symptoms were categorised based on the interviews with parents and teachers and results from the ratings on the ADHD rating scale—IV. Each DSM-IV criterion was checked to be met by the clinician. The four categories “pervasive ADHD,” “situational ADHD,” “subthreshold ADHD,” and “no ADHD” were classified at the time of the clinical assessment according to the following criteria:

1 “Pervasive ADHD” – children who met the criteria for ADHD according to the DSM-IV (six or more inattentive symptoms, six or more hyperactive-impulsive symptoms, or both) at home according to the parent and at school according to the teacher, with some impairment from the symptoms in both settings.

2 “Situational ADHD” – children who met the criteria for ADHD either at home according to the parent but not according to the teacher (home only ADHD), or at school according to the teacher but not according to the parents (school only ADHD) and with no reported impairment from the symptoms in the other setting (Buitelaar and Engeland, 1996; Ho et al., 1996; Mannuzza et al., 2002).

3 “Subthreshold ADHD” – children with four or five inattentive symptoms, four or five hyperactive-impulsive symptoms or both, at home, at school, or both at home and at school (AAP, 1997).

4 “No ADHD” – all other children, including those who were not selected for clinical assessment.

Information was collected about ADHD, Autistic spectrum disorder/Asperger syndrome, DAMP and Tourette syndrome having been diagnosed by other physicians previous to grade four. Co-occurring ADHD symptoms in these disorders were assessed and classified in the same way as for the rest of the population.
Attention and hyperactivity symptoms in the screen-positive children who did not participate in the clinical examination were assessed by information from parent and teacher questionnaires, teacher interviews, school nurses, and telephone interviews with parents. None of the children who dropped out was judged to have severe behavioural or attention problems and were therefore included in the study population in the “no ADHD” group.

No children were clinically diagnosed in the project. If the threshold for a diagnosis was met, parents were informed that referral for further evaluation by the multi-professional team in the community was recommended. The clinician (KH) made this referral after having obtained parental consent. Class teachers and headmasters were informed after agreement with parents if the child needed further educational evaluation and support.

Child questionnaire (Studies I and II)
Information about health complaints and bullying behaviour was collected from the children themselves in a classroom study. All information was collected in the same survey. The questionnaire was administered by the school nurse who gave oral information about the questionnaire and stayed in the classroom to answer any questions while the children completed the questionnaire. Children who were absent from school at the time of the data collection were approached by the school nurse within the next few weeks and given a second opportunity to fill in the questionnaire. In total, questionnaires from 97% of the children were returned.

Screening - Predictors of ADHD (Studies III and IV)
4 and 5.5 years of age
The children had participated in the routine health screening programme at CHC.

7 years of age in first grade
At school entry into first grade the whole population was screened for developmental and behavioural problems by parental report in a questionnaire in connection with the routine school health examination. Seven months into the school year, the same questionnaire was completed by the child's main teacher. The letters of information and study questionnaires to parents and teachers were distributed and retrieved in the same way as in step 1 in the case-finding procedure in grade four.
The parent questionnaire included the Conners 10-item scale (Conners, 1990a; Conners, 1973), the Parent Psychomotor Questionnaire (PPQ) (Landgren et al., 1996; Rasmussen and Gillberg, 1983) and some questions about the socio-demographic characteristics of the household. The teacher questionnaire comprised the Conners 10-item scale and four items pertaining to the child’s psychomotor development. Questionnaires were returned from 87% of the parents and 85% of the teachers.

Measures

Table 7. Outcome variables and measures in this thesis

<table>
<thead>
<tr>
<th>Study</th>
<th>Age (years)</th>
<th>Outcome variable</th>
<th>Measure</th>
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</thead>
<tbody>
<tr>
<td>Studies I - IV</td>
<td>10</td>
<td>ADHD category</td>
<td>Conners 10-item scale</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>EFSS</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>ADHD rating scale—IV</td>
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<td></td>
<td></td>
<td></td>
<td>Parent questionnaire</td>
</tr>
<tr>
<td>Study I</td>
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<td>Socio-demographic data</td>
<td>HBSC</td>
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<tr>
<td></td>
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<td>Headache</td>
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<td>Sleeping problems</td>
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<td></td>
<td>Day tiredness</td>
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<td>Study II</td>
<td>10</td>
<td>Bullying peers</td>
<td>HBSC</td>
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<td>Conners 10-item scale</td>
</tr>
<tr>
<td>Study III</td>
<td>5.5</td>
<td>Motor deviation</td>
<td>9-item motor-perceptual test</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td></td>
<td>Screening or referral to speech pathologist</td>
</tr>
<tr>
<td></td>
<td>5.5</td>
<td>Language delay</td>
<td>PPQ</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Developmental deviation</td>
<td>Teacher psychomotor questionnaire</td>
</tr>
<tr>
<td>Study IV</td>
<td>7</td>
<td>Hyperactive behaviour</td>
<td>Conners 10 item scale</td>
</tr>
</tbody>
</table>

Socio-demographic characteristics

The parent questionnaire in first grade included socio-demographic questions, including the sex of the child, maternal country of birth, and maternal educational level. Educational level was recorded in three categories: 9 years or less of basic education, more than 9 years of basic education but less than 3 years of university education, and 3 or more years of university education. Maternal country of birth was recorded as Sweden, other Nordic countries, other European countries, and the rest of the world.
Information about the child's day care (at home or in a preschool facility) was collected (Study III).

The Conners 10-item scale

The parent and teacher questionnaire included the Conners 10-item scale (Conners, 1990a; Conners, 1973). The Conners 10-item scale is a well validated, reliable instrument with excellent test-retest reliability (Barkley, 1988; Goyette et al., 1978; Parker et al., 1996; Rowe and Rowe, 1997; Sprague et al., 1974), and a frequently used screening instrument for behavioural problems related to hyperactivity/impulsivity and emotional lability in both preschool and school-age children. It is adequate for screening, but not as a specific tool for diagnosing ADHD (Conners, 1994).

This scale consists of ten statements regarding the child's behaviour rated on a 4-point Likert scale, ranging from “0 – not at all true” to “3 – very much true,” with a possible total score from 0 to 30 (Conners, 1990a). The scale is obtained from the 10 overlapping parent and teacher items constituting the Hyperactivity Index (HI) from longer versions of the Conners scales; the Revised Conners Parent and Teacher Scale (CPRS-R and CTRS-R) (Goyette et al., 1978). The 10-item scale is known as The Abbreviated Conners Rating Scales for parents (CPRS-HI) and teachers (CTRS-HI) (Conners, 1990a) and also as the Abbreviated Symptom Questionnaire-Parent/Teacher (ASQ-P/T) (Conners, 1973; Conners, 1990b).

A score of at least 10 has been recommended to identify attention deficits (Ullmann et al., 1985), while a score of 15 or higher, representing 2 standard deviations above the overall mean for the scale, has been the standard for selecting children with hyperactivity at a level of clinical concern (Conners, 1994; Rowe and Rowe, 1997; Ullmann et al., 1985).

The instrument is widely used in Sweden and has been validated in previous population-based studies of ADHD in 6 to 7-year-olds applying a cut-off score of at least 10 (Kadesjö and Gillberg, 1998; Landgren et al., 1996). Recent analyses from the present study population demonstrate that this scale discriminated very well between ADHD and no ADHD (Westerlund et al., 2009).

In the screening using the Conners scale in first grade (Studies II and IV), a parent score of 10 was equivalent to the 93rd percentile, and the 88th percentile for teacher ratings of at least 10. A parent Conner score of 12 and a teacher Conner score of 15 of would have corresponded to the 95th percentile.

In the study population in grade four (Studies I – IV), a score of 10 was equivalent to the 89th percentile in parents ratings and the 86th percentile in teachers ratings. A parent Conner score of 16 and a teacher Conner score of 19 of would have corresponded to the 95th percentile.
The executive functions screening scale (EFSS) was designed especially for this study to improve the possibility to identify children with mainly attention problems. There is evidence that the Conners 10-item scale is efficient at selecting children with hyperactivity, but may fail to select children with mainly inattentiveness (Rowe and Rowe, 1997; Ullmann et al., 1985). The EFSS consists of 17 items pertaining to executive functions such as slow behaviour, problems related to concentration and problem-solving, and learning difficulties (Ek et al., 2004). Similar to the Conners scale, the child's functioning is rated on a 4-point Likert scale, ranging from “0 – not at all true” to “3 – very much true,” with a possible total score from 0 to 51. A cut-off score of 17 was used on this scale, which has a range of 0 to 51, to obtain a total of 30% of screen-positive children in the study population.

The scale is not a “pure” EF measure but rather reflects children's overall cognitive problems, including executive difficulties. This scale has not been validated, so no systematic psychometric data exist for this scale. A parent EFSS score of 17 was equivalent to the 89th percentile, and the 84th percentile for teacher ratings of at least 17. A parent EFSS score of 25 and a teacher EFSS score of 27 of would have corresponded to the 95th percentile.

The ADHD rating scale—IV

Teachers rated symptoms of ADHD on a scale based on the DSM-IV diagnostic criteria for ADHD (DuPaul et al., 1998) as a part of the teacher questionnaire in grade four. Parents completed the same scale during the clinical evaluation of the screen-positive children.

The ADHD rating scale—IV consists of 18 items (i.e., statements) which correspond to all 18 of the DSM-IV criteria: 9 items indicating inattention; 6 items pertaining to hyperactivity, and 3 items related to impulsivity. A parent or a teacher rates the child’s behaviour on each item on a 4-point Likert scale, ranging from “0 – not at all true” to “3 – very much true.” Scores of 2 or 3 (indicating that a behaviour is present “often” or “very often”) on individual items were considered to indicate the presence of ADHD symptoms, thereby creating dichotomised outcome variables for each statement.

This scale has been validated (DuPaul et al., 1998; Magnusson et al., 1999) and is widely used in Sweden for rating of ADHD severity (Diamantopoulou et al., 2005; Kadesj, 2002). The scale has demonstrated excellent interrater reliability, also when applied as a standardised interview schedule (Landgren et al., 2000; Landgren et al., 1996; Thunström, 2002).

The total score on each dimension of symptoms was calculated by adding up the scores for each of the 9 inattentive items and the 9 hyperactive/impulsive items. The result was included in the clinical evaluation of ADHD and the classification of four levels of symptom severity.
HBSC – health complaints

Health complaints were measured by a child questionnaire that included four items from the questionnaire used in the WHO study “Health Behaviour in School-aged Children” (HBSC): headache, abdominal pain, difficulty of falling asleep and day tiredness (Danielsson, 2003; Due et al., 2003; Östberg, 2001a). These questions have been reported to have adequate face validity and test-retest reliability (Haugland and Wold, 2001). The frequency of symptoms was classified on four levels (never, once a month, once a week, daily) as suggested by Hagquist (Hagquist and Andrich, 2004).

Dichotomised outcome variables of health complaints were created by defining symptoms present at least once a week as “yes” and all other symptoms as “no.” Day tiredness was defined as “yes” only if present every day as weekly tiredness was very common (prevalence 51%).

Bullying

Bullying behaviour was explored by two items in the HBSC from the World Health Organisation study Health Behaviour in School-aged Children: (Danielsson, 2003; Due et al., 2005; Due et al., 2003; Östberg, 2001a). Two questions about bullying were asked in a section of the questionnaire that dealt with the school environment. In the questionnaire, the question “Have you bullied anyone?” was followed by “Have you yourself been bullied at school?”

The four-category responses were dichotomised with “often,” “very often” and “sometimes” as yes for bullies, as there was only one child who reported bullying often. Being bullied was coded into three categories; (1) often being bullied for those reporting often and very often; (2) sometimes being bullied; and (3) never bullied (Due et al., 2003; Östberg, 2001a).

Developmental screening

The screening procedures were a part of the child health surveillance programme and were identical for all children in the study.

4 years of age

1. A motor-perceptual examination including six items rated on a scale of normal/abnormal; (i) two motor tasks: Balance - walk on a line, Jump on one leg; (ii) three perception tasks: Count three objects, Draw a cross, Draw a man.
2. Assessment of language rated on a scale of normal/abnormal.

The screening was performed by the nurse at the CHC.
5.5 years of age

Nine items according to the Manual for the CHS in Stockholm County (Stockholms läns landsting 1991) at the time of the study rated on a scale of normal/abnormal; (1) four motor tasks: Cut a paper circle, Stand on one leg for 12 seconds, Jump on one leg 10 times, Associated movements when walking on lateral sides of feet for 10 seconds (Fog's test); (2) five visuo-motor integration / perceptual motor tasks: Draw a man, Draw a circle, Draw a square, Draw a triangle and Write one's name.

All screening tests were performed by the nurse at the CHC as a part of the routine developmental screening, except the last three motor tests (stand and jump one leg, and Fog's test) which were examined by the physician at the CHC (a general practitioner). At the time of the study, no structured parent interview was recorded in the CH record and no preschool questionnaire was in use in Stockholm County.

Screening for language problems was not included in the test for 5.5 year-olds. Information about all referrals to the speech pathologist or the local paediatrician or child psychologist for further evaluation registered in the CH record was collected. Information about the child’s day care (at home or in a preschool facility) was also collected.

The four motor tasks (cut a circle, stand and jump on one leg, and Fog's test) are included in the 6-item method suggested by Gillberg et al. This method was validated in a population-based group of 7-year-olds with symptoms of attention deficit, in combination with problems of motor control and perception according to a preschool teacher report (Rasmussen et al., 1983). Children with mental retardation were excluded. The interrater and test-retest reliability was good to excellent (Gillberg et al., 1983; Gillberg, 1985). All perceptual motor tasks, with the exception of “write one’s name”, have been demonstrated to have high discriminating capacity for DAMP (Gillberg et al., 1993; Landgren et al., 2000; Rasmussen et al., 1983). The three items draw a circle, draw a square, and draw a triangle are included in the Design Copying Visuomotor Test developed by Rasmussen et al. This test has been added to the 6 motor items as a part of the neurological screening for DAMP (Rasmussen et al., 1983).

Neither the Swedish National Board of Health and Welfare, nor the national or local CHS manual recommended any special cut-off score as an indication of DAMP at the time of the CHC examination of the children in the study population (Stockholms läns landsting 1991; Swedish National Board of Health and Welfare 1991; Swedish National Board of Health and Welfare 1981). In former Swedish studies using the 6-item scale in 5.5 to 7-year-olds suggested by Gillberg et al., at least two (Bondestam et al., 1992; Gillberg et al., 1983; Rydell et al., 1991) or at least three deviations (Gillberg et al., 1983; Gillberg et al., 1993; Landgren et al., 1996; Larsson et al., 1995; Thunström, 2002) have been applied as an index for DAMP/ADHD if there
was no other information about developmental deviation from a parent or preschool teacher. In a modified version of this method comprising 9 items, a cut-off score of two was found to be appropriate (Landgren et al., 2000).

According to the guidelines for the new national CH records from 2000, children with at least two positive tests out of seven possible positives should be referred for further evaluation (Swedish National Board of Health and Welfare, 2000). In the present manual (available on www.growingpeople.se), deviation in three of five motor tasks is considered as a screen-positive result if there are no reports on developmental problems at home or in the preschool setting. The 2000 CHS manual for Stockholm County recommended a cut-off score of at least 3 failures of the 9 items included in the present study as a possible index of DAMP or mental retardation (Stockholms läns landsting, 2000).

7 years of age

**Parent psychomotor questionnaire (PPQ)**

At school entry into first grade, the parents completed the Parent psychomotor questionnaire (PPQ) developed by Rasmussen and Gillberg. The questionnaire has been validated in seven-year-olds without mental retardation being screen-positive on the preschool teacher questionnaire as the motor screening method. The PPQ was suggested as an instrument for detection of attention and motor-perceptual problems at school entry (Gillberg et al., 1993; Rasmussen and Gillberg, 1983). The original version contained 6 items, but a shorter version with 4 questions has been applied in later research (Landgren et al., 1996). These questions pertain to the child's speech development, general motor development, gross motor and fine motor control and are rated on a four-point scale (early, average, somewhat late, very late). The criterion for developmental deviation (being screen-positive) was a score of “somewhat late” or “very late,” as suggested by Landgren et al. (Landgren et al., 1996). Gillberg and Rasmussen recommended to use at least one abnormal score as an indication of DAMP (Gillberg and Rasmussen, 1982b; Rasmussen and Gillberg, 1983). This criterion level has been validated in studies of Swedish 5.5 to 7 year-old children using PPQ as a screening instrument for DAMP/ADHD (Landgren et al., 1996; Rasmussen and Gillberg, 1983; Thunström, 2002).

**Teacher psychomotor questionnaire**

Seven months after school entry, the teacher completed a questionnaire consisting of four items pertaining to the child's attentional and language capacity and gross motor and fine motor control, rated on the same four-point scale as PPQ. The criterion for developmental deviation (being screen-positive) was at least one abnormal score. This teacher questionnaire is a shorter version of the 6-item Preschool Questionnaire (PSQ), demonstrating good interrater reliability and construct validity in 7-year-olds without mental retardation according to Gillberg and Rasmussen (Gillberg and Rasmussen, 1982a). The two questions about perceptual-conceptual capacity were
not included in our version. The PSQ has been used in previous Swedish studies of 5.5 to 6-year-olds using at least one abnormal score as an indication of DAMP/ADHD (Landgren et al., 1996; Thunström, 2002) as suggested by Gillberg and Rasmussen (Gillberg and Rasmussen, 1982b).

**Statistical Analyses**

Data are presented as percentages for categorical variables. Chi-square analyses (Pearson's chi-square or Fisher's exact test) were used in the bivariate analyses (Studies I – IV).

Associations of dichotomised outcome variables of health complaints, with the categories “pervasive ADHD” and “situational ADHD” collapsed into a single category, were tested in a stratified analysis adjusted for gender and parental educational level using the Mantel-Haenzel procedure (Rothman and Greenland, 1998) (Study I).

Somer's D directional ordinal analysis was used to test whether increasing severity of ADHD symptoms was associated with increasing frequency of bullying and/or being bullied in cross-tabulations of these variables (Study II). The single category ADHD variable that consisted of “pervasive ADHD” and “situational ADHD” collapsed into a single category was used as the dependent variable in logistic regression analyses, with the bullying variables, adjusted for sex and parental educational level, as possible confounders.

Relationships between parents' and teachers' ratings were assessed using the Pearson product moment correlation coefficient for developmental deviation (Study III) and Spearman's rank correlation for total Conners scores (Study IV).

Mann-Whitney U tests were used to test associations of total Conners scores and ADHD categories as well as socio-demographic indicators (Study IV).

The sensitivity, specificity and positive predictive value of screen-positive variables with the two categories “pervasive ADHD” and “situational ADHD” and the third category ADHD variable that consisted of “pervasive ADHD” and/or “situational ADHD,” were calculated for increasing number of developmental deviations (Study III) or high or low levels of the cut-off score on the Conners scale (Study IV).

All statistics were analysed using the Statistical Package for the Social Sciences (SPSS) version 13.0 – 15.0 for Windows, except the Mantel-Haenzel procedure which was carried out using the SAS 8.0 software package for Windows.
Ethical considerations

The individuals participated voluntarily, according to the Declaration of Helsinki. Parents and teachers were given written information about the studies in first and fourth grade. Oral information was given to all teachers in grade 4, as well as the children who were assessed clinically and their parents at the time of the interview in grade 4. Informed consent was obtained from parents. Ethical approval for the study was granted by the ethics committee at Karolinska Hospital, Stockholm.

Headmasters and school health staff were informed about the study and the possibility that children needing extra educational or psychosocial support might be detected.
Results

Screening for ADHD (Studies I-IV)
The entire population that was screened and assessed for ADHD symptoms comprised all 577 children (282 girls, 295 boys) in fourth grade (20 born in 1990, 539 born in 1991, 18 born in 1992). Another 14 children born in 1991 (2 girls, 12 boys) who had repeated one grade and, thus, were in third grade, were also screened, as they had participated in the data collection in first grade. Complete screening information was obtained from teachers and parents for 544 children.

Figure 11 provides an overview of the distribution of the screening results on the Conners and EFSS scales in the total population. A score of at least 10 on the Conners scale was used as the cut-off point indicating behavioural problems. In this cohort, 12.8% scored above the cut-off point in the parent reports and 14.7% in the teacher reports. In the EFSS a score of at least 17 indicated behavioural problems, learning problems, or both. At this cut-off, 12.5% and 17.7% of the children had such problems according to the parents' and teachers' ratings, respectively.

In the population screened in grade four, 422 children had been screened using the Conners scale in first grade. At seven years of age, 8.3% and 12.3% were reported to have a score of at least 10 according to parents and teachers, respectively. The correlation between the parents' ratings in first and fourth grade was moderate (Spearman's $r = .56$). The interrater agreement for teachers' reports was similar ($r = .50$), although the children were rated by different teachers in first and fourth grade.

In grade three, two children were diagnosed as having ADHD/DAMP prior to the study. In grade four, 17 children had been diagnosed with a neuropsychiatric diagnosis prior to the screening: 11 ADHD, 2 DAMP, 3 Asperger/autism, 1 Tourette. Four boys were treated with stimulants and only these children were followed up by physician on a regular basis.

Special educational support was provided in Swedish, English or maths to 18% of all children in grade four (students in remedial classes not included). Among children in grade four, 4% (22/577) of the children were educated in remedial class (Table 8).
The prevalence of the complete (pervasive) ADHD syndrome in the total cohort was 6.1% (n=36, 6 girls and 30 boys; p<0.001) (Table 8).

Five (14%) children in the pervasive ADHD group (n=36) received remedial class education. In the psychological examination, 47% (n=17) had low cognitive scores (IQ<85), and two of the children had IQ<71.

Table 8. Crude rates of sex, ADHD category and special education in grade 3 and 4

<table>
<thead>
<tr>
<th></th>
<th>Grade 3 (n=14)</th>
<th>Grade 4 (n=577)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>12 (86)</td>
<td>282 (49)</td>
</tr>
<tr>
<td>Girls</td>
<td>2 (14)</td>
<td>295 (51)</td>
</tr>
<tr>
<td><strong>ADHD category</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No ADHD</td>
<td>2 (14)</td>
<td>472 (82)</td>
</tr>
<tr>
<td>Subthreshold ADHD</td>
<td>4 (29)</td>
<td>36 (6)</td>
</tr>
<tr>
<td>Situational ADHD</td>
<td>5 (36)</td>
<td>36 (6)</td>
</tr>
<tr>
<td>Pervasive ADHD</td>
<td>3 (21)</td>
<td>33 (6)</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remedial class</td>
<td>1 (17)</td>
<td>22 (4)</td>
</tr>
<tr>
<td>Regular class</td>
<td>13 (83)</td>
<td>555 (96)</td>
</tr>
</tbody>
</table>

ADHD, attention-deficit/hyperactivity disorder.
Health complaints (Study I)

The overall prevalence of health complaints reported by the 516 children surveyed in grade four is illustrated in Figure 12.

Girls tended to have a slightly higher prevalence of recurrent headache, RAP, and sleep disturbances (see Study I, reprint: Table 2). The 21 children educated in small groups tended to report fewer health complaints per week than the other children. Only 14% of the children in small classes reported two or more health complaints, while 57% reported at least one. The corresponding prevalence for children in normal classes was 34% and 60%.

Prevalence of ADHD (Studies I and II)

The overall prevalence of the complete (pervasive) ADHD syndrome was 5.6% (29/516); 75.9% (22/29) had the combined type, 20.7% (6/29) the inattentive type, and 3.4% (1/29) were hyperactive-impulsive according to the DSM-IV (APA 1994). Both “pervasive” and “situational ADHD” were more common in boys than in girls (boys: 18.2% and girls: 5.2%; $p<0.001$) and in children from households where the parents had poor education (ADHD 18.8%), compared with households where the parents had a university education (8.1%) ($p<0.05$). There were no major differences in the prevalence of ADHD in children from foreign-born and Swedish-born parents (See Study I, reprint: Table 1).

The category “situational ADHD” comprised children whose assessments by the parents and the teacher differed strongly. In this group, 78% (25/32)
fulfilled the DSM-IV criteria at school (school only ADHD) and had only a few symptoms at home, while 22% (7/32) had ADHD symptoms according to the parent and no impairment at school (home only ADHD). Six of the 69 (9%) children in the pervasive or situational ADHD group were in a special class.

Psychosomatic symptoms in ADHD

Children in the pervasive and situational ADHD group in grade four reported RAP, sleeping problems and day tiredness about twice as often as other children. (p<0.001) (Figure 13). The risk increase was similar in children who fulfilled the ADHD criteria in one or two settings (home and school) (See Study I, reprint: Table III).

![Figure 13. Proportions of children reporting health complaints at least once a week (day tiredness daily) in relation to ADHD diagnosis (pervasive or situational); ** p < 0.01, *** p < 0.001](image)

In the stratified analysis, the relative risk of ADHD for health complaints decreased only marginally when adjustment was made for parental education (Table 9).

Children with ADHD and low cognitive test scores (IQ<85) tended to report at least one health complaint slightly less often (70%) than children with ADHD and a test score in the normal range (IQ>85) (84%). In the group
with normal test scores, children with ADHD had a higher prevalence of health complaints than children without ADHD ($p<0.001$). This was not seen in the group with low test scores.

Table 9. Stratified analyses of health complaints and pervasive or situational ADHD in the fourth grade (N=516) (See Study I, reprint: Table IV)

<table>
<thead>
<tr>
<th>Health Complaint</th>
<th>Model 1 RR (95% CI)</th>
<th>Model 2 RR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recurrent abdominal pain</td>
<td>2.3 (1.4-3.7)</td>
<td>2.2 (1.4-3.4)</td>
</tr>
<tr>
<td>Headache</td>
<td>1.1 (0.6-1.8)</td>
<td>1.0 (0.6-1.6)</td>
</tr>
<tr>
<td>Sleeping problems</td>
<td>1.8 (1.2-2.9)</td>
<td>1.7 (1.1-2.7)</td>
</tr>
<tr>
<td>Day tiredness</td>
<td>2.9 (1.8-4.6)</td>
<td>2.7 (1.7-4.1)</td>
</tr>
</tbody>
</table>

Model 1 is crude.
Model 2 is adjusted for sex and maternal education.
RR = relative risk; CI = confidence interval.

Byllying (Study II)

Among the children in grade four, 9.1% (47/516) reported that they bullied peers sometimes (Table 10). One child (a girl with no ADHD) was bullying often. Boys were more likely to be bullies (12.1%) than girls (6.3%) ($p<0.05$). Two thirds of the bullies were boys. The prevalence of being bullied sometimes was 17.1% (88/516) and being bullied often was 4.5% (23/516). There were no major differences in the prevalence of being victims between boys and girls.

Table 10. Crude rates of bullying behaviour in grade four

<table>
<thead>
<tr>
<th>Bullying behaviour</th>
<th>Bullies peers n (%)</th>
<th>Bullied by peers n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Never</td>
<td>468 (90.7)</td>
<td>405 (78.5)</td>
</tr>
<tr>
<td>Sometimes</td>
<td>47 (9.1)</td>
<td>88 (17.1)</td>
</tr>
<tr>
<td>Often</td>
<td>1 (0.2)</td>
<td>23 (4.5)</td>
</tr>
</tbody>
</table>

Being a bully was more prevalent among children in special education classes (24%) than in normal classes (9%) ($p<0.05$) (See Study II, reprint: Table I). Reports of being bullied by peers did not vary across educational settings. Nine per cent of the children in small classes were bullied sometimes and 5% were bullied often. The corresponding prevalence for children in normal classes was 17% and 4%. 
Bullying in ADHD

Children diagnosed with situational or pervasive ADHD in fourth grade reported being active bullies about three times as often and being bullied often ten times as often as other children (p<0.001) (Figure 14). The risk increase was similar in children who fulfilled the ADHD criteria in one or two settings (home and school) (See Study II, reprint: Table II) . In the stratified analysis, the relative risk of ADHD for bullying behaviour changed only marginally when parental education was adjusted for (Table 11 and 12).

There was an increased risk of bullying behaviour in ADHD irrespective of low (IQ<85) or normal (IQ≥85) cognitive test results (p<0.05 - 0.001).

![Figure 14. Proportions of children reporting bullying peers or being bullied by peers in relation to ADHD diagnosis; ** p < 0.01, *** p < 0.001](image-url)
Table 11. Logistic regression of bullying peers and pervasive or situational ADHD in the fourth grade (N=516) (See Study II, reprint: Table III)

<table>
<thead>
<tr>
<th></th>
<th>Model 1 OR (95% CI)</th>
<th>Model 2 OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bullying peers; yes</td>
<td>4.2 (2.1-8.2)</td>
<td>3.8 (2.0-7.2)</td>
</tr>
<tr>
<td>Bullying peers; no</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Sex: male</td>
<td>-</td>
<td>1.6 (0.8-3.1)</td>
</tr>
<tr>
<td>Sex: female</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Maternal education: low</td>
<td>-</td>
<td>1.3 (0.6-2.9)</td>
</tr>
<tr>
<td>Maternal education: high</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

CI, confidence interval.

Table 12. Logistic regression of being bullied and pervasive or situational ADHD in the fourth grade (N=516) (See Study II, reprint: Table IV)

<table>
<thead>
<tr>
<th></th>
<th>Model 1 OR (95% CI)</th>
<th>Model 2 OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bullied: often</td>
<td>8.4 (3.4-20.6)</td>
<td>10.8 (4.0-29.0)</td>
</tr>
<tr>
<td>Bullied: sometimes</td>
<td>2.6 (1.4-4.9)</td>
<td>2.9 (1.5-5.7)</td>
</tr>
<tr>
<td>Bullied: never</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Sex: male</td>
<td>-</td>
<td>4.8 (2.4-9.3)</td>
</tr>
<tr>
<td>Sex: female</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>Maternal education: low</td>
<td>-</td>
<td>1.5 (0.6-3.3)</td>
</tr>
<tr>
<td>Maternal education: high</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

CI, confidence interval.

Parental ratings of behavioural problems using the Conners scale at entry into first grade were available for 382 children in the study. High scores (at least 10) on the Conners scale predicted reporting being a bully in fourth grade (p<0.007; See Study II, reprint: Table V), whereas there was no significant association with parental Conners scores and being a victim of bullying in fourth grade (reprint: Table V). There were seven children with situational or pervasive ADHD in fourth grade who reported being bullied often in this subpopulation, five of whom had very low parental Conners scores (no greater than 2) in first grade. Four of these five children continued to have very low Conners scores on parental reports in fourth grade.
Bullying and health complaints

Complementary results

Boys and girls bullying peers were more likely to report tiredness \((p<0.01)\) than other children. Being bullied was associated with an increased prevalence of all kinds of health complaints (Figure 15). There was no specific gender differences.

![Figure 15. Proportions of children reporting health complaints at least once a week (day tiredness daily) in relation to being bullied; ** \(p < 0.01\), *** \(p < 0.001\)](image)

Developmental screening (Study III)

The mean age of all the children at the CHC examination was 66 months. In first grade the mean age was 85 months for parental screening and 92 months for teacher screening. Boys had greater difficulties in fine motor tasks \((p<0.01-0.001)\) than girls.

There was an association between developmental deviations in 5.5-year-olds and teacher ratings of 7-year-olds with a later diagnosis of ADHD at 10 years of age. The positive predictive value of developmental deviations for ADHD was 8-16\%: Fifteen to sixteen per cent of children classified as screen-positive for developmental deviations at the CHC at 5.5 years and 8-11 \% of children with at least one developmental delay in first grade were
diagnosed with ADHD four years later (See Study III, manuscript: Table 3 and Table 4).

The efficiency of the 9 items in the 5.5-year screening at CHC and the 4 items in the parents' and teachers' questionnaires at predicting pervasive ADHD in grade four is presented in Table 13 and Table 14.

Table 13. Crude rates of not passing screening tests at 5.5 years; sensitivity, specificity and positive predictive value in relation to pervasive ADHD in fourth grade

<table>
<thead>
<tr>
<th>Item</th>
<th>No ADHD (n=417)</th>
<th>ADHD (n=25)</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Positive predictive value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Draw a man</td>
<td>40 (10)</td>
<td>7 (28)*</td>
<td>28</td>
<td>90</td>
<td>15</td>
</tr>
<tr>
<td>Draw a circle</td>
<td>18 (4)</td>
<td>1 (4)</td>
<td>4</td>
<td>96</td>
<td>5</td>
</tr>
<tr>
<td>Draw a square</td>
<td>18 (4)</td>
<td>1 (4)</td>
<td>4</td>
<td>96</td>
<td>5</td>
</tr>
<tr>
<td>Draw a triangle</td>
<td>57 (14)</td>
<td>9 (36)*</td>
<td>36</td>
<td>86</td>
<td>14</td>
</tr>
<tr>
<td>Cut a paper circle</td>
<td>32 (8)</td>
<td>6 (24)*</td>
<td>24</td>
<td>92</td>
<td>16</td>
</tr>
<tr>
<td>Write one's name</td>
<td>47 (11)</td>
<td>9 (36)***</td>
<td>36</td>
<td>89</td>
<td>16</td>
</tr>
<tr>
<td>Stand on one leg</td>
<td>28 (7)</td>
<td>3 (13)*</td>
<td>13</td>
<td>93</td>
<td>10</td>
</tr>
<tr>
<td>Jump on one leg</td>
<td>40 (10)</td>
<td>3 (13)*</td>
<td>13</td>
<td>90</td>
<td>7</td>
</tr>
<tr>
<td>Fog's test</td>
<td>18 (43)</td>
<td>1 (4)</td>
<td>4</td>
<td>95</td>
<td>5</td>
</tr>
</tbody>
</table>

* p < 0.05
*** p < 0.001

Table 14. Crude rates of not passing developmental screening tests as 7-year-olds according to parents' and teachers' ratings; sensitivity, specificity and positive predictive value in relation to pervasive or situational ADHD in fourth grade

<table>
<thead>
<tr>
<th>Item</th>
<th>No ADHD (n=417)</th>
<th>ADHD (n=25)</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>Positive predictive value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
<td>%</td>
<td>%</td>
<td>%</td>
</tr>
<tr>
<td>Parent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late speech development</td>
<td>50 (13)</td>
<td>3 (13)</td>
<td>13</td>
<td>87</td>
<td>6</td>
</tr>
<tr>
<td>Late motor development</td>
<td>19 (5)</td>
<td>1 (4)</td>
<td>4</td>
<td>95</td>
<td>5</td>
</tr>
<tr>
<td>Gross motor clumsiness</td>
<td>21 (5)</td>
<td>2 (8)</td>
<td>8</td>
<td>95</td>
<td>9</td>
</tr>
<tr>
<td>Fine motor clumsiness</td>
<td>27 (7)</td>
<td>4 (17)</td>
<td>17</td>
<td>93</td>
<td>13</td>
</tr>
<tr>
<td>Teacher</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Late speech development</td>
<td>54 (14)</td>
<td>3 (13)</td>
<td>13</td>
<td>86</td>
<td>5</td>
</tr>
<tr>
<td>Gross motor clumsiness</td>
<td>77 (19)</td>
<td>10 (42)**</td>
<td>42</td>
<td>81</td>
<td>12</td>
</tr>
<tr>
<td>Fine motor clumsiness</td>
<td>71 (18)</td>
<td>15 (63)***</td>
<td>63</td>
<td>82</td>
<td>17</td>
</tr>
<tr>
<td>Attention problems</td>
<td>76 (19)</td>
<td>14 (58)***</td>
<td>58</td>
<td>81</td>
<td>16</td>
</tr>
</tbody>
</table>

** p < 0.01
*** p < 0.001

ADHD, attention-deficit/hyperactivity disorder.
Combining screening results

Gillberg and Rasmussen recommended a screening method combining motor examination with information about the child's development from parents and preschool teachers for tracing DAMP (Gillberg and Rasmussen, 1982b). This method has been evaluated in previous studies (Bergström et al., 1988; Bondestam et al., 1992; Landgren et al., 1996; Thunström, 2002). We therefore assessed the efficiency of the combination of screening information from all three sources, i.e., CHC, parents and teachers (Table 15). No combination of informant data in grade one or from the CHC resulted in an estimated predictive value above 20%.

Table 15. Crude rates of not passing screening tests as 5.5 or 7-year-olds; sensitivity, specificity and positive predictive value in relation to ADHD in fourth grade

<table>
<thead>
<tr>
<th>Developmental deviation</th>
<th>No ADHD (n=417)</th>
<th>ADHD (n=25)</th>
<th>Sensitivity %</th>
<th>Specificity %</th>
<th>Positive predictive value %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parent 1-4 deviations</td>
<td>84 (21)</td>
<td>7 (29)</td>
<td>29</td>
<td>79</td>
<td>8</td>
</tr>
<tr>
<td>Teacher 1-4 deviations</td>
<td>162 (41)</td>
<td>19(79)***</td>
<td>79</td>
<td>59</td>
<td>11</td>
</tr>
<tr>
<td>P or T 1-4 deviations</td>
<td>188 (47)</td>
<td>19(79)***</td>
<td>79</td>
<td>53</td>
<td>9</td>
</tr>
<tr>
<td>P and T 1-4 deviations</td>
<td>58 (15)</td>
<td>7 (29)</td>
<td>29</td>
<td>85</td>
<td>11</td>
</tr>
<tr>
<td>P or T 1-4 deviations and 1-9 deviations at 5.5 years</td>
<td>71 (21)</td>
<td>13(65)***</td>
<td>65</td>
<td>80</td>
<td>16</td>
</tr>
<tr>
<td>P and T 1-4 deviations and 1-9 deviations at 5.5 years</td>
<td>33 (10)</td>
<td>5 (25)*</td>
<td>25</td>
<td>91</td>
<td>13</td>
</tr>
<tr>
<td>P or T 1-4 deviations and 2-9 deviations at 5.5 years</td>
<td>42 (12)</td>
<td>7 (35)**</td>
<td>35</td>
<td>88</td>
<td>14</td>
</tr>
<tr>
<td>P and T 1-4 deviations and 2-9 deviations at 5.5 years</td>
<td>23 (6)</td>
<td>4 (20)*</td>
<td>20</td>
<td>93</td>
<td>15</td>
</tr>
</tbody>
</table>

* p < 0.05
** p < 0.01
*** p < 0.001

ADHD, attention-deficit/hyperactivity disorder.

Complementary results

Screening at 4 years of age

In the study population of 5.5-year-olds (N=442), results from the screening at 4 years +/- 3 months were available for 417 children. There was no association between developmental deviations at 4 years of age with a later diagnosis of pervasive ADHD at 10 years of age (Table 16). The sensitivity, specificity and positive predictive values at different levels of deviation in the CHC screening of 4-year-olds for ADHD diagnoses in grade 4 are presented in Table 17. The predictive value for pervasive ADHD in grade four was very low; 3-7%. The sensitivity for language deviation at this age was 8%, the specificity 85% and the positive predictive value 3%.
Table 16. Crude rates of not passing developmental screening tests as 4-year-olds by ADHD category in fourth grade

<table>
<thead>
<tr>
<th>Developmental deviation</th>
<th>Total (n=417)</th>
<th>No ADHD (n=336)</th>
<th>Subthreshold ADHD (n=28)</th>
<th>Situational ADHD (n=29)</th>
<th>Pervasive ADHD (n=24)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
<td>n (%)</td>
</tr>
<tr>
<td>Balance - walk on a line</td>
<td>35 (8)</td>
<td>25 (7)</td>
<td>3 (11)</td>
<td>5 (17)</td>
<td>2 (8)</td>
</tr>
<tr>
<td>Jump on one leg</td>
<td>64 (15)</td>
<td>44 (13)</td>
<td>8 (29)*</td>
<td>8 (28)*</td>
<td>4 (17)</td>
</tr>
<tr>
<td>Draw a man</td>
<td>61 (15)</td>
<td>44 (13)</td>
<td>8 (29)*</td>
<td>6 (21)</td>
<td>3 (13)</td>
</tr>
<tr>
<td>Draw a cross</td>
<td>26 (6)</td>
<td>16 (5)</td>
<td>4 (14)*</td>
<td>5 (17)**</td>
<td>1 (4)</td>
</tr>
<tr>
<td>Count three objects</td>
<td>53 (13)</td>
<td>35 (10)</td>
<td>6 (21)</td>
<td>8 (28)**</td>
<td>4 (17)</td>
</tr>
<tr>
<td>Language evaluation</td>
<td>60 (14)</td>
<td>45 (13)</td>
<td>6 (21)</td>
<td>7 (24)</td>
<td>2 (8)</td>
</tr>
<tr>
<td>No deviation</td>
<td>274 (66)</td>
<td>230 (68)</td>
<td>13 (46)</td>
<td>15 (52)</td>
<td>16 (67)</td>
</tr>
<tr>
<td>1-6 deviations</td>
<td>143 (34)</td>
<td>106 (32)</td>
<td>15 (54)*</td>
<td>14 (46)</td>
<td>8 (33)</td>
</tr>
<tr>
<td>2-6 deviations</td>
<td>70 (17)</td>
<td>49 (15)</td>
<td>7 (25)</td>
<td>9 (31)*</td>
<td>5 (21)</td>
</tr>
<tr>
<td>3-6 deviations</td>
<td>35 (8)</td>
<td>23 (7)</td>
<td>5 (18)*</td>
<td>6 (21)**</td>
<td>1 (4)</td>
</tr>
</tbody>
</table>

* p < 0.05
** p < 0.01

ADHD, attention-deficit/hyperactivity disorder.

Table 17. Crude rates of not passing developmental screening tests as 4-year-olds; sensitivity, specificity and positive predictive value in relation to pervasive or situational ADHD in fourth grade

<table>
<thead>
<tr>
<th>Developmental deviation</th>
<th>No ADHD n (%)</th>
<th>ADHD n (%)</th>
<th>Sensitivity %</th>
<th>Specificity %</th>
<th>Positive predictive value %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n=393)</td>
<td>(n=24)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pervasive ADHD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No deviation</td>
<td>258 (66)</td>
<td>16 (67)</td>
<td>67</td>
<td>34</td>
<td>6</td>
</tr>
<tr>
<td>1-6 deviations</td>
<td>135 (34)</td>
<td>8 (33)</td>
<td>33</td>
<td>66</td>
<td>6</td>
</tr>
<tr>
<td>2-6 deviations</td>
<td>65 (17)</td>
<td>5 (21)</td>
<td>21</td>
<td>84</td>
<td>7</td>
</tr>
<tr>
<td>3-6 deviations</td>
<td>34 (9)</td>
<td>1 (4)</td>
<td>4</td>
<td>91</td>
<td>3</td>
</tr>
<tr>
<td>Situational ADHD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No deviation</td>
<td>243 (67)</td>
<td>15 (52)</td>
<td>52</td>
<td>33</td>
<td>6</td>
</tr>
<tr>
<td>1-6 deviations</td>
<td>121 (33)</td>
<td>14 (48)</td>
<td>48</td>
<td>67</td>
<td>10</td>
</tr>
<tr>
<td>2-6 deviations</td>
<td>56 (15)</td>
<td>9 (31)</td>
<td>31</td>
<td>85</td>
<td>14</td>
</tr>
<tr>
<td>3-6 deviations</td>
<td>28 (8)</td>
<td>6 (21)</td>
<td>21</td>
<td>92</td>
<td>18</td>
</tr>
<tr>
<td>Pervasive or Situational ADHD</td>
<td>(n=364)</td>
<td>(n=53)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No deviation</td>
<td>243 (67)</td>
<td>31 (58)</td>
<td>58</td>
<td>33</td>
<td>11</td>
</tr>
<tr>
<td>1-6 deviations</td>
<td>121 (33)</td>
<td>22 (42)</td>
<td>42</td>
<td>67</td>
<td>15</td>
</tr>
<tr>
<td>2-6 deviations</td>
<td>56 (15)</td>
<td>14 (26)*</td>
<td>26</td>
<td>85</td>
<td>20</td>
</tr>
<tr>
<td>3-6 deviations</td>
<td>28 (8)</td>
<td>7 (13)</td>
<td>13</td>
<td>92</td>
<td>20</td>
</tr>
</tbody>
</table>

* p < 0.05

ADHD, attention-deficit/hyperactivity disorder.
Behavioural screening (Study IV)

Boys more often were reported to be hyperactive (Conner score at least 10 or at least 15) than girls according to teachers (p<0.001) (See Study IV, manuscript: Table 1).

The efficiency of the behavioural screening by parents and teachers using the Conners scale in grade one to predict pervasive ADHD in grade four is presented in Table 18 (and Study IV, manuscript: Table 3). The sensitivity of teacher ratings of moderate or severe hyperactivity was higher than that of parental reports, but the specificity and the positive predictive value were approximately the same for both raters.

When combining a Conners score of at least 10 according to both parents and teachers, the positive predictive value for pervasive ADHD was 50%; i.e., half of the children (6/12) with moderate hyperactivity in two settings in grade one received the diagnosis of pervasive ADHD in grade four (Table 18). The four children reported to have severe behaviour problems (score >=15) at home and at school in first grade fulfilled the criteria for pervasive ADHD three years later. However, the sensitivity of combined ratings of low and high cut-off scores was only 25% and 17%, respectively.

Table 18. Crude rates of screen-positive results in first grade according to parent and teacher ratings on the Conners 10-item scale; sensitivity, specificity and positive predictive value in relation to pervasive ADHD in fourth grade (See Study IV, manuscript: Table 3).

<table>
<thead>
<tr>
<th>Conners score</th>
<th>No ADHD (n=398)</th>
<th>ADHD (n=24)</th>
<th>Sensitivity %</th>
<th>Specificity %</th>
<th>Positive predictive value %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parent 10-30</td>
<td>28 (7)</td>
<td>7 (29)***</td>
<td>29</td>
<td>93</td>
<td>20</td>
</tr>
<tr>
<td>Parent 15-30</td>
<td>8 (2)</td>
<td>5 (21)***</td>
<td>21</td>
<td>98</td>
<td>39</td>
</tr>
<tr>
<td>Teacher 10-30</td>
<td>37 (9)</td>
<td>15 (63)***</td>
<td>63</td>
<td>91</td>
<td>29</td>
</tr>
<tr>
<td>Teacher 15-30</td>
<td>18 (5)</td>
<td>11 (46)***</td>
<td>46</td>
<td>96</td>
<td>38</td>
</tr>
<tr>
<td>P and T 10-30</td>
<td>6 (2)</td>
<td>6 (25)***</td>
<td>25</td>
<td>99</td>
<td>50</td>
</tr>
<tr>
<td>P and T 15-30</td>
<td>0 (0)</td>
<td>4 (17)***</td>
<td>17</td>
<td>100</td>
<td>100</td>
</tr>
</tbody>
</table>

* p < 0.05     ** p < 0.01     *** p < 0.001

ADHD, attention-deficit/hyperactivity disorder.
Discussion

Representativeness and generalisability

All studies are population-based and have been carried out in Sigtuna, a medium-sized municipality with a population with a slightly more disadvantaged socioeconomic situation than the country as a whole, in terms of education, single parent household and the immigrant proportion of the population (Table 19). According to the Register of the Total Population and the Swedish Education Register, 33% of all Swedish 10-year-olds had a mother with a university education and 18% a foreign-born mother in 2002 (Hjern A, pers communication) compared with 21% and 23%, respectively, in the population in this thesis. Thus, considering the higher rates of ADHD in families with low socioeconomic status (Hjern et al., 2009), somewhat higher rates of ADHD compared with the national average should be expected in this study population.

The school system is similar to the systems in most Swedish communities with a preponderance of community-run schools with mainstream teaching methods.

Table 19. Socio-demographic variables in the study population and in the municipality of Sigtuna and in the whole of Sweden (data from 2002)

<table>
<thead>
<tr>
<th>Socio-demographic variables</th>
<th>Study data Study population (N=516) %</th>
<th>Register data Sigtuna (N=566) %</th>
<th>Register data Sweden (N=121 494) %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single parent household</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maternal education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-9 years</td>
<td>25</td>
<td>16</td>
<td>12</td>
</tr>
<tr>
<td>10-12 years</td>
<td>54</td>
<td>56</td>
<td>54</td>
</tr>
<tr>
<td>13 + years</td>
<td>21</td>
<td>28</td>
<td>33</td>
</tr>
<tr>
<td>Maternal country of birth</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sweden</td>
<td>77</td>
<td>72</td>
<td>82</td>
</tr>
<tr>
<td>Other</td>
<td>23</td>
<td>28</td>
<td>18</td>
</tr>
</tbody>
</table>

The child and school health services in the municipality are organised in a similar way and follow the same national health surveillance programme as
the rest of Sweden. The child health questionnaire (Studies I and II) was distributed in the same way as in other class-room surveys in Swedish primary schools. The children in Study III were assessed at five different health care centres by 11 different CHC nurses and 11 general practitioners. It is unlikely that the CHC nurses and physicians in this municipality examined the children differently from other CHCs, as everyone had received the same education and had long experience of child health work. Thus, it seems quite probable that the results are representative of most societal contexts in Sweden.

The major limitation of this study is that the data were collected within the school health system and used in connection with health visits to the school nurses and physicians. Thus, the data were not blinded to the school health personnel. This means that the information may have been biased by thoughts about how it might be used within the school. It seems possible, for example, that parents and children may have withheld information about psychosomatic symptoms, bullying and behavioural problems if they preferred to find solutions to these problems outside of the school setting. Children may hesitate to report bullying because of shame (Danielsson, 2003). With regards to screening for ADHD, this problem was probably limited by using teachers as informants, but for health complaints and bullying, the only data available were the information collected from the children. Moreover, the rates of ADHD, health complaints, and bullying behaviour in this thesis are quite similar to reports in other recent Swedish studies (Kadesjö and Gillberg, 1998; Landgren et al., 1996; Östberg, 2001a), which seems to indicate that this bias was of minor importance.

However, this data collection method is also the greatest strength of the study, as it explains the extraordinarily high participation rate of parents, teachers and children. The School Health Services provide the ideal setting for a total childhood population study (Kadesjö, 2000). Almost all children participate in school health programmes, and it is easy to elicit information from parents and teachers based on confidence and collaboration with the school health staff. All teachers in grade four participated in completing questionnaires and were interviewed by the project leader (KH). Questionnaires from parents and children in grade four and the 14 children in grade three were returned from 92% and 94%, respectively. The drop-out rate at the clinical interview of children who were screen-positive for behaviour and learning difficulties was 9% (15/174). The participation rate in grade one was 87% for parents and 85% for teachers. It is possible that two additional factors are important to explain these results: 1) the researcher responsible for the data collection (KH) had worked as a paediatrician in the primary care in the municipality for five years prior to this study and was well-known to parents, health personnel, teachers and school leaders in the community, and 2) considerable effort was put into the implementation of the purpose of the project at all levels.

Another strength of the study is the use of multiple informants, with data on behaviour being provided by both teachers and parents, data on socio-
economic conditions by parents, and data on health complaints by the children themselves (Weissman et al., 1987). This structure of the data collection procedure also made it possible to evaluate the rate of behaviour problems in the 10.6% who dropped out of Studies I and II. The Conners scores in the teacher ratings were similar to those of the study population (mean 4.7 vs. 4.3, respectively), as were the EFSS scores rated by teachers (mean 9.3 vs. 8.4, respectively), thus suggesting that the study population was fairly representative of the whole cohort.

The fairly low participation rate (124/160=77.5%) in the WISC testing of children selected in the screening makes it necessary to interpret the findings regarding children with intellectual disabilities with some caution, but otherwise the results presented can be expected to be representative of the entire study population.

In the study population in Studies I and II, the pervasive ADHD or situational ADHD groups (n=61) consisted of 13 girls (21%) and 48 boys (79%). In the pervasive group (n=29), the female: male ratio was 1:6. Our sample is too small to allow for any conclusions to be drawn about gender differences in ADHD. For the same reason, we could not evaluate the predictive accuracy of screening for hyperactive behaviour in girls (Study IV).

Sweden has comparatively low rates of bullying (Danielsson, 2003), indicating that the strength of the associations between ADHD and bullying may be different in other societal contexts. One must also remember that school demands and peer relation patterns as well as the prevalence of ADHD, bullying and health complaints vary considerably with age, suggesting that the results of this thesis may, to a certain extent, be specific to the age group studied. On the other hand, the limited age variation is also a strength of the studies in this thesis. It increases the precision, as age-dependent variation of health symptoms and behavioural problems has no influence on the results.

Validity and reliability

Diagnostic categorisation and procedure

The criteria of DSM-IV were used in this study rather than the ICD-10, as the concept of ADHD is commonly used in clinical practice in Sweden. Like all mental disorders, there is no golden standard for diagnosing ADHD. The assessment and diagnosis of ADHD relies on subjective evaluation of the diagnostic criteria and requires a clinical judgement (Hechtman, 2000; Kadesjö, 2000; Langberg et al., 2008; Spencer et al., 2007). The assessment of impairment is central to arriving at a decision about the diagnosis, as the ADHD syndrome involves different levels of symptom severity. The diagnosis of ADHD is behaviourally defined (APA, 1994). A physical examination or an IQ assessment is not required at the level of diagnosis.
(Landgren et al., 2000; Spencer et al., 2007), but it may be helpful if academic underachievement is reported (Seidman et al., 1997).

We used a two-stage epidemiological design which is common in child neuropsychiatric research; first a screening of the total population followed by in-depth examination of screen-positive children by an experienced clinician (KH).

All parents were interviewed using the same semi-structured questionnaire. The decision about the child being impaired was based on overall functioning according to the teacher and parent interviews. No special rating scale, such as the Children's Global Assessment of Functioning (CGAS) (Bird et al., 1990; Shaffer et al., 1983) or Global Assessment of Functioning Scale (GAF) (APA, 1994; Pelham et al., 2005), which have been applied in some other Swedish studies (Danielsson et al., 2009; Miniscalco et al., 2006), was used. Thereby, impairment in specific domains may not have been identified.

The evaluation of ADHD symptom severity and impaired function may have been biased due to subjectivity - by parents and teachers as well as the physician. In this thesis, the clinician's judgment provided a “gold standard” in terms of impairment and diagnostic assessment. No specific test of diagnostic validity by re-assessment was performed. In some cases the diagnosis was discussed with an experienced colleague who did not examine any children, and with the psychologist responsible for the cognitive assessments. The physician had long experience in the field of neurodevelopmental disorders which may have improved the reliability of diagnosing. However, the clinician was not blinded to the subjects. The fact that the same physician performed all interviews and clinical assessments gives strength to the study by reducing the measurement error. In addition, the case-defining method by structural interviews with parents, including medical, developmental and behavioural history, and checking that each DSM-IV criterion was met, is consistent with research practice in several other Swedish population-based studies of young children with attention deficits (Gillberg et al., 1983; Gillberg, 1987; Kadesjö and Gillberg, 1998; Landgren et al., 2000; Landgren et al., 1996; Thunström, 2002). The interrater reliability has been demonstrated to be good to excellent, suggesting that assessment of ADHD symptoms can be achieved with good discrimination using this standardised information from parent interviews (Landgren et al., 2000).

Comorbid symptoms, such as learning difficulties or disruptive behaviour, were evaluated in the clinical interview. However, extensive screening for these symptoms or clinical assessment of whether the criteria for comorbidity (e.g., conduct or anxiety disorder) were met was not carried out, which is a weakness. The severity of concomitant disorders may have been underestimated.
**Informant perspective**

The diagnosis of childhood ADHD requires information from both parents and teachers regarding the core symptoms and the degree of functional impairment. However, parents and teachers tend to have different opinions about the child, which may complicate the diagnostic process. As in several previous studies (Achenbach et al., 1987; Brown et al., 2006; de Nijs et al., 2004; Langberg et al., 2008; Mares et al., 2007; Sayal and Taylor, 2005; Wolraich et al., 2004), parents and teachers tended to report different children in grade four as screen-positive for ADHD symptoms. We did not require pervasiveness of symptoms to be included for the clinical assessment. The correlation between the parents' and the teachers' ratings of hyperactivity (total Conners score) in grade four was moderate; Spearman's \( r = .45 \), and \( .49 \) concerning executive functions (total EFSS score).

These discrepancies do not necessarily mean that either reporter is inaccurate. Low agreement between informants may indicate that parents and teachers have different perceptions of the child's behaviour (e.g., different thresholds for impairment) (Jensen et al., 1999). Another explanation is that the child may behave somewhat differently from one situation to another, depending on different demands and contexts set by the school and the home environment (Achenbach et al., 1987; Brown et al., 2006; de Nijs et al., 2004; Jensen et al., 1999; Langberg et al., 2008; Sayal and Taylor, 2005; Schachar and Tannock, 2006; Wolraich et al., 2004).

**Parent**

Parent's report may be biased due to the limited exposure parents have to the range of behaviour that exists in young children compared with teachers (Bennett and Offord, 2001). Parents' perception of their children's behaviour appears to be influenced by their mental health (Sayal and Taylor, 2005; Sayal et al., 2003; Schachar and Tannock, 2006) and their belief in their own ability to handle hyperactive behaviours (Maniadaki et al., 2007). Maternal depression (Pelham et al., 2005), maternal ADHD (Chronis-Tuscano et al., 2008), and parental stress with a negative parenting style seem to be related to increased ratings of externalising behaviour in children (Modesto-Lowe et al., 2008; Moffitt, 2005).

**Teacher**

Teachers tend to identify more attention problems than parents (Brown et al., 2006; Sayal and Taylor, 2005), probably due to increased demands for sustained attention in the classroom and the need for the child to regulate his/her behaviour in relation to peers (Buitelaar, 2002; Wolraich et al., 2004). School work also demands executive functions such as time management, planning and organising, completing tasks and regulating behaviour. Teachers are more familiar with age-appropriate expectations in the school setting.
and may compare the child with other children in the same group (Atkins and Pelham, 1991; Dwyer et al., 2006; Schachar and Tannock, 2006), thereby identifying attention problems not observed by parents (Mares et al., 2007). Teachers are more likely to rate children as hyperactive if they are oppositional (Abikoff et al., 1993; Schachar et al., 1986). Strained pupil-teacher relationships and poor classroom environments may further increase hyperactivity and conduct problems (Oliver et al., 2008; Somersalo et al., 2002).

On the other hand, teachers may also underestimate ADHD symptoms. Because of fluctuations in the expression of ADHD symptoms across time and settings (e.g., classroom, playground), teachers may consider failure to persist in a task to be a sign of lack of interest, low motivation, boredom or learning disability rather than inattention (Schachar and Tannock, 2006). It has been discussed whether girls are more likely to be unidentified as they are less disruptive than boys (Biederman and Faraone, 2005; Gillberg et al., 2004). Lack of educational resources may contribute to underestimation of school problems, as case definition is related to being entitled to additional resources for academic and social problems (Atkins and Pelham, 1991).

**Child**

Youth self-reporting is of limited use in clinical assessments for ADHD because of the poor reliability (Fombonne, 2006; Langberg et al., 2008; Pelham et al., 2005; Rowland et al., 2008). Children seem to overestimate their competence in relation to parental and teacher reports (Hoza et al., 2004). The diagnostic assessment of ADHD in this thesis was based on information from parents and teachers.

Although there may be a tendency to poor self-awareness in ADHD (McQuade and Hoza, 2008), it has been recommended that the children themselves be asked about their perception of problems at school and in the family that may have an impact on their quality of life (Jensen et al., 1999; Klassen et al., 2006; Langberg et al., 2008; Norrby et al., 2003). The outcome in Studies I and II was based on children's report.

**ADHD classification**

In this thesis, both the categorical and dimensional approaches to ADHD classification have been applied. The outcome variables in all studies have been analysed in relation to 5 levels or categories of ADHD symptoms: no ADHD, subthreshold ADHD, situational ADHD, pervasive ADHD and the two last categories collapsed into a single group. The subtype classification (combined, inattentive, or hyperactive ADHD) was not utilised due to the small number of pervasive ADHD cases (n=24 – 29 in the different studies). Implementing the five categories of ADHD symptoms in the analyses makes it possible to assess whether elevated levels of attention problems are associated with stress symptoms and peer problems such as bullying, despite not
reaching the level of clinical ADHD. The rationale for including the situational group in the outcome analysis was to evaluate whether symptoms above the threshold for diagnosis at school or at home only could predict the same outcome as pervasive problems.

The efficiency of the developmental and behavioural screening (Studies III and IV) was evaluated in relation to a clinical diagnosis (pervasive ADHD) in grade 4. The situational group was included in these analyses (See Study III, manuscript: Table 3 and 4; and Study IV, manuscript: Table 3), as the risk increase for health complaints and bullying had been found to be similar in children who fulfilled the ADHD criteria in one or two settings (home and school). It may therefore be of importance to identify children at risk of developing both categories of ADHD. Besides, these children may also need special educational support.

The value of a dimensional approach

The category “situational ADHD” comprised children for whom there was a great difference between the parents' and the teacher's assessments. Most of the children (78%) in the situational group were classified as school only ADHD. Children with situational ADHD (i.e., mainly school only ADHD) reported similar high levels of health complaints and bullying as children in the pervasive group. Even if situational ADHD is not equivalent to clinical ADHD, it is evident that children with high levels of ADHD symptoms at school are just as likely to experience health complaints and bullying as children with pervasive ADHD. This observation suggests that behaviour problems at school may result in relationship problems with peers and teachers and secondary psychosomatic symptoms; or the other way around, even if the home situation is balanced. Our results confirm previous findings (Ho et al., 1996; Mannuzza et al., 2002), indicating that school only ADHD is associated with an increased risk of impaired psychosocial functioning.

There was no elevated risk of health complaints in subthreshold ADHD. It is possible that a more nuanced outcome variable, such as impaired functioning assessed by the global functioning scale, instead of the number of DSM-IV criteria met, is needed to identify differences depending on the severity of the ADHD symptom. The risk of being bullied was increased in ADHD as well as in subthreshold ADHD. This observation is in agreement with the finding that subclinical levels of ADHD also seem to be related to peer problems (Hoza, 2007).

The results from Studies I and II support the importance of applying a dimensional approach rather than a categorical approach to the research into ADHD. This may also have clinical implications (Kraemer et al., 2004). Even if school-only ADHD is a context-dependent construct that may have less biological underpinning (Buitelaar and Engeland, 1996), our findings suggest that school only ADHD deserves the same clinical attention and
psychosocial treatment as pervasive ADHD. Functioning in the school setting is a major aspect of a child's life (Wolraich et al., 2004).

On the other hand, it has been argued by clinicians that situational ADHD “does not exist” and should not be included as a separate entity in treatment planning as it does not qualify for a clinical diagnosis. This kind of argument may deny children with school-related problems associated with ADHD the possibility to receive proper evaluation and to prevent further impairment.

There are still unresolved questions concerning the validity, reliability and utility of the situational-pervasive distinction (Buitelaar and Engeland, 1996). Increased prevalence of health complaints and bullying in school only ADHD indicated that the impact of ADHD is not only related to pervasiveness. It may therefore not be the pervasiveness as such that is the main issue, but rather the school context. Additional research with follow-up into young adulthood is required to clarify the impact of school only ADHD on long-term outcome.

Due to the small number of subjects, the impact of home only ADHD can not be fully evaluated. Further investigations into larger samples are needed to clarify the importance of home only ADHD.

Assessment measures

All rating scales except the EFSS and teacher rating scale in first grade (Study III) have been proven to be reliable and valid in Sweden and other countries. The prevalence of health complaints (Danielsson, 2003; Östberg, 2001a), bullying behaviour (Danielsson, 2003; Östberg, 2001a), and screen-positive results on the Conners scale (Kadesjö, 2000), are in line with previous population-based studies of Swedish children of the same age. Two recent Swedish population-based studies of pain in school children based on parents' information tend to report lower prevalence rates (Laurell et al., 2004; Petersen et al., 2003). These differences further confirm the importance of obtaining information on subjective complaints by the children themselves to avoid the prevalence being underestimated (Sweeting and West, 1998; Weissman et al., 1987).

The executive functions screening scale (EFSS)

This questionnaire was designed especially for this study. The content validity of a screening test refers to the degree to which a measure represents the domain that it was originally designed to measure (Kenny et al., 1991). This scale has not been validated and its content validity may be questioned. When comparing teacher EFSS ratings of children without hyperactivity (low Conners score) with information from teacher interviews, it seems that the EFSS identified children with learning difficulties and overall subnormal cognitive function, not only those with impaired EFs.
HBSC – bullying

Information about bullying was collected from the children themselves, as suggested by previous research (Fekkes et al., 2005; Liau et al., 2004). Many previous studies about bullying have used several questions to capture different kinds of experience of bullying and being bullied (Olweus, 1993). The concept of bullying as defined by Olweus (Olweus, 1994) was not thoroughly explained to the children before the interview, which is a limitation, but their answers may still be an expression of bad relationships with peers. The validity of general questions about bullying, such as those used in this study, depends greatly on how the children themselves interpret the word bullying in their everyday language. It is quite possible that this differs considerably from the original concept defined by Olweus (Olweus, 1993). Some children may feel hesitant about reporting bullying because of shame (Östberg, 2001a). As disinhibition is often connected with the ADHD syndrome, the possibility that this gave rise to some bias cannot be excluded. However, the rates of bullying behaviour in Study II are quite similar to reports in other recent Swedish studies of school children (Danielsson, 2003; Östberg, 2001a). Interestingly, the prevalence rates are also in line with results from studies of Norwegian school children in grade 4, although these studies were performed in the 1980s (Olweus, 1994).

Motor-perceptual screening at 5.5 years of age

The 9-item motor-perceptual test used for screening at 5.5 years of age at CHCs in Study III has not previously been validated. Eight of the nine items have been validated as a part of screening tests for DAMP suggested by Gillberg and Rasmussen (Gillberg et al., 1983; Rasmussen et al., 1983), but there is no test-retest data available on the combination of items used in Study III. We found the prevalence of developmental deviations at 5.5 years of age, defined as at least three failures, to be almost twice as many as reported in other Swedish studies in study populations of six-year-olds (Bergström et al., 1988; Bohlin and Borres, 2000; Kornfält et al., 1991; Larsson et al., 1995). One possible explanation could be that in previous studies, children were assessed on 6 motor items, as suggested by Gillberg and Rasmussen (Gillberg et al., 1983), whereas 9 screening items were included in our study. Although we identified almost twice as many screen-positive children as the previously reported number, we still failed to identify children with ADHD in a satisfactory manner. There may be several possible explanations for the low efficiency of the 5.5-year screening for predicting ADHD in grade four.

1. The method

The method was developed to identify children with attention and motor-perceptual difficulties, but Gillberg et al. comments that attention or behav-
joural measures were not included (Gillberg et al., 1983). The 6-item screening method appeared to be appropriate in a community population of 7-year-olds; the majority (98%) of MBD/DAMP was identified after being screen-positive according to preschool teachers' ratings. Some children may have been reported by a teacher as being inattentive, but this was not described.

The content validity for the motor screening in relation to ADHD, a behaviourally defined disorder (APA, 1994), may be questioned. As the screening method comprises only motor items, the screening may have identified children at risk of DCD at 10 years of age, but this could not be evaluated in Study III as motor problems were not included in the screening of the total population in grade four. Only children participating in the clinical examination were assessed for motor problems. Motor clumsiness in DAMP has been reported to be apparent in only 50% at 10 years of age (Gillberg, 1985). To assess the efficiency of the preschool screening to predict DCD in fourth grade, additional research with larger samples is required.

2. The examiner and the evaluation
The 6-item method was developed and evaluated by physicians with special education in collaboration with a physiotherapist (Gillberg et al., 1983; Gillberg, 1985), while Study III was designed to assess the efficiency of developmental screening for ADHD in a routine child health care setting. It is quite probable that an efficacy evaluation in an ideal setting with highly motivated and trained staff, as in the validation studies, would have yielded a higher predictive value (Flay et al., 2005). It does not seem very likely, however, that the CHC nurses and physicians in this municipality examined the children differently from other CHCs in Sweden, as everyone had received the same education and had long experience of child health work. There seems to be a tendency among CHC staff to underestimate the significance of deviant performance in developmental assessments (Larsson et al., 1994). As there were no clear directions for scoring, the staff at the CHC may have found it difficult to classify the child's motor performance as normal or abnormal (Bohlin and Borres, 2000). On the other hand, we identified twice as many screen-positives as other Swedish studies (Bergström et al., 1988; Bohlin and Borres, 2000; Kornfält et al., 1991; Larsson et al., 1995), which appears to limit the bias.

3. Documentation.
The internal attrition rate in the CH records was extremely low, close to zero.

4. Decision on referral
Most of the screen-positive 5.5-year-old children were not referred to a paediatrician or psychologist for further evaluation. Although this was not clearly stated in the CH records, this seems to indicate either that a relevant referral policy was lacking (Bohlin and Borres, 2000) or that the staff did not
find this screening method very helpful. Another explanation may be that parents were reluctant to go along with further referral as they perceived the child’s behaviour to be within the normal range, despite a screen-positive result (Maniadaki et al., 2007).

**Teacher psychomotor questionnaire**

This questionnaire used in Study III has not previously been validated. It is a shorter version of the Preschool Questionnaire (PSQ), validated by Gillberg and Rasmussen (Gillberg and Rasmussen, 1982a), and has been used in more recent Swedish studies of 5.5 to 6-year-olds (Landgren et al., 1996; Thunström, 2002) with reliable results. Our version of the teacher questionnaire contained the same four questions about speech and motor development and gross and fine motor control as the PSQ, but the PSQ includes another 2 items measuring perceptual-conceptual capacity. The 9-item screening method at the CHC comprised more perceptual tasks than the 6-item method. When combining screen-positive results from the teacher questionnaire with screen-positive results on the motor examination, as suggested in previous studies, the predictive value of developmental deviations for ADHD was low. Therefore, if our teacher questionnaire had included the two perceptual-conceptual questions, like the PSQ, the positive predictive value of screen-positive results of the teachers' ratings would probably still have been low.

The teacher questionnaire contained the same question about attention difficulties as the PSQ. Attention problems in first grade according to teacher reports was 21% and seemed to be more prevalent at all levels of ADHD than in no ADHD (p<0.001). Despite this association, the sensitivity was 58% and the positive predictive value 16% for ADHD in grade four. This demonstrates that it is not possible to predict ADHD in a satisfactory manner on the basis of a single item.

**Main results**

**Screening for ADHD (Studies I-IV)**

Previous to the screening for ADHD symptoms in grade four, 2.9% (17/577) had already been diagnosed as a having a neuropsychiatric disorder, including ADHD, and another five had MMR. The proportion of screen-positive results from the first step of the case-finding procedure in grade four was 28% (160/577). We did not require pervasiveness to be screen-positive.

We did not expect as many as almost one in three children to have behavioural and/or learning problems according to parents' and/or teachers' ratings. It is possible that the proportion of children requiring special attention at school was more than 28%, as conduct or emotional problems without concurrent symptoms of ADHD were not addressed in this study.
It has been suggested that in addition to the prevalence of developmental disorders, such as MMR, ADHD, and autistic spectrum disorders, this high rate could be explained by milder cognitive deficits that may lead to overt behaviour problems in combination with inappropriate demands (Ek et al., 2004). The fairly low participation rate (75 to 80% in different studies) in the WISC testing for children selected in the screening process makes it necessary to interpret these findings with some caution. Learning disabilities, i.e., significant problems in one or more school subjects indicated by remedial education of some kind in the regular compulsory school, have been estimated to be present in around 35% of all pupils in an age cohort in Sweden (Sonnander, 2000). Previous Swedish studies have reported the total prevalence of neurodevelopmental disorders or attention problems in non-referred 6 to 7-year-olds to be 10 to 20% (Kadesjö and Gillberg, 1998; Landgren et al., 1996), and the need for special education among 10-year-olds to be a minimum of 15% (Landgren et al., 2003). Based on these reports, the screen-positive rate of 28% in the population under study appears to be reasonable.

Another important issue is the fact that the overall prevalence of pervasive ADHD was estimated to be 5.6% (Studies I and II) to 5.7% (Studies III and IV). This result is in line with previous population-based studies of Swedish school children (Kadesjö and Gillberg, 1998; Landgren et al., 1996), indicating that the screen-positive result in this project was valid.

Attention and hyperactivity symptoms in the 15 screen-positive children who did not participate in the clinical examination were assessed on the basis of information from parent and teacher questionnaires, teacher interviews, the school nurses, and some telephone interviews with parents. None of the drop-outs were judged to have severe behavioural or attention problems and were therefore included in the study population in the “no ADHD” group. We did probably not underestimates the rate of ADHD.

**Gender differences**

As expected from previous research (Biederman and Faraone, 2005; Sechill et al., 1999; Schneider and Eisenberg, 2006), both “pervasive” and “situational ADHD” were more common in boys than girls (boys: 18.2% and girls: 5.2%; \( p < 0.001 \)). In the pervasive group, the male:female ratio was 6:1, which is almost equivalent to the ratio of 5.7:1 among 6-year-olds reported by Landgren et al. (Landgren et al., 1996).

Research on gender differences in clinically referred ADHD suggests that girls demonstrate lower levels of disruptive behaviour and higher levels of inattentiveness, internalising symptoms and social impairment (Biederman et al., 2002b). Less marked gender differences have been reported in non-clinical samples (Biederman et al., 2005), indicating that ADHD in females is under-identified and under-treated (Biederman and Faraone, 2005; Gillberg et al., 2004; Warner-Rogers et al., 2000). Our results and the findings reported by Landgren et al. (Landgren et al., 1996) suggest that there are
gender differences among children in Sweden. In the present community-sample with low attrition rate, the gender differences are similar to those reported from clinical studies (Biederman, 2005).

**Socio-demographics**

Both “pervasive” and “situational ADHD” were more common in children from households where the parents had poor education (Studies I and II: ADHD 18.8%) compared to households where the mothers had a university education (8.1%; \( p < 0.05 \)). There were no major differences in the prevalence of ADHD in children from foreign-born and Swedish-born parents.

Low parental education is associated with social disadvantages in general (Hjern et al., 2009), and socioeconomic factors, including low maternal education, seem to be strong predictors of ADHD according to both Swedish (Hjern et al., 2009; Landgren et al., 1998) and international studies (Biederman et al., 1995; Scahill et al., 1999; Schneider and Eisenberg, 2006). Subthreshold ADHD was not associated with psychosocial adversity defined as low maternal education, which confirms the findings of Scahill et al. (Scahill et al., 1999).

**Associated social and psychosomatic symptoms in ADHD (Studies I and II)**

We have explored stress symptoms in children with ADHD expressed as health complaints. Involvement in bullying, which denotes extreme, deviant peer relationships, may cause further distress.

**Health complaints and ADHD**

Study I is population-based and demonstrates that ADHD is associated with subjective health complaints in school children. There seems to be a twofold increased risk of RAP, sleeping problems, and day tiredness compared to “no ADHD.” The risk increase was similar in children who fulfilled the ADHD criteria in one or two settings (home and school). There was no association with headache.

It is possible that there is a common neurobiological pathway underlying the association between ADHD and more frequent health complaints. Deficits in working memory and self-regulation that are common in children with ADHD may impair the child's ability to interpret and process stressful stimuli (Barkley, 1997). Psychosocial stress and ADHD symptomatology have been reported to be associated with disturbances in the hypothalamus-pituitary-adrenal axis (HPA) as well as the sympathetic-adrenal-medullary (SAM) system (Jansen et al., 1999; King et al., 1998; Schommer et al., 2003). Dysfunction of neurotransmitters may be a common pathway for interrelated somatic and behavioural symptoms (Egger et al., 1998). Hypo-
thetically, the association of ADHD with health complaints could therefore be mediated through disturbances in the HPA as well as the SAM system. Neurophysiological connections between stress and ADHD are an important area for future exploration in ADHD research.

**Bullying and ADHD**

To our knowledge, Study II is the first Swedish study of ADHD and bullying in school children. The study demonstrates a connection between ADHD and bullying. Children diagnosed with situational or pervasive ADHD in fourth grade report being active bullies about three times as often, and being bullied frequently ten times as often as other children. The risk increase was similar in children who fulfilled the ADHD criteria in one or two settings (home and school).

ADHD is associated with deficits in social skills (Hoza, 2007). Peer rejection in ADHD has been estimated to be 50 to 80% (McQuade and Hoza, 2008). The core symptoms of ADHD: inattention, hyperactivity and impulsivity, have effects on social interactions (Hoza, 2007; Rydell, 1993). Being unable to regulate and adjust emotions in peer situations appropriately, due to deficits in executive functions, increases the risk of aggressive responses to provocation by peers (Diamantopoulou et al., 2007; King et al., 2008; McQuade and Hoza, 2008). ADHD is associated with lack of self-awareness regarding own social behaviour and difficulties to read social codes (Henker and Wahlen, 1999; Hoza, 2007; McQuade and Hoza, 2008; Mrug et al., 2009; Nijmeijer et al., 2008). ADHD with predominantly inattentive symptoms are more reluctant and avoidant. This group has problems with participating actively in social interactions (Henker and Wahlen, 1999) and tends to be socially isolated (McQuade and Hoza, 2008).

Being a bully is characterised by impulsivity and aggressive behaviour (Olweus, 1994). Victims seem to be insecure, are more withdrawn and suffer from low self-esteem, but a smaller group of victims display a combination of both anxious and aggressive reaction patterns. These children often have problems with attention (Fekkes et al., 2005; Gini, 2008; Kumpulainen et al., 1998; Olweus, 1994).

The results from Study II are in line with previous studies of school children in Finland suggesting that ADHD is a risk factor for bullying and becoming a victim of bullying (Kumpulainen, 2008; Kumpulainen et al., 2001). According to Bacchini et al. (Bacchini et al., 2008), peer rejection in ADHD (defined by teacher symptom score) aged 8 to 10, is mediated by bullying behaviour. This may be too simple an explanation. Their study was cross-sectional, which does not make it possible to draw conclusions about the causal direction of these associations. Our study with longitudinal data indicates that a reversed causal link between ADHD and being bullied may possibly be present.
Bullying behaviour was increased in both the situational and the pervasive ADHD groups. Subthreshold ADHD was related to being bullied by peers. These results indicate that problematic relationships with peers may be associated with levels of behaviour problems below the threshold for a clinical diagnosis of ADHD, as previously suggested (Hoza, 2007).

**Bullying and health complaints**

Complementary analyses of the study population in Study I and II demonstrate an association between bullying and health complaints (ADHD not included in these analyses). Children being bullied were more likely to report all kinds of health complaints (p<0.01-0.001) while being a bully was associated with day tiredness (p<0.01). These results coincide with previous research. In the school environment, harassment by peers (Alfven et al., 2008; Hjern et al., 2008) and being bullied (Danielsson, 2003; Fekkes et al., 2006; Fekkes et al., 2004; Forero et al., 1999; Ghandour et al., 2004; Kumpulainen et al., 1998; Östberg, 2001a) are strongly associated with recurrent pain.

**Possible interactions**

To summarise, we found associations between attention deficits, psychosomatic complaints and bullying behaviour (Figure 16). Environmental factors and child-related factors may influence the impact of these interactions on daily life. A negative causal role for the ADHD symptoms is usually presumed in studies of relations with peers, such as in Study II (Diamantopoulou et al., 2005; Henker and Wahlen, 1999; Klassen et al., 2004). Bullying has been demonstrated to be a particularly important risk factor for health complaints (Danielsson, 2003; Ghandour et al., 2004; Hjern et al., 2008; Östberg, 2001a). The cross-sectional nature of the analysis in fourth grade does not make it possible to draw conclusions about the causal direction of these associations.

The stress caused by bullying may result in subjective health complaints. On the other hand, it seems quite possible that children with vulnerability to developing pain symptoms tend to experience and rate the school environment as more problematic than other children and that children with severe psychosomatic symptoms more often become victims of harassment (Hjern et al., 2008). Internalised behavioural problems have been found to precede being bullied and increase the risk of being bullied over time (Fekkes et al., 2005).
Attention problems and difficulties at school may result in health complaints, but recurrent pain may also cause inattentive behaviour. Pain in school children has been reported to result in difficulties to concentrate (Smedbraten et al., 1998), mental distress and sleeping difficulties (Bruusgaard et al., 2000), which presumably may aggravate the ADHD symptoms.

Finally, it is difficult to determine whether children with ADHD more often become involved in bullying because of their ADHD-related behaviour or if they develop the ADHD symptoms in response to the bullying experienced. Bullying and peer rejection may also maintain symptoms of ADHD. The causal direction in the association between bullying and psychopathology has been much debated (Kim et al., 2006). The longitudinal design with parental information about behavioural problems at school entry seems to clarify the causal direction to some extent. The high predictability of parental reports of behaviour problems when entering first grade for being an active bully in fourth grade indicates that ADHD-related behavioural problems most often were present in these children before starting school, thus establishing a tentative causal link between the presence of these symptoms and development of bullying behaviour at school in these children. This seems to be in line with previous reports that children with a diagnosis of ADHD more often than others demonstrate aggressive behaviour and have difficulties interpreting social codes (Henker and Wahlen, 1999; Nijmeijer et al., 2008). Furthermore, this may support the claims that physical aggression usually starts early in childhood. Longitudinal studies on aggressive behaviour in children have demonstrated that onset of physical aggression in
school-age children is highly unusual. Instead, precursors of physical aggression tend to be present before school entry and continue throughout childhood (Brame et al., 2001).

The lack of a significant association between child behaviour problems in parental reports when entering school and being bullied in fourth grade, on the other hand, suggests that a reversed causal link between ADHD and being bullied may be present in some of these children. Thus, feelings of insecurity and fear because of being bullied may be important in the development or aggravation of ADHD symptoms in these children. The similarity with the symptoms of attention problems in post-traumatic stress disorder in the school setting may be a useful model for understanding such a mechanism (Broberg et al., 2005).

Further investigations are needed to clarify the role of troubled relationships in the development of health complaints in children diagnosed with ADHD. The effects of peer problems in ADHD appear to be additive, leading to a greater risk of adjustment problems when both are present (Mikami and Hinshaw, 2006). Presence of psychosomatic symptoms might increase the risk of a negative prognosis even further if no intervention is initiated.

Predictors of ADHD - Screening (Studies III and IV)

Efficiency

These population-based studies demonstrate a significant, but modest, association between developmental deviations in 5.5 and 7-year-olds, as well as hyperactive behaviour defined as screen-positive results on the Conners 10-item scale, at age 7 with a later diagnosis of ADHD at 10 years of age. However, the developmental screening for DAMP/ADHD at 5.5 and 7 years of age does not identify children who are diagnosed with ADHD in grade four with a high degree of selectivity. The predictive value of developmental deviations for ADHD was low; no more than 20% for any combination of data sources.

The efficiency of behavioural screening by parents or teachers, using the Conners 10-item scale, in first grade for a diagnosis of ADHD in fourth grade is moderate. However, behavioural screening seems to have a better potential to identify children who continue to have ADHD symptoms in fourth grade than developmental screening, if information from both parents and teachers is considered. Fifty percent of children with a score of at least 10 in both ratings and the four children with a score of at least 15 in both ratings were diagnosed with ADHD three years later.

Behavioural screening being more efficient than developmental screening for predicting ADHD may appear to be evident as ADHD is a diagnosis based on behavioural symptoms. However, the sensitivity was low, 25% for
a score of at least 10 and 17% for a score of at least 15. Most of the children with ADHD in grade four were not identified by either screening method.

Our results are similar to those of Gillberg (Gillberg, 1985) in finding an association of being screen positive at 5.5 and 7 years of age with ADHD at age 10, but also confirm previous Swedish research in demonstrating low efficiency of developmental screening at CHC (Bergström et al., 1988; Bondestam et al., 1992; Rydell et al., 1991).

There was no association between developmental deviations at 4 years of age and school-age pervasive ADHD at 10 years of age. This result confirms previous studies that it may be difficult to screen for developmental deviation at this age (Kornfält et al., 1991; Mellbin et al., 1982; Rydell et al., 1991).

Delayed language development at any age was not associated with ADHD at 10 years of age, in contrast to previous findings in Swedish studies (Rasmussen and Gillberg, 1983). (Kadesjö and Gillberg, 1998; Landgren et al., 1998; Landgren et al., 2000; Miniscalco et al., 2006; Rasmussen and Gillberg, 1983; Westerlund et al., 2002).

It has been suggested that the problem load, identified through a broad assessment, rather than the type of problem is of interest for predicting school difficulties (Rydell et al., 1991) (Bergström et al., 1988). Gillberg and Rasmussen recommended a screening method with a combination of motor examination with information from parents and preschool teachers for tracing DAMP. This method has been evaluated in several previous studies (Bergström et al., 1988; Bohlin and Borres, 2000; Bondestam et al., 1992; Gillberg et al., 1982; Gillberg, 1987; Gillberg et al., 1993; Kadesjö and Gillberg, 1998; Landgren et al., 1998; Landgren et al., 2000; Landgren et al., 1996; Larsson et al., 1995; Thunström, 2002). The efficiency of all three routine screening methods evaluated in this study was low, and no combination of informant data from CHCs, parents or teachers resulted in an estimated predictive value above 20% (Table 15). Thus, our results do not support the concept that ADHD is a developmental as well as a behavioural disorder (Loe et al., 2008; McGee et al., 1991).

Even if the broad assessment did not predict ADHD in fourth grade, it is quite possible that this method may identify children with other kinds of school problems. Screen-positive results at 5.5 or 7 years of age were related to remedial education in special class at 10 years of age. Whether developmental deviation before school entry predicts school achievement problems or not has been discussed (Bergström et al., 1988; Bondestam et al., 1992; Rydell et al., 1991). Further investigations are needed to clarify the role of delayed development during the preschool years for need of special education at school age.
**Teacher and parent perspective**

Teachers identified more than twice as many children with at least one developmental deviation or hyperactive behaviour (Conners score of at least 10 or 15) in the ADHD group, compared with parent ratings. The validity of teacher reports in identifying ADHD has been emphasised in previous studies (de Nijs et al., 2004; Dwyer et al., 2006; Jensen et al., 1999; Mannuzza et al., 2002), but in our study their ratings in first grade had no greater predictive accuracy than parental reporting.

Combining the screening results on the Conners scale used in different settings improved the positive predictive value. This result confirms previous studies demonstrating that information from different settings gives complementary information and captures multiple perspectives of a child's behaviour, which enhances the predictive accuracy (Holmbeck et al., 2002; Jensen et al., 1999). However, combining parents' and teachers' rating of developmental deviations did not change the low positive predictive value.

**Situational ADHD**

In Studies I and II we demonstrated that both situational and pervasive ADHD in 10-year-olds are associated with increased health complaints and increased risk of bullying behaviour. It may be of importance to identify children at risk of developing both categories of ADHD. The positive predictive value of combined parental and teacher screening information on the Conners scale was approximately the same for these two ADHD categories collapsed into a single category as pervasive ADHD alone. In the developmental screening, the positive predictive value was low at all possible cut-off points for both ADHD groups.

**Shortcomings**

The main problem with a screening procedure for ADHD with the developmental items is the high number of false-positive children who needs to be evaluated in one way or another (moderate specificity). The high rate of false positive children does not necessarily have to be a serious problem if many of these children have other developmental problems such as motor or language problems, which may also require professional evaluation and adjustment at school (Blomquist, 2000; Bondestam et al., 1992; Hall and Elliman, 2003; Rydell et al., 1991). Thus, further studies with a wider range of outcomes are needed to determine whether screening is meaningful or not in a wider child health context.

Children being classified as false positive in the screening using the Conners scale may have other school problems such as aggression and oppositional behaviour, which require attention. If children who are being reported as screen positive by parents and teachers in first grade constitute a subgroup of ADHD with a particularly bad prognosis, screening of six to seven-year-
olds may be warranted. Additional research with follow-up into young adulthood is required to evaluate whether this screening can identify children at risk of later adverse educational and social outcomes.

The shortcomings of the screening methods used to predict ADHD in grade four may not depend on the screening method not being valid. The low predictive value could probably be explained by a range of underlying biological and environmental factors or a combination of these factors. Genetic risk factors are important for the development of ADHD in children (Faraone et al., 2005; Larsson et al., 2004b; Mick and Faraone, 2008) Recent research using gene-environment interaction models, however, have suggested that environmental factors also play an important role in the development of ADHD in children exposed to genetic risk (Lasky-Su et al., 2007). Children at risk of developing ADHD may be screen-negative at school entry, but adverse family factors, such as family stress and negative parenting, or school factors, such as lack of support and understanding from teachers and peer problems (e.g., being bullied) may contribute to the development of ADHD in grade four.

Prevention

A potential evidence-based preventive intervention for children who are screen-positive for behavioural problems in first grade is parent training (Jones et al., 2007; Sonuga-Barke et al., 2001). Parent training programmes usually target all children with disruptive behaviour, not exclusively ADHD. In this perspective, it is problematic to use only ADHD as the end point when evaluating this screening procedure with Conners 10-item scale. To determine whether screening with the Conners scale is meaningful or not in a wider child health context, further studies are needed with a wider spectrum of behaviour problems as end points including CD and ODD.
Conclusions

Conclusions and Clinical implications

• ADHD is associated with recurrent abdominal pain (RAP), sleeping problems, and tiredness in school children in grade four, irrespective of socio-economic confounding. The risk increase was similar in children who fulfilled the ADHD criteria in one or two settings (home and school). Treatment strategies for ADHD need to include effective evaluation and treatment of these conditions. Evaluation of ADHD should be considered in children with recurrent health complaints.

• ADHD is associated with bullying (bullying others or being bullied) in the peer group in school children in grade four, irrespective of socio-economic confounding. The risk increase was similar in children who fulfilled the ADHD criteria in one or two settings (home and school). Evaluation and treatment strategies for ADHD need to include assessment and effective interventions against bullying. Evaluation of ADHD should be considered in children involved in bullying, and this is particularly important for children who lack a history of core symptoms before school age and have little impairment in the home environment.

When children are identified as being bullied, individual treatment is not enough: effective intervention in the peer group should be implemented and evaluated before other treatment choices for ADHD symptoms are considered. Evidence-based school interventions to address bullying have been developed and should be used in close collaboration with the child's school. When ADHD is related to bullying other children, more individually oriented approaches may be a more appropriate choice of treatment. Parent training combined with child-centred social skills training has been demonstrated to be a successful method to improve peer relations and may be appropriate also in this situation.

• Developmental screening for DAMP/ADHD at 4, 5.5 and 7 years of age does not identify children who are later diagnosed with ADHD in grade four with a high degree of selectivity. In the future, new developmental assessment methods in the CHC or school health surveillance programme should be evaluated according to the WHO criteria before being put into practice.
• Behavioural screening seems to have a better potential than developmentnal screening to identify children who continue to have ADHD symptoms. Screening for hyperactive-inattentive behaviour in first grade using Conners 10-item scale identifies children who are diagnosed with ADHD in grade four with a moderate degree of selectivity if ratings from both parents and teachers are considered. Screening for hyperactivity at a population level may be supplemented by interviews with parents and teachers when children are given high scores, in order to enhance the specificity and identify children in need of diagnostic evaluation and medical treatment.

The direction of future research

Associated social and psychosomatic symptoms in ADHD

The risk of increased health complaints and bullying was similar in situational and pervasive ADHD. Further studies on situational ADHD, particularly school only ADHD, with longer follow-up periods may reveal whether elevated ADHD symptoms in one setting only has the same impact on adverse outcome as the pervasive disorder. Studies with follow-up into young adulthood may also clarify the impact of health complaints and bullying in ADHD on the long-term outcome.

Larger samples are needed to explore bullying behaviour and health complaints in ADHD in girls. Additional research is required to clarify the mechanisms responsible for the association between ADHD and health complaints, particularly the role of troubled relations in the development of health complaints in children diagnosed with ADHD. The possible impact of other school-related factors such as learning difficulties, educational support, and class-room environment on psychosomatic complaints and bullying behaviour in ADHD might be explored.

Further studies in populations of patients are needed to clarify the mechanisms responsible for the association between ADHD and bullying, and what levels of ADHD symptoms predict bullying behaviour, so that effective interventions can be developed. The tentative causal link between ADHD and being an active bully and the suggested reversed causal link between ADHD and being bullied should be further explored in larger populations and with longer follow-up.

Predictors of ADHD – Screening

Children with screen-positive results on developmental screening may have other developmental problems, such as motor or language problems, which may also need professional evaluation and adjustment at school. Further
studies covering different aspects of the child's function and with a wider range of outcomes than only ADHD are needed to determine whether developmental screening is meaningful or not in a wider child health context.

Additional research with follow-up into young adulthood is required to clarify if high-risk status identified by behavioural screening in first grade emerges into later adverse educational and social outcomes. Research on preschool children exhibiting externalising behaviour should include ratings of aggressiveness in addition to hyperactivity.

Boys and all children from households where the parents had short education had an increased rate of externalising behaviour problems and were more likely to receive a diagnosis of pervasive or situational ADHD in grade four. This calls for more research into high-risk strategies when screening for ADHD.

Further developmental work is needed to find efficient methods that can identify school children in need of early interventions because of behavioural problems and/or learning difficulties.

Concluding remarks

In the first two articles we have explored stress symptoms in children with ADHD expressed as health complaints. Involvement in bullying, which denotes extreme, deviant peer relationships, may cause further distress. ADHD was associated with increased levels of psychosomatic symptoms and an increased risk of being involved in bullying, particularly being bullied by peers. It was evident that children with high levels of ADHD symptoms at school only were just as likely to experience health complaints and bullying as children in the pervasive ADHD group. Difficulties at school often constitute the main problems for children diagnosed with ADHD. Health complaints like recurrent headache, RAP and sleeping disturbances can be expected to aggravate these problems at school by interfering with learning and causing school absence. Bullying might cause further impairment.

According to the ICF model, a comprehensive assessment involving various domains of functioning facilitates our understanding of how and to what extent problems experienced in daily life have an impact on quality of life in ADHD. It is important to evaluate the child's strengths and needs in the areas of academic, social (e.g., bullying), emotional, physical (e.g., psychosomatic symptoms), and familial functioning in childhood ADHD. This provides not only a more accurate diagnosis, but also shows what the problems are and what sort of a multifaceted treatment plan that is needed to produce current improvement and a long-term positive outcome. Intervention seems to be important also for children with high levels of attention deficit or hyperactivity at school, even if the home situation is balanced.
Associated symptoms in ADHD may well be used in the diagnostic work-up of ADHD, in the evaluation of school interventions or the follow-up of medical treatment in addition to an assessment of reduction of core symptoms and school achievement. Health complaints and bullying may also be included in further research on impairment in ADHD.

Article 3 and 4 in this thesis evaluate two different ways of screening for ADHD at, or before, school entry. Developmental indicators were demonstrated to be of little use in predicting ADHD in the routine child health services, while behavioural indicators were found to be somewhat more useful. Neither of these two screening strategies identified cases of ADHD at 10 years with sufficient precision to be recommended for implementation in the general population. These results seem to point to a need for developing better screening instruments or strategies. Such improvements could, for instance, include improved questionnaires, or the addition of a second step with a clinical interview by a school nurse or physician.

It is also possible; however, that these results should be interpreted as indicating that screening for ADHD before, or at, school entry is not a very good idea from a public health perspective. The behaviour of an individual child is influenced by many different factors that change over time. Changing family, teacher and peer relationships and increased demands on the child's intellectual capacity in the classroom in close interaction with the maturing brain create a dynamic context for the child's behaviour over time. Thus, instead of screening it may be more important for schools to have an effective strategy for identifying and dealing with children who develop ADHD - or other neuropsychiatric disabilities that may interfere with learning - in the classroom when these problems evolve, rather than before school entry. Such a strategy could be built on close collaboration between educators, who meet the children in the classroom every day, and the school health team. It is possible that such a strategy may overlook the potential for interventions in the family and peer environment. Therefore, effective anti-bullying programmes in the schools and parent management training programmes may be other important ingredients in such an alternative public health strategy for ADHD.

Close collaboration between teachers and the school health team requires sufficient resources – both in terms of competence and finances. Efficient models for cooperation are available (Östberg, 2005) and may be further developed. The school health staff may act as a bridge facilitating communication between parents, educators, social workers and the health care system. ADHD affects several areas of everyday life and requires a multifaceted treatment plan over a long period of time. It is time to start working together to find an effective solution with integrated services for children with attention problems and their families.
I wish to express my sincere gratitude to all those who have contributed to the finalising of this work.

First of all, special thanks goes to all children participating in this study, their parents and teachers for outstanding attendance, for generously sharing your time and experience.

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Svensk sammanfattning

Psykosomatiska symptom, mobbning och prediktorer för attention-deficit/hyperactivity disorder (ADHD) hos barn i årskurs 4

ADHD (Attention-Deficit/Hyperactivity Disorder) eller uppmärksamhetsstörning/hyperaktivitet kännetecknas av problem med uppmärksamhet, överaktivitet och svårkontrollerad impulsivitet. ADHD förekommer hos 3-5% av svenska skolbarn. Återkommande problem hos barn med ADHD är sociala svårigheter i relationer till kamrater och till familjemedlemmar. Inlärningssvårigheter och uppmärksamhetsproblem leder till hinder i skolarbetet. Både relations- och skolproblematik kan skapa stress och psykosomatiska besvär.

Syftet med denna avhandling var att undersöka förekomsten av ADHD, psykosomatiska symptom och mobbning bland barn i årskurs 4. Vidare att studera om det finns samband mellan ADHD och stressrelaterade psykosomatiska symptom, och om ADHD har samband med mobbning. Barn med ADHD symptom bör identifieras tidigt, redan vid skolstart, för att få rätt stöd och för att kunna förebygga svårigheter i vardagen. Ett tredje syfte var därför att undersöka möjligheten att genom screeningprogram på BVC och i årskurs 1 förutsäga vilka barn som löper hög risk att utveckla ADHD i årskurs 4.

Samtliga barn i årskurs 4 (10 åringar, N=577) i Sigtuna kommun inbjöds läsåret 2001/2002 att delta. I samband med skolhälsovårdens hälsoundersökning i årskurs 4 besvarade föräldrar och lärare enkäter om barnens beteende och inlärning. Alla lärare intervjuades om barnens skolsvårigheter. Eleverna besvarade en hälsoenkät med frågor om psykosomatiska symptom, trivsel och mobbning. Studiepopulationen omfattade de 516 barn (89% av alla i årskurs 4) där det fanns information från alla 3 datakällor. Barn med beteende och/eller inlärningssvårigheter (n=160) genomgick en fördjupad klinisk bedömning (n=145) och grad av ADHD-relaterade problem fastställdes. Föräldra- och lärarskattning av språk- och motoriska svårigheter samt överaktivitet/impulsivitet (enligt Conners formulär) hos barnen i årskurs 1 hade tidigare samlats in (n=422 varav 382 fanns med i elevundersökningen). Resultat från den skolförberedande undersökningen vid 5.5 års ålder på BVC (n=442) samlades in i samband med undersökningen i årskurs 4.

Barn med ADHD angav ökad förekomst av psykosomatiska besvär jämfört med andra barn. Risken för magont, sömnsvårigheter och trötthet var dubbel så hög som för andra barn. Det fanns ingen ökad risk för huvudvärk hos barn med ADHD.


Skolhälsovården/Elevvården har goda möjligheter att upptäcka stressymptom och mobbning hos barn med ADHD. Det är angeläget att detta beaktas i Skolhälsovårdens/Elevvårdens hälsoarbete.

Screening av språk och motorisk utveckling vid 5.5 och 7 års ålder kunde inte identifiera barn med hög risk att utveckla ADHD i årskurs 4, medan screening för överaktivitet/impulsivitet (enligt Conners formulär) hade viss möjlighet att kunna förutsäga vilka barn som lägger risk för ADHD om resultatet från föräldra- och lärarskattning sammanvägdes. Om screening med Conners formulär skulle införas i hälsovårdsarbetet, bör den kompletteras med föräldra- och lärarintervju om barnet rapporteras ha ett överaktivt beteende både i hem och skola.

Ett alternativt sätt att möta de ADHD-relaterade problemen skulle kunna vara att skjuta screeningproblemen i bakgrunden till förmån för ett bredare interventionsperspektiv med stark anknytning till barnens vardagstillvaro. Resultaten tyder på att beteendeproblem, psykosomatiska symtom och mobbning är utbredda problem hos eleverna i årskurs 4 med uppmärksamhetssvårigheter.

Problemen drabbar barn med ADHD mer än andra barn men finns också hos många barn som ej kvalificerar för denna diagnos. Skolan behöver generellt mer kunskap, bättre kompetens och klarare strategier för att bemöta dessa problem i den pedagogiska miljön. Det krävs att skolan har tillgång till såväl psykosocial och medicinsk som specialpedagogisk kompetens som

Det är viktigt från folkhälsosynpunkt att uppmärksamma och ge stöd till alla elever med beteendeproblem och i synnerhet elever med utagerande beteende. Det är viktigt för alla barn att skolorna tillämpar effektiva metoder för att förebygga mobbning.

Barn med beteendeproblem i hemmet kan få en bättre situation genom utbildning av föräldrar. Föräldrastödsprogram kan leda till att föräldrar kan förbättra sina relationer till barnet och de lättare kan hitta vägar att bemöta barn med svårigheter.

Det ovan antydda synsättet på ADHD och andra beteendeproblem i skolan står inte i motsättning till att barn med stora svårigheter bör erbjudas neuropsykiatrisk eller barnmedicinsk kontakt och eventuell farmakologisk behandling.

Hög kompetens, tillräckliga resurser och god samverkan mellan Skolhälsovård/Elevvård, lärare och föräldrar kring barn med beteendesvårigheter är angeläget.
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Appendix I

Table 20. Diagnostic criteria of Developmental Coordination Disorder (DSM-IV)
A. Performance in daily activities that require motor coordination is substantially below that expected given the person's chronological age and measured intelligence. This may be manifested by marked delays in achieving motor milestones (e.g., walking, crawling, sitting), dropping things, "clumsiness," poor performance in sports, or poor handwriting.

B. The disturbance in Criterion A significantly interferes with academic achievement or activities of daily living.

C. The disturbance is not due to a general medical condition (e.g., cerebral palsy, hemiplegia, or muscular dystrophy) and does not meet criteria for a Pervasive Development Disorder.

D. If Mental Retardation is present, the motor difficulties are in excess of those usually associated with it.

Table 21. Diagnostic criteria for Oppositional Defiant Disorder (DSM-IV)
A. A pattern of negativistic, hostile, and defiant behavior lasting at least 6 months, during which four (or more) of the following are present:

1. often loses temper
2. often argues with adults
3. often actively defies or refuses to comply with adults' requests or rules
4. often deliberately annoys people
5. often blames others for his or her mistakes or misbehavior
6. is often touchy or easily annoyed by others
7. is often angry and resentful
8. is often spiteful or vindictive

Consider a criterion met only if the behavior occurs more frequently than is typically observed in individuals of comparable age and developmental level.

B. The disturbance in behavior causes clinically significant impairment in social, academic, or occupational functioning.

C. The behaviors do not occur exclusively during the course of a Psychotic or Mood Disorder.

D. Criteria are not met for Conduct Disorder, and, if the individual is age 18 years or older, criteria are not met for Antisocial Personality Disorder.
Table 22. Diagnostic criteria for Conduct Disorder (DSM-IV)

A. A repetitive and persistent pattern of behavior in which the basic rights of others or major age-appropriate societal norms or rules are violated, as manifested by the presence of three (or more) of the following criteria in the past 12 months, with at least one criterion present in the past 6 months:

**Aggression to people and animals**
(1) often bullies, threatens, or intimidates others
(2) often initiates physical fights
(3) has used a weapon that can cause serious physical harm to others (e.g., a bat, brick, broken bottle, knife, gun)
(4) has been physically cruel to people
(5) has been physically cruel to animals
(6) has stolen while confronting a victim (e.g., mugging, purse snatching, extortion, armed robbery)
(7) has forced someone into sexual activity

**Destruction of property**
(8) has deliberately engaged in fire setting with the intention of causing serious damage
(9) has deliberately destroyed others' property (other than by fire setting)

**Deceitfulness or theft**
(10) has broken into someone else's house, building, or car
(11) often lies to obtain goods or favors or to avoid obligations (i.e., "cons" others)
(12) has stolen items of nontrivial value without confronting a victim (e.g., shoplifting but without breaking and entering; forgery)

**Serious violations of rules**
(13) often stays out at night despite parental prohibitions, beginning before age 13 years
(14) has run away from home overnight at least twice while living in parental or parental surrogate home (or once without returning for a lengthy period)
(15) is often truant from school, beginning before age 13 years

B. The disturbance in behavior causes clinically significant impairment in social, academic, or occupational functioning.

C. If the individual is age 18 years or older, criteria are not met for Antisocial Personality Disorder.

*Specify* severity based on age at onset:
**Childhood-Onset Type:** onset of at least one criterion characteristic of Conduct Disorder prior to age 10 years
**Adolescent-Onset Type:** absence of any criteria characteristic of Conduct Disorder prior to age 10 years

*Specify* severity:
**Mild:** few if any conduct problems in excess of those required to make the diagnosis and conduct problems cause only minor harm to others
**Moderate:** number of conduct problems and effect on others intermediate between "mild" and "severe"
**Severe:** many conduct problems in excess of those required to make the diagnosis or conduct problems cause considerable harm to others
### Appendix II

Table 23. The Conners 10-item scale

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>1</td>
<td>Restless or overactive</td>
</tr>
<tr>
<td>2</td>
<td>Excitable, impulsive</td>
</tr>
<tr>
<td>3</td>
<td>Disturbs other children</td>
</tr>
<tr>
<td>4</td>
<td>Fails to finish what he/she starts</td>
</tr>
<tr>
<td>5</td>
<td>Constantly fidgeting</td>
</tr>
<tr>
<td>6</td>
<td>Inattentive, easily distracted</td>
</tr>
<tr>
<td>7</td>
<td>Demands be met immediately – easily frustrated</td>
</tr>
<tr>
<td>8</td>
<td>Cries often and easily</td>
</tr>
<tr>
<td>9</td>
<td>Mood changes quickly and drastically</td>
</tr>
<tr>
<td>10</td>
<td>Temper outbursts, explosive and unpredictable behaviour</td>
</tr>
</tbody>
</table>

Note: Items are rated on a Likert scale with four categories: *not at all* (0), *just a little* (1), *pretty much* (2), and *very much* (3).
## Table 24. The Executive Functions Screening Scale (EFSS)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Often has difficulty awaiting his/her turn</td>
</tr>
<tr>
<td>2</td>
<td>Is often hypoactive, passive and day-dreaming</td>
</tr>
<tr>
<td>3</td>
<td>Has difficulties to get friends</td>
</tr>
<tr>
<td>4</td>
<td>Has difficulties with time perception</td>
</tr>
<tr>
<td>5</td>
<td>Has difficulties to remember things that have recently happened</td>
</tr>
<tr>
<td>6</td>
<td>Has difficulties to remember what he/she has learnt from one day to another</td>
</tr>
<tr>
<td>7</td>
<td>Has difficulties to initiate tasks, such as schoolwork, without help</td>
</tr>
<tr>
<td>8</td>
<td>Is often sitting fiddling with something instead of doing schoolwork</td>
</tr>
<tr>
<td>9</td>
<td>Has difficulties with planning and organising his or her tasks, such as schoolwork</td>
</tr>
<tr>
<td>10</td>
<td>Has difficulties to concentrate on mental demanding tasks</td>
</tr>
<tr>
<td>11</td>
<td>Has difficulties sustaining his/her attention even if the task is interesting</td>
</tr>
<tr>
<td>12</td>
<td>Often needs a lot of help in order to finish schoolwork</td>
</tr>
<tr>
<td>13</td>
<td>Often needs more time to accomplish tasks</td>
</tr>
<tr>
<td>14</td>
<td>Has difficulties to remember more than one instruction at a time</td>
</tr>
<tr>
<td>15</td>
<td>Has difficulties in reading</td>
</tr>
<tr>
<td>16</td>
<td>Has difficulties in writing</td>
</tr>
<tr>
<td>17</td>
<td>Has difficulties in mathematics</td>
</tr>
</tbody>
</table>

Note: Items are rated on a Likert scale with four categories: not at all (0), just a little (1), pretty much (2), and very much (3).
## Appendix IV

### Table 25. Parent psychomotor questionnaire (PPQ)

1. How will you describe your child's speech development
2. How will you describe your child's general motor development
3. How will you describe your child's gross motor control
4. How will you describe your child's fine motor control

Note: Items are rated on a Likert scale with four categories: *early* (0), *average* (1), *somewhat late* (2), and *very late* (3).

### Table 26. Teacher psychomotor questionnaire

5. How will you describe the child's speech development
6. How will you describe the child's gross motor control
7. How will you describe the child's fine motor control
8. Has the child attention difficulties

Note: Items are rated on a Likert scale with four categories: *early* (0), *average* (1), *somewhat late* (2), and *very late* (3).
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