Children's Relative Age and ADHD Medication Use: A Finnish Population-Based Study

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abstract

OBJECTIVES: The youngest children in a classroom are at increased risk of being medicated for attention-deficit/hyperactivity disorder (ADHD). We examined the association between children's birth month and ADHD medication rates in Finland.

METHODS: Using a population-based study, we analyzed ADHD medication use among children born in 2005 to 2007. Cases (n = 7054) were identified from the first purchase of medication for ADHD. Cox proportional hazard models and hazard ratios (HRs) were examined by birth month and sex. Finnish children start first grade in the year of their seventh birthday. The cutoff date is December 31.

RESULTS: Risk of ADHD medication use increased throughout the year by birth month (ie, January through April to May through August to September through December). Among boys born in September to December, the association remained stable across cohorts (HR: 1.3; 95% confidence interval [CI]: 1.1–1.5). Among girls born in September to December, the HR in the 2005 cohort was 1.4 (95% CI: 1.1–1.8), whereas in the 2007 cohort it was 1.7 (95% CI: 1.3–2.2). In a restricted follow-up, which ended at the end of the year of the children's eighth birthday, the HRs for boys and girls born in September to December 2007 were 1.5 (95% CI: 1.3–1.7) and 2.0 (95% CI: 1.5–2.8), respectively.

CONCLUSIONS: Relative immaturity increases the likelihood of ADHD medication use in Finland. The association was more pronounced during the first school years. Increased awareness of this association is needed among clinicians and teachers.

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WHAT'S KNOWN IN THIS SUBJECT: The relative age effect (RAE) in attention-deficit/hyperactivity disorder (ADHD) indicates that ADHD medication use is more common in the relatively youngest children within a school grade. Within-country sex differences in ADHD medication use vary and are among the largest in Finland.

WHAT THIS STUDY ADDS: This population-based study reveals that the RAE in ADHD medication use among children was more pronounced during the first school years (ages 6–8). The RAE in ADHD medication was stable among boys across 3 cohorts but increasing among girls.

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Attention-deficit/hyperactivity disorder (ADHD) is a common neurodevelopmental condition characterized by age-inappropriate levels and persistent patterns of inattention or hyperactivity-impulsivity or both, which interferes with social functioning and development.[1,2] ADHD is recognized as a lifelong disorder.[3,4] Prevalence of ADHD is estimated to be ~5% in children.[2,5] However, the relative age effect (RAE) refers to the fact that the youngest children in classrooms are more likely to receive a diagnosis and be prescribed medication for ADHD than their relatively older classmates.[6–8] Researchers of previous studies have indicated that relative age plays a more important role with ADHD symptoms than the season of birth,[8,9] particularly during childhood.[10] One line of research suggests that RAE may represent a situation in which the more immature behavior of younger children is treated as ADHD.[11–13] There is empirical evidence of the RAE from countries with high prescription rates, such as Iceland,[14] the United States,[15] Canada,[16] and Sweden,[17] but also from countries with moderate rates, such as Norway[18] and Taiwan.[19]

The strength of the RAE may vary within countries across time. A Danish study found evidence for an RAE between 2000 and 2004,[20] which then diminished during study years 2006 to 2012.[20,21] These findings are possibly explained by the fact that ~40% of the relatively younger children are held back one year in the Danish school system.[20,22] The fact that the RAE is associated with school entry regulations further implies that the effect size may depend on the duration of the follow-up.[23] This is an under-researched perspective.[17] There is also notable variation between countries in prescribing rates for ADHD, and studies also differ by the years studied.[6,24] For example, prevalence rates of ADHD medication use among the child population in Finland have been relatively low, particularly among girls,[24,25] but the rates of ADHD diagnoses and medication use are increasing relatively rapidly.[26] Sex differences are also important to consider because the rates of ADHD vary by sex in middle childhood. Emotion dysregulation and externalizing behaviors drive referral for ADHD.[27,28] However, in recent studies on sex differences, it has been indicated that emotional and behavioral difficulties are stronger predictors of ADHD diagnosis in girls when compared with boys.[29,30] In addition, girls with externalizing symptoms are more likely to have a referral for ADHD at a younger age compared with boys with similar behaviors.[30] Interestingly, the findings with regard to sex differences in the RAE have been inconclusive.[14,16,18,20] This may relate to the fact that sex differences in ADHD medication use vary between countries. In a recent study in which worldwide ADHD medication use in children was examined, the male-to-female ratio in medication use was the highest in Finland.[24]

Our purpose with this study was to examine the extent to which relative age is associated with ADHD medication use among children in Finland born in 2005 to 2007. Importantly, we were able to use the study by Sayal et al,[13] which examined the association between relative age and an ADHD diagnosis among Finnish children (born between 1991 and 2004) as a baseline. Altogether, with our study, we add to the global understanding of the RAE in ADHD by providing a more-complete picture of the phenomenon from a single jurisdiction where the rates of children with ADHD have increased somewhat rapidly and delayed school entry has decreased.[13,26] First, we hypothesized that with delayed school entry being somewhat rare in Finland, there would be at least a modest RAE in prescribing ADHD medication for children. Second, given that difference in maturity is more extreme at young ages, we expected that the RAE in ADHD medication use would be stronger at ages 6 to 7, when children start primary education. Third, because of the prominent sex differences in the rates of ADHD, we expected that the RAE would be different in boys and girls.

METHODS

Study Setting and Data Sources

The study outcome was ADHD medication prescribing. All permanent residents of Finland are covered under the National Health Insurance system. Reimbursements for medical expenses are available for products that the Pharmaceuticals Pricing Board has confirmed as reimbursable. A particular medicine can only be reimbursed with respect to specific medical indications noted in the summary of product characteristics. For example, children are eligible for reimbursements for the costs of ADHD prescription medication when the prescription indication is ADHD. Reimbursements from all Finnish pharmacies are recorded in the National Prescription Register maintained by the Social Insurance Institution. The register contains information on the child's birth date and sex and the prescription dispensing date. Although the register does not include information on ADHD diagnoses, all children presumably had an adequate diagnosis of ADHD before a medication prescription was dispensed.

Study Population and ADHD Medication Use

ADHD medication use was examined by age-, sex-, and birth month–matched population, with follow-up data from children born in 2005, 2006, and 2007 with permanent residence in Finland (N = 182 802) at the end of December 31, 2017. The children were followed from their sixth birthday until the end of calendar years of their 12th (born 2005), 11th (born 2006), or 10th (born 2007) birthday.

The first purchase of medication for ADHD was the main outcome. Altogether, 7054 cases with medication were identified. Medication for ADHD included all the substances reimbursable in Finland within the category of centrally acting sympathomimetic drugs according to the Anatomic Therapeutic Chemical Classification System (N06BA): methylphenidate, atomoxetine, dexamphetamine, and lisdexamphetamine. The prevalence of ADHD medication use was defined as the number of children who had at least one reimbursed purchase of ADHD medication compared with the number of children in the total population.

Relative Age

Children were classified into 3 groups depending on their month of birth: the oldest were born in January to April, the middle group in May to August, and the relatively youngest in September to December. Finnish children must attend kindergarten (refers to a preprimary education in Finland) for one year before compulsory basic education begins. The cutoff date for school eligibility is December 31. Children start kindergarten in the calendar year of their sixth birthday and first grade of comprehensive school (basic education) in the year of their seventh birthday. The school year starts in mid-August. Although delayed school entry is possible, this is a relatively uncommon procedure, and the number of children whose school entry is delayed is decreasing. According to Statistics Finland (V. Hämäläinen, personal communication, 2019), 1100 children were held back one year in 2010 (875, 713, and 698 children in 2012, 2013, and 2014, respectively). Furthermore, delayed entry into primary education because of inattention and hyperactivity deficits is rare. Instead, children are expected to receive either special or intensified support at school if needed.

Statistical Analyses

The time of the first ADHD medication purchase was analyzed by a series of sex-stratified Cox proportional hazards regression models by using right censoring.[31] The follow-up ended on December 31, 2017. Children born in the first months of the calendar year were set as a reference group. Inspection of log-minus-log survival curves did not indicate a violation of the proportional hazard assumption. For sensitivity analyses, we further assessed whether hazard ratios (HRs) change over time. Regarding use of medication, it is possible that children born in January to April will later move toward their classmates born in September to December, which would result in different HRs depending on the duration of the study.[17,23] In a restricted model, the follow-up ended in the year of the children's eighth birthday. In additional analyses, we also examined incidence rate ratios (IRRs). This relates to the fact that children born in September to December are relatively close in age compared with children born in January to April in the following year. Pairwise comparisons were examined for children born in September to December 2005 and 2006 relative to children born in January to April 2006 and 2007. Analyses were performed by using SPSS version 25 (IBM SPSS Statistics, IBM Corporation) and the computing environment R (ggplot2 package).

RESULTS

Cumulative Proportions of ADHD Medication Use

The study population included 182 802 Finnish children born in 2005 to 2007 (93 374 boys, 89 428 girls). By the end of follow-up, 7054 children had received ADHD medication at least once (5775 boys, 1279 girls). Cumulative proportions for ADHD medication use in boys and girls born in 2005 to 2007 are shown in Fig 1. Cumulative proportions increased somewhat steadily until age 9 and then started to slow down across both sexes. At the end of follow-up (December 31, 2017), 5.9% to 6.4% of boys and 1.4% to 1.6% of girls had at least 1 reimbursed purchase of ADHD medication.

In Cox regression analyses, it was shown that the HRs for boys (Table 1) were somewhat stable across cohorts. For boys born in May to August (HRs ~1.1–1.2) and September to December (HRs ~1.3), ADHD medication use was more common compared with those born in January to April. Among girls born in either May to August or September to December 2005, the HRs were 1.3 and 1.4, respectively, when compared with those born between January and April. Among girls born in either May to August or September to December 2007, the HRs were 1.6 and 1.7, respectively. After restricting the follow-up to the year of the children's eighth birthday, the RAE became more pronounced (Tables 1 and 2). Among boys born in May to August and September to December, the HRs were 1.2 to 1.3 and 1.5 to 1.7, respectively, compared with those born in January to April. Among girls, HRs for later-born children (born in May to August and September to December) were 1.7 to 1.9 and 2.0 to 2.1, respectively, compared with their early-born peers (January to April).

Incidence Ratios in ADHD Medication Use by Birth Month

ADHD medication incidence per 1000 persons across 3 cohorts are presented in Tables 3 and 4. Further analyses showed that incidence ratios

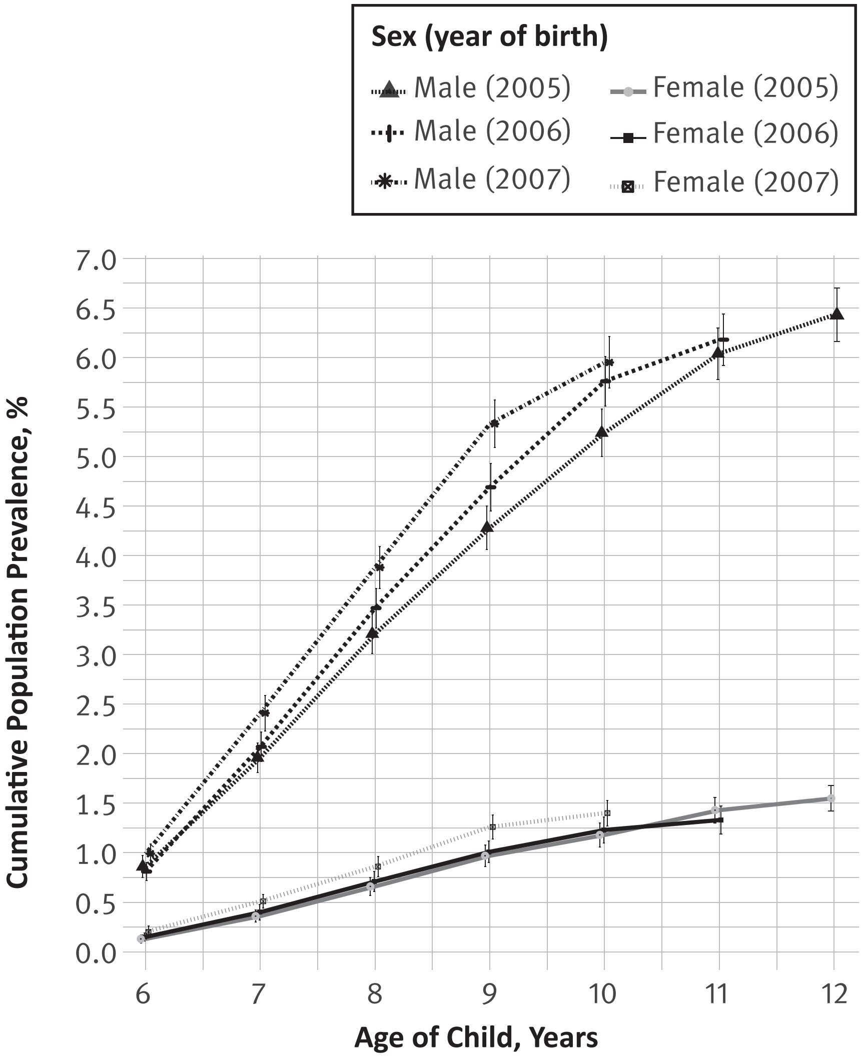

FIGURE 1
Cumulative proportions of ADHD medication use across cohorts by sex.

were significant in the years of primary education entry. After comparing boys (Table 3) born at the end of years 2005 and 2006 (ie, September to December) and who are relatively close in age with children born in the first months of the following calendar years, the IRRs at age 6 (ie, the year of kindergarten entry) were 1.8 and 1.7, whereas the IRRs at age 7 were 1.4. In girls (Table 4), the corresponding analyses yielded significant IRRs at age 7 (IRRs 2.5 and 2.8), when children enter school. IRR estimates were >1 for each age interval. This indicates that there was no catch-up effect among those born in January to April.

DISCUSSION

With this study, we provide up-to-date evidence for the association between children's birth month and ADHD from a single jurisdiction. In line with our hypothesis, our findings reveal an association among children between younger relative age in the school year and receiving medication for ADHD. The findings further reveal that differences in maturity, which are stronger at younger ages, moderate the association between children's birth month and ADHD medication use because the RAE was stronger across sexes in the years of school entry. We also observed that the RAE in medication for ADHD seemed more pronounced in the female population than the male population. Importantly, the comparison of 3 consecutive cohorts indicated that the association between ADHD medication use and relative age was stable among the male population but showed signs of increase among the female population.

Our findings are consistent with earlier studies on the influence of relative age on the increased likelihood of receiving ADHD medication.[6,7] The observed RAE among children (born between 2005 and 2007) in our study also corroborates the findings from the Finnish study that revealed greater cumulative incidence of clinically diagnosed ADHD among relatively younger children within the Finnish male and female populations born between 1991 and 2004.[13] Most importantly, along with the aforementioned study, our findings increase the understanding of the RAE in ADHD by providing a comprehensive picture of the association within a single country. Although researchers of previous studies have suggested relatively low prescribing rates for ADHD in Finland,[24] our results indicated that the prevalence of ADHD medication use has increased somewhat rapidly among Finnish children. In our study, we observed that 7.3% of boys born in September to December in 2005 had received at least one reimbursed ADHD medication purchase by the end of follow-up, whereas in girls, the comparable figure was 1.8%.

An important discovery that emerged was that the RAE in ADHD among Finnish children is particularly prominent in the early school years. This is in line with the results of a Swedish study,[17] whereas a Norwegian study concluded that the RAE increased from grade 3 onwards.[18] The finding that the relatively youngest children in classrooms are more likely to be

TABLE 1 Risk of ADHD Medication Use Among Boys Born 2005–2007 by Birth Month

	2005			2006			2007		
	Persons	Cases With ADHD Medication, *n* (%)	HR (95% CI)	Persons	Cases With ADHD Medication, *n* (%)	HR (95% CI)	Persons	Cases With ADHD Medication, *n* (%)	HR (95% CI)
Total	30 580	1967 (6.4)	—	31 414	1941 (6.2)	—	31 380	1867 (5.9)	—
Follow-up on December 31, 2017									
January to April (ref)	9911	529 (5.3)	1	10 500	572 (5.4)	1	10 350	548 (5.3)	1
May to August	10 638	705 (6.6)	1.24*** (1.10–1.40)	10 822	665 (6.1)	1.13* (1.01–1.27)	10 927	652 (6.0)	1.13* (1.01–1.27)
September to December	10 031	733 (7.3)	1.39*** (1.24–1.54)	10 092	704 (7.0)	1.29*** (1.16–1.45)	10 103	666 (6.6)	1.26***(1.12–1.41)
Follow-up at the end of the year of eighth birthday									
January to April (ref)	9911	225 (2.3)	1	10 500	306 (2.9)	1	10 350	322 (3.1)	1
May to August	10 638	350 (3.3)	1.27** (1.07–1.50)	10 822	362 (3.3)	1.15 (0.99–1.34)	10 927	422 (3.9)	1.25** (1.08–1.44)
September to December	10 031	407 (4.4)	1.67*** (1.42–1.97)	10 092	423 (4.2)	1.45*** (1.25–1.68)	10 103	472 (4.7)	1.51*** (1.31–1.74)

Cox proportional hazards regression model. Cases include all the children who had ≥1 reimbursed purchase of ADHD medication by the end of follow-up (% = cumulative incidence). CI, confidence interval; ref, reference category; —, not applicable.
*** $P \leq .001$
** $P \leq .01$
* $P \leq .05$.

prescribed medication for ADHD than their relatively older peers in the years of school entry underscores the notion that school entry regulations may play an important role.[7] For example, children in Finland and Denmark start first grade in the calendar year of their seventh birthday, and the cutoff date for school eligibility in both countries is December 31. However, in findings from the Danish study, it is shown that although the use of medication for Danish children with ADHD had increased during the years 2000 to 2012, the RAE on ADHD medication use decreased and further vanished during the aforementioned study years.[20] This may stem from the fact that ~40% of children born in October to December are held back one year in the Danish school system.[20–22] In Finland, delayed school entry is rare and ever decreasing. Meanwhile, the prevalence of ADHD medication use has increased steadily. Therefore, it is possible that in countries with an RAE, the more immature behavior of younger children within the school year is treated as ADHD.[7,11] In line with this notion, teacher ratings of whether children display clinically significant ADHD symptomology are more strongly associated with relative immaturity when compared with parent ratings.[15,17] In addition to school entry regulations, we speculate that the increased availability and improved use of school contingency management could also protect from the RAE among children with ADHD susceptibility.[27,28]

Our findings indicate a large male-to-female discrepancy in ADHD medication use among the Finnish child population. This was also addressed in a recent retrospective observational study in which researchers examined trends in ADHD medication use among children in 13 countries.[24] Furthermore, our study findings extend previous research by showing that the association between relative age and ADHD medication use is more prominent among the female population.[7] This finding is in line with studies from Canada[16] and Norway.[18] In fact, the observed HRs in the male and female populations are similar to those of a Canadian study.[16] In comparison, researchers of studies from Iceland,[14] Denmark,[21] and Sweden[17] did not discover sex-based differences. Regarding sex differences, our findings indicate that the prescribing rates for ADHD medication among boys born toward the end of the year are close to the upper threshold of pooled estimates of ADHD prevalence.[5] Consequently, there is less room for an increase in ADHD medication use in boys compared with girls. This might explain why the RAE appeared to remain stable in boys born in 2005 to 2007.

Additionally, because of a significant sex discrepancy in ADHD medication use, the average prevalence ratio among girls is well below the population average. We speculate that over the long-term, as the prevalence ratio among girls moves closer to the population average, the RAE may weaken.[32] Another possible explanation is that, at present, different manifestations of ADHD may go unnoticed in the female population in Finland, and those with ADHD medication are perhaps more likely to suffer from co-occurring disorders,

TABLE 2 Risk of ADHD Medication Use Among Girls Born 2005–2007 by Birth Month

	2005			2006			2007		
	Persons	No. Cases With ADHD Medication (%)	HR (95% CI)	Persons	No. Cases With ADHD Medication (%)	HR (95% CI)	Persons	No. Cases With ADHD Medication (%)	HR (95% CI)
Total	29 528	459 (1.6)	—	30 060	401 (1.3)	—	29 840	419 (1.4)	—
Follow-up at December 31, 2017									
January to April (ref)	9753	122 (1.3)	1	10 004	99 (1.0)	1	9979	98 (1.0)	1
May to August	10 177	165 (1.6)	1.30* (1.03–1.64)	10 306	149 (1.4)	1.47** (1.14–1.89)	10 205	160 (1.6)	1.60*** (1.25–2.06)
September to December	9598	172 (1.8)	1.44** (1.14–1.81)	9750	153 (1.6)	1.59*** (1.24–2.05)	9656	161 (1.7)	1.71*** (1.33–2.19)
Follow-up at the end of year of eighth birthday									
January to April (ref)	9753	41 (0.4)	1	10 004	43 (0.4)	1	9979	55 (0.6)	1
May to August	10 177	72 (0.7)	1.69** (1.15–2.47)	10 306	82 (0.8)	1.85*** (1.28–2.68)	10 205	96 (0.9)	1.71** (1.23–2.38)
September to December	9598	81 (0.8)	2.01*** (1.38–2.93)	9750	87 (0.9)	2.08*** (1.44–3.00)	9656	107 (1.1)	2.02*** (1.46–2.79)

Cox proportional hazards regression model. Cases include all the children who had ≥1 reimbursed purchase of ADHD medication by the end of follow-up (% = cumulative incidence). CI, confidence interval; ref, reference category; —, not applicable.

*** $P \leq .001$

** $P \leq .01$

* $P \leq .05$.

such as oppositional defiant disorder. Recent studies on sex differences indicate that emotional and behavioral difficulties are stronger predictors of ADHD diagnosis in girls when compared with boys.[29,30] There is also evidence that emotional and behavioral difficulties are also in greater contrast to what is perceived as normative functioning in girls compared with boys.[30] Interestingly, researchers of one study discovered that delayed school entry improved, in particular, social functioning among girls in early school years.[21] Nevertheless, there is a need for studies in which researchers examine the extent to which relative age is associated with long-term outcomes and social functioning.

The main strength of our study is the population-based design using prescription register data that cover all reimbursed outpatient ADHD medication purchases in children. However, it is important to acknowledge that with our register-based data, we could not rule out whether the increased risk for ADHD medication use among relatively younger children relates to the

TABLE 3 Incidence per 1000 Persons for ADHD Medication Among Boys Born 2005–2007 by Birth Month

Age, y	No. Cases and Incidence (95% CI) January to April			No. Cases and Incidence (95% CI) May to August			No. Cases and Incidence (95% CI) September to December			IRR (95% CI)	
	2005	2006	2007	2005	2006	2007	2005	2006	2007	2005 September to December versus 2006 January to April	2006 September to December versus 2007 January to April
6	45; 4.5 (3.4–6.1)	69; 6.6 (5.2–8.3)	68; 6.6 (5.2–8.3)	101; 9.5 (7.8–11.5)	74; 6.8 (5.4–8.6)	111; 10.2 (8.4–12.2)	116; 10.6 (8.7–12.8)	112; 11.1 (9.2–13.3)	131; 13.0 (10.9–15.3)	1.76 (1.31–2.38)^{a}	1.69 (1.25–2.29)^{a}
7	82; 8.2 (6.7–10.3)	104; 9.9 (8.1–12.0)	117; 11.3 (9.4–13.5)	114; 10.7 (8.9–12.9)	134; 12.4 (10.5–14.7)	156; 14.3 (12.2–16.7)	140; 14.0 (11.8–16.5)	156; 15.5 (13.2–18.1)	172; 17.0 (14.7–19.7)	1.41 (1.09–1.82)^{a}	1.37 (1.08–1.74)^{a}
8	98; 9.9 (8.1–12.0)	133; 12.7 (10.7–15.0)	137; 13.2 (11.2–15.6)	135; 12.7 (10.7–15.0)	154; 14.2 (12.2–16.7)	155; 14.2 (12.1–16.6)	151; 15.1 (12.8–17.6)	155; 15.4 (13.1–18.0)	170; 16.8 (14.5–19.5)	1.19 (0.94–1.50)	1.16 (0.92–1.46)
9	88; 8.9 (7.2–10.9)	112; 10.7 (8.9–12.8)	124; 12.0 (10.0–14.3)	108; 10.2 (8.4–12.2)	130; 12.0 (10.1–14.3)	159; 14.6 (12.5–17.0)	131; 13.1 (11.0–15.5)	140; 13.9 (11.8–16.4)	172; 17.0 (14.7–19.7)	1.22 (0.95–1.58)	1.16 (0.91–1.48)
10	88; 8.9 (7.2–10.9)	88; 8.4 (6.8–10.3)	102; 9.9 (8.1–12.0)	103; 9.7 (8.0–11.7)	117; 10.8 (9.0–12.9)	71; 6.5 (5.2–8.2)	101; 10.1 (8.3–12.2)	131; 13.0 (10.9–15.4)	22; 2.2 (1.4–3.3)	1.20 (0.90–1.60)	1.31 (1.02–1.71)^{a}
11	69; 7.0 (5.5–8.8)	66; 6.3 (4.9–8.0)	—	101; 9.5 (7.8–11.5)	56; 5.2 (4.0–6.7)	—	77; 7.7 (6.1–9.6)	10; 1.0 (0.5–1.8)	—	1.22 (0.88–1.70)	—
12	59; 6.0 (4.6–7.7)	—	—	43; 4.0 (3.0–5.4)	—	—	17; 1.7 (1.1–2.7)	—	—	—	—

IRRs are between boys born in the last third of the year (September to December) and boys born in the first third (January to April) of the following year. CI, confidence interval; —, not applicable.

^{a} IRR is significant at $P < .05$.

TABLE 4 Incidence per 1000 Persons for ADHD Medication Among Girls Born 2005–2007 by Birth Month

Age, y	No. Cases and Incidence (95% CI) January to April			No. Cases and Incidence (95% CI) May to August			No. Cases and Incidence (95% CI) September to December			IRR (95% CI)	
	2005	2006	2007	2005	2006	2007	2005	2006	2007	2005 September to December versus 2006 January to April	2006 September to December versus 2007 January to April
6	6; 0.6 (0.2–1.3)	11; 1.1 (0.6–1.9)	12; 1.2 (0.7–2.0)	18; 1.8 (1.1–2.7)	19; 1.8 (1.1–2.8)	23; 2.3 (1.5–3.3)	14; 1.5 (0.8–2.4)	14; 1.4 (0.8–2.4)	26; 2.7 (1.8–3.9)	1.33 (0.60–3.01)	1.19 (0.55–2.64)
7	18; 1.8 (1.1–2.9)	11; 1.1 (0.6–1.9)	14; 1.4 (0.8–2.3)	23; 2.3 (1.5–3.3)	27; 2.6 (1.8–3.8)	31; 3.0 (2.1–4.3)	26; 2.7 (1.8–3.9)	38; 3.9 (2.8–5.3)	45; 4.7 (3.4–6.2)	2.46 (1.23–5.19)[a]	2.78 (1.53–5.29)[a]
8	17; 1.7 (1.0–2.7)	21; 2.1 (1.3–3.2)	29; 2.9 (2.0–4.1)	31; 3.0 (2.1–4.3)	36; 3.5 (2.5–4.8)	42; 4.1 (3.0–5.5)	41; 4.3 (3.1–5.7)	35; 3.6 (2.5–4.9)	36; 3.7 (2.7–5.1)	2.04 (1.21–3.50)[a]	1.24 (0.75–2.04)
9	26; 2.7 (1.8–3.9)	22; 2.2 (1.3–3.2)	25; 2.5 (1.7–3.6)	34; 3.3 (2.4–4.6)	33; 3.2 (2.2–4.4)	45; 4.4 (3.3– 5.8)	31; 3.2 (2.2–4.5)	36; 3.7 (2.6–5.1)	47; 4.9 (3.6–6.4)	1.47 (0.85–2.57)	1.47 (0.89–2.48)
10	20; 2.1 (1.3–3.1)	19; 1.9 (1.2–2.9)	18; 1.8 (1.1–2.8)	17; 1.7 (1.0–2.6)	25; 2.4 (1.6–3.5)	19; 1.9 (1.2–2.9)	26; 2.7 (1.8–3.9)	24; 2.5 (1.6–3.6)	7; 0.7 (0.3–1.4)	1.43 (0.79–2.62)	1.37 (0.74–2.55)
11	17; 1.8 (1.0–2.7)	15; 1.5 (0.9–2.4)	—	28; 2.8 (1.9–3.9)	9; 0.9 (0.4–1.6)	—	30; 3.1 (2.1–4.4)	6; 0.6 (0.2–1.3)	—	2.09 (1.13–3.97)[a]	—
12	18; 1.9 (1.1–2.9)	—	—	14; 1.4 (0.8–2.3)	—	—	4; 0.4 (0.1–1.0)	—	—	—	—

IRR are between girls born in the last third of the year (September to December) and girls born in the first third (January to April; reference category) of the following year. CI, confidence interval; —, not applicable.

[a] IRR is significant at $P < .05$.

misidentification of ADHD or perhaps to the fact that relative immaturity aggravates ADHD traits. Nevertheless, the empirical findings support the idea that school entry plays an important role. Further studies with better used information from various national registers and adjustment for confounding factors are needed to examine the extent to which the RAE is associated with medication use and diagnoses and whether ADHD presentations moderate the RAE. Importantly, as the Finnish Current Care Guideline of ADHD enhances the notion that it is pivotal to assess children's symptomology relative to age, clinicians have become more aware of the RAE in ADHD. Therefore, it is important to replicate our analyses in children born after 2007 in the near future to examine the extent to which increased awareness is associated with standards in prescribing for children with ADHD.

CONCLUSIONS

With our study, we provide evidence that children born in May to August and September to December (ie, relatively younger children in a school class) are more likely to receive ADHD medication in Finland compared with children born in January to April. The risk of a modest RAE was stable among boys but appeared to be increasing among girls. These findings may stem from the fact that ADHD medication use among boys has become common in Finland, whereas ADHD medication use among girls is still relatively low. The RAE in ADHD medication use was more pronounced in the years when children enter school. Therefore, there is a need to consider school entry regulations and, particularly, increase the availability of school contingency management programs to reduce the RAE. Importantly, there is a need for prospective studies in which researchers examine whether relative age is associated with youth and adult outcomes in children with ADHD susceptibility.

ABBREVIATIONS

ADHD: attention-deficit/hyperactivity disorder
HR: hazard ratio
IRR: incidence rate ratio
RAE: relative age effect

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