Appendix 1 – Summary of the 22 studies identified in the literature search

Location **Lead author Year published**	**Study period**	**Total ADHD and non-ADHD population + Age range of children**	**ADHD diagnosed cohort**	**ADHD medicated cohort**	**School intake dates**	**Primary comparison**	**Increased risk of medication and/or diagnosis (+X%) with 95% confidence intervals if reported**	**Other findings or comments**
1 **Germany** Schwandt and Wuppermann 2016	2008-2011	**6,585,039** **4 to 14**	**3.840%**	2.745%.	Varies across the 16 states in Germany	Diagnosis rates in youngest children (born in month before cut-off) compared with oldest (born in month after cut-off), among children aged 9 to 13	**Diagnosis risk +22%**	"These jumps occur at different months across states in accordance with the different cut-off dates".
2 **Sweden** Halldner et al 2014	July 2005 to December 2009	**1,821,939** **6 to 17**	**0.60%** **Reported as % with a diagnosis of hyperkinetic disorder, as defined in ICD-10**	17,565 (0.96%)	1 Jan to 31 Dec	Medication and diagnosis rates in youngest (born November and December) compared with older classmates (born previous January and February)	**Medication risk +39%** **Diagnosis risk +30%** Note: relative risk ratios and confidence intervals are quoted for both diagnosis and medication for each year of age from 6 to 17 at Table 1 (page 898)	This late birthdate effect was strongest in children aged 6 to 7 (70% increased risk) and decreased progressively among older children (among adolescents aged 16 and 17 there was a 20% increased risk). It tapered further in early adulthood so that after age 35 there was no discernible difference. Despite the relative age differences, the authors found "no corresponding differences in parent or self-reported ADHD symptoms by calendar birth month".

3 **Israel** Hoshen et al 2016	2006 to 2011	**1,013,149** **6 to 17**	**Not reported**	2.6% in 2006 rising to 4.9% in 2011 Stimulants only	Early/mid Dec to early/mid Dec Exact date varies with lunar cycles	Medication rates in youngest third (born August to November) compared with oldest third (born mid-December to March)	**Medication risk** **+17%** (95% CI 1.12-1.23)	The effect was stronger in early school years than in later school years. A significant limitation is that individual information on whether children were in their expected grade level was not available. Delayed start of school is common among the youngest children born in November and early December. This may be part of the explanation for why the effect demonstrated in this study although statistically significant, is not as strong as in other studies.
4 **Finland** Sayal et al 2017	Medical records of all Finnish children born between 1991 and 2004	**870,695** **7 to 19**	**6,136 (0.7%)**	Not stated	1 Jan to 31 Dec	Diagnosis rates in youngest third (born September to December) compared with oldest third (born January to April)	**Diagnosis risk** Boys +26% (95% CI 1·18-1·35) Girls +31% (95% CI 1·12-1·54) **Combined +27%**	The chances of a child being diagnosed before age 10 were 64% higher (95% CI 1·48–1·81) for the youngest in a class (born September to December) compared with their older classmates born from January to April. The effect was not as strong among older children.
5 **Norway** Karlstad et al 2016	2004 to 2014	**509,827** **6 to 16**	**17,105 (3.4%)**	15,717 (3.1%) Ever received medication	1 Jan to 31 Dec	Medication and diagnosis rates in youngest quarter of children (born October to December) compared with oldest quarter (born January to March)	**Medication risk** Boys +41% (95% CI 1.4-1.5) Girls +79% (95% CI 1.7-2.0) **Combined +50%** **Diagnosis risk** Boys +43% Girls +75% **Combined +51%**	Unlike most of the other studies detailed in this paper, the late birthdate effect was “most marked” in higher grades. In Norway “Early or delayed enrolment is rare and only permitted under special circumstances, after evaluation by an appropriate expert and approval by the child’s parents and the municipality”.

6 **Taiwan** Chen et al 2016	1 Sept 1997 to 31 Aug 2011	**378,881** **4 to 17**	**8,714 (2.3%)**	6,062 (1.6%)	1 Sept to 31 Aug	Medication and diagnosis rates in August-born (youngest) compared with those born previous September (oldest)	**Medication risk +65%** (95% CI 1.48-1.83) **Diagnosis risk +73%**(95% CI 1.53-1.97)	The effect was stronger in early school years than in later school years.
7 **Australia** (Western Australia) Whitely et al 2017	2013	**311,384** **6 to 15**	**Not known**	5,937 (1.9%) Received subsidised ADHD medication in 2013	1 July to 30 June	Medication and diagnosis rates in June-born (youngest) compared with those born previous July (oldest)	**Medication risk** Boys +52% (95% CI, 1.30-1.73) Girls +73% (95% CI, 1.42-1.94) **Combined +57%**	For children aged 6-10 years, the youngest children in a class (born in June) were approximately twice as likely to take medication as the oldest (born the previous July). For children aged 11 to 15, those born in June were 30% more likely to be medicated than those born the previous July. Similar patterns were found when comparing children born in the first 3 (or 6) months and the last 3 (or 6) months of the school-year intake. There was a high degree of compliance with recommended age input (98%). To the limited extent that it occurs, most out -of -year children were late born children with delayed entry.

8 **Iceland** Zoega et al 2012	2003 to 2008	**11,785** **7 to 14**	**Not reported**	740 (6.3%) Ever received stimulants	1 Jan to 31 Dec	Ever use of stimulants by children in youngest third (born September to December) compared with oldest (born January to April)	**Medication risk +50%**	The effect was stronger in early school years than in later school years. Children born between September and December also performed significantly worse in mathematics and language tests than their older peers, although the gap narrowed between ages 9 and 12.
9 **Netherlands** Krabbe et al 2014	A survey of GPs was conducted in 2013	**2,218** **5 to 12**	**Not reported**	85 (3.8%)	1 Dec to 30 Sept	Methylphenidate prescribing rate for relatively young (born August and September) compared with older classmates (born December and January).	**Medication risk +143%**	Note: Children born in October and November were excluded from the study because parents choose when these children start school, with many having a delayed start.
CANADIAN STUDIES								
10 **Canada** (British Columbia) Morrow et al 2012	1 Dec 1997 to 30 Nov 2008	**937,943** **6 to 12**	**(4.6%)**	33,775 (3.6%)	1 Jan to 31 Dec	Medication and diagnosis rates in December-born (youngest) compared with January-born (oldest)	**Medication risk** Boys +41% (95% CI 1.33-1.50) Girls +77% (95% CI 1.57-2.00) **Combined +49-%** **Diagnosis risk** Boys +30% (95% CI 1.23-1.37) Girls +70% (95% CI	The strength of the late birthday effect "remained relatively stable for the duration" of the 11-years of the study despite increasing diagnosis and medication prescribing rates. The late birthdate effect was present among all age groups but was weaker in older children. The risk for medication use rose consistently month by month for both genders for January to September and plateaued from September to December. The

							1.53–1.88) **Combined +40%**	authors suggest this plateauing may occur because late born children (born in October to December) who show ADHD type behavioural problems may "be held back from school for a year, thus allowing them more time to develop sociable behaviours".
11 **Canada** Kowalyk et al 2012								This study reviewed the distribution of ADHD symptoms by relative age and season of birth among adults, and found no link. It did not identify the proportion diagnosed or medicated by month of birth.
SPANISH STUDIES								
12 **Spain** Librero et al 2015	2013 Prevalence of medication use data at Nov 2013	**20,237** **6 to 12**	**Not reported**	350 1.73% Boys 2.70% Girls 0.71%	1 Jan to 31 Dec	Medication use by youngest half (born July to December) compared with older classmates (born January to June)	**Medication risk +51%**	
13 **Spain** Rivas-Juesas 2015								This study reviewed the records of 3,469 patients who attended a child neurology clinic between 1992 and 2012. 61.6% of those with suspected ADHD were born between July and December (the youngest half).

DANISH STUDIES								
14 Denmark Pottegård et al 2014	2000 to 2012	**932,032** **7 to 12**	**Not reported**	10,932 (1.2%)	1 Jan to 31 Dec	Medication rates of youngest quarter (born October to December) compared with oldest quarter (born January to March)	**Medication risk +8%** (95% CI 1.04-1.12)	It is very common in Denmark for late-born children to have delayed school entry. 40% of children (boys 51%, girls 29%) born in October, November and December started late, but only 4% of children born in January, February or March had a delayed start.
15 Denmark Dalsgaard et al 2014	Information from 2004 review	**418,396** **7 to 20**	**Not reported**	8,720 (2.08%) "purchased ADHD medication after the age of seven"	1 Jan to 31 Dec	Medication purchase rates of December-born (youngest) compared with January-born	"No effect of being born in the beginning of January- compared to the end of December on the likelihood of having purchased ADHD medication" was found.	"In Denmark, school entry rules imply that children born in December are typically enrolled in school 1 year earlier than children born in January." The methodology described compared January-born to December-born children, and it makes no reference to the effect of the majority (51%) practice of delayed entry for late-born boys (identified in the Pottegård 2014 study discussed above).
16 Denmark Atladóttir et al 2007	Not specified	**669,995** **5 to 15**	**2,033 diagnosed with Hyperkinetic Disorder – equivalent of ADHD combined type**	Not reported	Not specified	Examined seasonal effects in diagnosis rates in children born in spring, summer, autumn, winter	Table 1 demonstrates a modest rising trend across the months of the calendar year, indicating the existence of a late birthdate effect. The authors did not identify this trend.	The authors found “there was some evidence of a seasonal effect for hyperkinetic disorder, with higher rates in autumn and lower in spring”. December (the last month of the Danish school year intake) was grouped with the other winter months January and February (the first two months of the school year intake).

USA STUDIES								
17 **USA** Boland et al 2015		New York Medical Centre's records for 1,749,000 individuals born between 1990 and 2000	Not reported	Not reported	1 Jan to 31 Dec	Examined the association between 1,688 diseases and birth month.		It found a rising trend across the year for the diagnosis of ADHD. The study did not report absolute medication or diagnosis rates.
18 **USA** (33 states) Evans et al 2010	1997 to 2006 A variety of data sources	**34,173** **7 to 17**	**8.7%**	1,982 (5.8%)	Varies from state to state	Diagnosis and medication rates in youngest third (born 120 days before cut-off) compared with oldest third (born 120 days after cut-off)	**Medication risk +24%** **Diagnosis risk +27%**	Covered 33 different US states, with differing school starting dates.
19 **USA** Elder 2010	Nationwide survey conducted in spring (Mar-May) 2007	**11,784** **At age 13**	**754 (6.4%)**	At age 13, 530 (4.5%) regularly used behavior-modifying stimulants	Varies from state to state	Diagnosis and medication rates of children born <181 days before their state's eligibility cut-off dates (youngest) compared with those born <181 days after cut-off dates (oldest).	**Medication risk +54%** **Diagnosis risk +47%**	"A child's birth date…strongly influences teachers' assessments of whether the child exhibits ADHD symptoms but is only weakly associated with similarly measured parental assessments" Prior research lead by this author (Elder et al 2009) found evidence of a range of relative age effects including increased probability of grade repetition and diagnoses of learning disabilities such as ADHD. An

								additional year of age at entry of kindergarten was found to decrease the probability of an ADD or ADHD diagnosis by two-thirds.
20 **USA** Schneider et al 2006	2002	**9,278** **Mainly 8-year-olds**	**505 (5.4%)**	Not reported	Varies across US states	Diagnosis rates in youngest quarter (born October to December) compared with oldest quarter (born January to March)	**Diagnosis risk +69%** (95% CI 1.10-2.61)	
21 **USA** LeFever et al 1999		2,177 children, of whom 613 received medication	**N/A**	N/A	N/A	N/A	N/A	This is the first study to suggest a late birthday effect, reporting that: “being young for one's grade was positively associated with medication use”. However, it was a small-scale study with inconsistent results across two cities.
22 **USA** Mick et al 1996								This study compared the birthdates of 140 Caucasian boys diagnosed with ADHD and 120 boys without ADHD diagnoses. The study found a relationship between month of birth and probability of being diagnosed.