Factors influencing perceived ADHD symptoms in primary school children in the Netherlands: A cross-sectional analysis of age and gender trends

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Abstract

This study aims to investigate relative age within primary school grades as a potential influential factor of perceived ADHD symptoms. It examines whether relatively younger pupils show more ADHD symptoms than their classmates. The study is of cross-sectional design, using data of primary school children throughout the Netherlands. Participating children are in the age range of four to twelve years old, $N = 168$. To measure ADHD symptoms, the SNAP-IV (18) has been filled out by parents of the participating children. Relative age serves as the main predictor of this study. Simple linear regressions have been run on relative age (predictor) and ADHD symptoms (dependent). Analyses showed that relative age is no predictor of ADHD symptoms, implying that relative age is no influential factor in perceived ADHD symptoms. However, data screening pointed out that the sample of the current study might not be representative for the general population. Furthermore, the current research design worked with parental observations of ADHD symptoms, and not official ADHD diagnoses. Whether a child has had an ADHD diagnosis was unknown during this study. Incorporating this information in future research could potentially lead to a better understanding of the topic. All in all, the results of this study must be interpreted with care and future research is needed to (dis)prove the relation between relative age and ADHD symptoms.

Layman's Abstract

Attention-deficit/hyperactivity disorder is a very prevalent disorder, affecting 5% of children and 2.5% of adults. The diagnostic process of ADHD is based on interpretations of observed behavior. This subjective process is sensitive to mistakes. It is known that ADHD symptoms decrease over time: younger children show more of the symptoms than older children or adults. An age difference of only one month can already make big differences in observed ADHD behaviors. Age differences are very common within grades of Dutch primary school, even though the same behavior is expected from the children. This could result in the younger cohort's behavior being misinterpreted for ADHD symptoms, when the difference in behavior is actually caused by underlying developmental nuances between age groups.

This study uses data on ADHD symptoms in primary school children throughout the Netherlands, observed by their parents (SNAP-IV (18)). The relative age of the children within their grade served as the main predictor of this study, which investigates whether relative age is a predictor of ADHD symptoms.

The analyses that have been carried out show that, our sample, relative age was not a predictor for ADHD symptoms. However, the sample has been screened thoroughly, and some findings point out that it may not be representative for the general population. This means that, when the same research is done on a different population, the results might be different and perhaps do show that relative age is a predictor of ADHD symptoms. Future research is therefore needed to draw a reliable conclusion about the relationship between relative age and ADHD, as it could be important for the diagnostic process of the disorder.

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Introduction

The assessment of behavioural patterns as problematic is dependent on deviations from widely recognised standards, including expected behaviours associated with individuals of comparable age. This also applies for the diagnostic process of attention-deficit/hyperactivity disorder (ADHD). According to the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.; DSM–5; American Psychiatric Association, 2013), ADHD entails “a persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with functioning or development” (p. 59). Diagnosing ADHD is not an objective process, since there is no objective test to prove the presence of ADHD, and the DSM-5 criteria are based on perceived behaviour (Gualtieri & Johnson, 2005). The diagnosis is very prevalent. In most cultures, 2.5% of adults and 5% of children is diagnosed with ADHD (American Psychiatric Association, 2013), which supports previous research, stating that ADHD symptoms decrease over time (Wüstner et al., 2019; Döpfner et al., 2015). Comparing behaviour in younger and older children reveals a higher presentation of ADHD symptoms among the younger cohort.

In the Dutch primary school system, there are eight different grades. Grades 1 and 2 are considered preschool and grades 3 through 8 are seen as school grades. You start primary school in grade 1 as soon as you reach the age of four years and finish it after grade 8. An academic year starts in September and ends in June, making the duration of an academic year ten months. In the month that a child turns four years old, he or she can start in preschool (grade 1[1], see Table 1), even though this might be in the middle of an academic year. How long a child spends in these preschool grades, depends on their birth month, as portrayed below in Table 1 (Driessen et al., 2014; Van der Veen & Karssen, 2019). Ideally, children spend twenty months in preschool – two complete academic years – but birth month variations may affect this. October to December births, who miss only a fraction of their first year, often progress to the next grade. However, parents or teachers may decide on an extra preschool year based on readiness. An extra preschool year concludes a total of almost three preschool years, but early progression to grade 3 creates a total preschool period of less than two complete years. Children born in October, November or December are often considered relatively young compared to their peers, as parents and teachers often choose the latter option. This means that they will be younger than their peers when they start their first school year. Children born in January to March are generally considered relatively old when starting in school, and children born from April to September are usually considered regular. So, within one school grade, ages can differ up to almost one year, which comes with big developmental differences.

Table 1

Age Distribution of Children within Preschool Grades depending on Birth Month in the Netherlands

Month in which a child turns 4	Months in grade 1^1	Common procedure after grade 1^1	Months in grade 1^2	Months in grade 2	Total months in preschool (grades 1^1, 1^2, and 2)
January – March	6 – 4	Often stays in grade 1 for another year.	10 + 10	10	26 – 24
April – September	3 – 0	Often stays in grade 1 for another year.	10 + 10	10	23 – 20
October – December	9 – 7	Often progresses to grade 2;	NA [a]	10	19 – 17 [a]
		But sometimes teachers/parents decide on an extra year in grade 1.	10 [b]	10	29 – 27 [b]

Note. [a] Children that start in school earlier are relatively young; [b] Children whose parents or teachers decide they need another year in preschool start relatively old in school.

Even though children could differ up to one year of age within one grade, they are expected to function on the same level. The first studies on this "age-effect" within grades have suggested that relatively younger pupils show more ADHD symptoms compared to their relatively older peers, and therefore, have a higher risk of getting an ADHD diagnosis (Stijntjes et al., 2014) compared to their peers. Even though people with ADHD keep experiencing symptoms of the disorder when they get older, the symptoms may change over time. Hyperactivity and impulsivity generally fade, but inattention is still being reported over time (Greven et al., 2011). With the age difference of one year, research has shown that the youngest boys in a grade were 30% more likely to receive an ADHD diagnosis and 70% of the youngest girls were (Morrow et al., 2012). Even if the age difference is only one month, 8.4% of the younger pupils are diagnosed with ADHD, compared to only 5.1% of the older pupils in the same grade (Elder, 2010). It is crucial to determine whether younger students exhibit more ADHD symptoms than their older classmates, as this could result in an inaccurate diagnosis of ADHD, stemming from unwarranted comparisons of behaviour to the wrong age group. Consequently, this may influence interventions and the needless prescribing of ADHD medication (Morrow et al., 2012), which might expose individuals to undesirable side effects (Massuti et al., 2021). The comparison of behavioural patterns between younger and older children within the same primary school grade may result in a higher likelihood of younger children receiving an ADHD diagnosis, potentially leading to misdiagnosis due to age-related variations in behaviour (Stijntjes et al., 2014).

The decline in the overall ADHD symptoms that is observed with increasing age, is contingent upon gender-specific factors (Faheem et al., 2022; Greven et al., 2011). ADHD was long thought to be a male dominant disorder, but research has shown it affects both men and women equally (Faheem et al., 2022). This implies varying clinical presentations of the disorder across gender. As boys with ADHD show more hyperactive or impulsive behaviour during childhood, in contrast to the more inattentive presentation observed in girls (Øie et al., 2018), it is important to note that hyperactivity and impulsivity symptoms commonly fade as a child ages (Greven et al., 2011). By adolescence, gender differences in ADHD hyperactivity levels have usually decreased already, implying that this development takes place during primary school ages (Ingram et al., 1999). By adulthood, hyperactivity symptoms have decreased even more significantly (Ingram et al., 1999). This implies that the course of these symptoms over time is different for men and women. Therefore, it is expected that variations in hyperactivity-related ADHD symptom trends between male and female children can be observed across primary school grade levels.

The aim of this study is to identify the relationship between ADHD symptoms and relative age within the same grade, and whether this changes over time during the eight years in primary school. This study will try to answer the following research question: *Do children that are relatively younger within a primary school grade show more ADHD symptoms than their relatively older peers that are in the same class?* To answer this question, the interaction between ADHD symptoms and relative age of pupils within the same grade will be investigated. These findings could provide important information for the process of diagnosing ADHD. Because total ADHD symptoms diminish with age (Wüstner et al., 2019; Döpfner et al., 2015), this effect is hypothesised to decrease with ascending school grades. In conclusion, these findings lead to the following hypotheses:

$H1_a$: *Relatively younger pupils within a primary school grade show more total ADHD symptoms than their relatively older peers.*

$H1_b$: *The effect in $H1_a$ decreases with the progression of school grades.*

Further, we expect to find varying hyperactivity-related ADHD symptom trends between male and female children across primary school grade levels when studying the effect of relative age on ADHD symptoms. This is hypothesised because girls with ADHD generally appear to be more inattentive, whereas boys show more hyperactive and impulsive behaviour (Øie et al., 2014). By adolescence, however, hyperactivity has usually decreased (Ingram et al., 1999), indicating different gender-related hyperactivity trends over time. So, when previously formulated hypothesis $H1_b$ can be accepted, the following exploratory hypothesis will be tested:

$H_{exploratory}$: *The ADHD hyperactivity symptom trend over ascending grades is different for boys and girls.*

Methods

Design

The current study uses cross-sectional data of participants of different ages and in different grades at different primary schools. It is part of a larger on-going research project, investigating the effects of a preventative school programme aiming on the development of social-emotional skills in primary school children. Participating schools implement this programme to increase the wellbeing of their students. This current study only uses the baseline (*T0*) data and has an observational study design.

Participants

The participants of the study are children (*N* = 168) of 13 participating primary schools in the Netherlands, with the age range of four to thirteen years. All parents and children from the age of twelve signed informed consent as an inclusion criterium. Other inclusion criteria are a complete filled out SNAP-IV (Swanson, 1983) questionnaire, and that the information that the *relative age* calculations require (birth date, current grade) is provided.

Measures

The ADHD symptoms will be measured using the SNAP-IV (Swanson, 1983), a questionnaire filled out by the children's parents. It is an abbreviated version of the Swanson, Nolan, and Pelham (SNAP) Questionnaire (Swanson, 1992; Swanson et al., 1983). It consists of 18 items that are rated on a 4-point scale (0 = *not at all*, 1 = *just a little*, 2 = *quite a bit*, 3 = *very much*). It has an *inattention* (*Q1-9*) and a *hyperactivity* (*Q10-18*) subscale, based on the DSM-5 criteria (American Psychiatric Association, 2013). The sum scores of the items within each subscale indicate whether symptoms appear to be not clinically significant (< 13), mild (13-17), moderate (18-22) or severe (23-27). Existing literature points out that the SNAP-IV is a valid screening tool for use in randomized controlled trials and clinical settings (Hall et al., 2020), which applies for this current research. The current study assumes that ADHD symptoms are experienced as a problem when they are increased compared to peers.

The relative age of the pupils will be represented by a proxy variable regarding the number of days spent in preschool. A continuum will be made on which all students get scored, illustrating the number of days spent in preschool more or less than average.

With a child's date of birth and grade, the variable *relative age* can be computed. First, the total number of days spent in school will be calculated. For all participating schools, we assume that academic years start on the first Monday of September and that they end on the last Friday of June. This study uses the number of days spent in preschool rather than the number of months, unlike previous research. This is done because an age difference of one month can already result in variations of perceived ADHD behaviour (Elder, 2010), which would be overlooked when using the number of preschool months. Second, the actual number of days spent in preschool will be calculated. Third, an assumption will be made about the expected number of days in preschool, which then is subtracted from the actual number of days. This results in a discrepancy score, which will be standardized to increase interpretability, using the mean and standard deviation of the entire sample population. In order to increase interpretability of these scores, they have been standardised and make up the variable *relative age*, which will be used in analysis.

A positive z-score implies that a child has spent more days in preschool than the ideal, meaning the child is a relatively old student. In general, children born in January, February and March will be placed on this side of the spectrum (above $z = 0$). A negative z-score means the child has spent fewer days in preschool than expected, which concludes the child to be relatively young. Children born in October, November, or December will be categorized either on this *relatively young* side (below $z = 0$) or the *relatively old* side of the spectrum (above $z = 0$).

In this study, it is assumed that grade skipping and repetition are only applicable in grades 3 through 8. Due to data limitations on specific grade-relation information, binary controlling variables, *repeated grade* (0 = no; 1 = yes) and *skipped grade* (0 = no; 1 = yes), will be computed. Criteria for these variables are attendance percentages and grade levels. Additionally, whether a child is currently enrolled in a preschool grade will be considered using controlling variable *grade 1/2 indicator*, as these early grades may influence the relationship between relative age and ADHD scores. In conclusion, when using the *relative age* variable, analyses will be controlled for grade skipping, grade repetition, and current enrolment in preschool.

Procedure

At the beginning of the academic year 2023-2024 – in September 2023 – data has been collected at the participating schools throughout the Netherlands. The data collection entailed parent-report online questionnaires about all participating children on ADHD symptoms. They have also filled out a form with demographic information, such as the children's dates of birth and the grades they are in.

The research proposal (2023-04-04-B.E.Boyer-V4-4377) has been reviewed and approved by the Leiden University Psychology Research Ethics Committee on April 12th, 2023. Parents and children from the age of twelve have signed informed consent.

Statistical analysis

Assumptions. The assumption of linearity proposes that the relationship between the predictor and outcome variables is linear. To verify this, scatterplots of the variables and fitted lines were inspected. At first, the visual examination provided no support for the linearity assumption. After a square root transformation, however, the assumption of linearity was met.

The independence of residuals assumes that the errors are not correlated with each other. To check this assumption, residual plots were examined. The plot does not show any clear patterns or trends, conforming the independence of residuals.

Homoscedasticity implies constant variance of residuals across all levels of the independent variable. The residual plot was examined against predicted values. This did not reveal any systematic change in variance, therefore supporting the assumption of homoscedasticity.

Normality of residuals assumes that errors are normally distributed. A Q-Q plot was assessed, which indicated a normal distribution. The Kolmogorov-Smirnov test is not statistically significant ($p = .091$), therefore supporting the assumption of normally distributed residuals.

Analysis. An a priori power analysis in *G*Power* (Erdfelder et al., 1996) concludes a minimum sample size of N_{min} = 89 for a power of .95 in a simple linear regression with one predictor variable and three controlling variables ($H1_a$). For a simple linear regression with two predictor variables (interaction) and three controlling variables ($H1_b$), N_{min} = 107. As this current study has more participants, there is enough statistical power for the analyses. As this study does not use a specific population based on ADHD symptoms, scores of the SNAP-IV (Swanson, 1983) can be widely distributed, although outliers will not be excluded from the study. There was no missing data, as a complete questionnaire was one of the inclusion criteria of this study.

Hypothesis H1 will elaborate whether there is an effect of relative age on total ADHD symptoms ($H1_a$), and whether this effect changes with the progression of grades ($H1_b$). For hypothesis $H1_a$ – *Relatively younger pupils within a primary school grade show more total ADHD symptoms than their relatively older peers* – a linear regression will be run on relative age (predictor) and total ADHD symptoms (dependent). Total ADHD symptoms (*SNAP_Total*) showed a skewed distribution, thus a square root transformation was performed to ease interpretation of the results. A regression analysis will be run on the dependent variable *ADHD symptoms SQRT* and independent variable ($H1_a$) *relative age*. As explained previously, controlling variables will be grade repetition, grade skipping, and presently being in preschool. For the second part of the hypothesis ($H1_b$), the same simple linear regression analysis as in $H1_a$ will be run to analyse this same effect of relative age on total ADHD symptoms, but now taking into consideration the grade in which the children currently are. This is done through an interaction variable, capturing the combined effect of relative age and grade on total ADHD symptoms. The first regression analysis ($H1_a$) will tell us whether there is a total effect of relative age on ADHD symptoms. The analysis in $H1_b$ will tell us whether this effect changes with the progression of school grades, as it is hypothesised to decrease. Effects will be determined as statistically significant when $p <$ 0.05, taking the effect size (R^2) into consideration. If no statistically significant effects are found, the same analyses will be run on a sample of only the highest and lowest scoring 5% of total ADHD scores, to indicate whether future research might be of importance.

If the found effect for hypothesis $H1_b$ – *The effect of relative age on total ADHD symptoms decreases with the progression of school grades* – shows statistical significance, the previously mentioned additional exploratory hypothesis will be analysed to elaborate whether the effect found for ADHD symptoms and grade applies differently for different genders. Previous literature points out that most gender differences in ADHD symptoms entail impulsive or hyperactive behaviour. Hence, we narrow this exploratory analysis down to the *hyperactivity* subscale of the SNAP-IV (18) data. ADHD hyperactivity symptoms showed a skewed distribution, thus a square root transformation was performed to ease interpretation of the results. For this exploratory hypothesis ($H_{exploratory}$), a multiple regression analysis will be run on the dependent variable *ADHD hyperactivity symptoms SQRT* and independent variables *gender* and *gender x grade*. Effects will be determined as statistically significant when $p <$ 0.05, taking the effect size (R^2) into consideration.

Results

Data screening

168 (36.5%) out of the 460 children in the original group of participating children, spread out over 13 different schools throughout the Netherlands, met the criteria of the current study. Mean age at the day of assessment was 8.68 years (*SD* = 2.24). The sample contained 78 males (46.6%), 88 females (52.2%), and 2 identified as "other" (1.2%). There were no missing data on the SNAP-IV items. The distribution of the SNAP-IV scores (Swanson, 1983) can be viewed in Table 2. The number of participants scoring *moderate* to *severe* has been used to examine whether the prevalence of ADHD would be representative for the general population. Categorised in the three subtypes of ADHD that are listed in the DSM-5, the sample population entails ten *inattentive*, two *hyperactive/impulsive*, and one participant with a *combined* presentation of symptoms. This makes a total of thirteen children, which represents 7.7% of all participating children. From this analysis can be concluded that the percentage of children with moderate or severe ADHD symptoms would represent the total number of ADHD diagnoses of children in the general population in the Netherlands (Ten Have et al., 2023). However, the distribution of the hyperactive/impulsive and inattentive subtypes across gender is not representative (American Psychiatric Association, 2013).

Table 2

Distribution of ADHD Inattention (top) and ADHD Hyperactivity (bottom) Symptoms across Gender

	Not clinically significant			Mild			Moderate			Severe		
		N	%		N	%		N	%		N	%
Inattention	Boys	60	35.7	Boys	11	6.5	Boys	6	3.6	Boys	1	0.6
	Girls	76	45.2	Girls	8	4.8	Girls	4	2.4	Girls	0	0
	Other	2	1.2	Other	0	0	Other	0	0	Other	0	0
	Total	138	82.1	Total	19	11.3	Total	10	6.0	Total	1	0.6
Hyper-activity	Boys	69	41.1	Boys	6	3.6	Boys	1	0.6	Boys	2	1.2
	Girls	81	48.2	Girls	7	4.2	Girls	0	0	Girls	0	0
	Other	2	1.2	Other	0	0	Other	0	0	Other	0	0
	Total	152	90.5	Total	13	7.7	Total	1	0.6	Total	2	1.2

Note. Symptom scores of <13 are interpreted as *not clinically significant*. Scores of 13-17 are considered *mild*, 18-22 is viewed as *moderate*, and symptom scores of 23-27 are considered to be *severe*.

To check whether the population is representative for the general population in terms of age and ADHD symptoms, a correlation analysis was carried out on total ADHD symptoms and age. Contradictory to existing literature, results showed no statistically significant relationship between the two variables. Results should be interpreted with care, as these findings indicate that the sample population may not be representative for the general population.

Analysis results

Hypothesis $H1_a$. To test hypothesis $H1_a$, *Relatively younger pupils within a primary school grade show more total ADHD symptoms than their relatively older peers*, a linear regression with total ADHD symptoms (dependent) and relative age (predictor) was used. Whether a child is currently in preschool, whether a child has skipped a grade, and whether a child has repeated a grade are controlling variables that were included in the analysis. Descriptive statistics and correlations for these variables are shown in Table 3. No significant correlations were found.

Table 3

Descriptive Statistics and Correlations

	Total ADHD symptoms	***N***	**%**	***M***	***SD***
Relative age	-.031			.000	1.000
Presently in grade 1 or 2	-.070	29	17.3		
Skipped a grade	-.022	9	5.4		
Repeated a grade	.118	64	38.1		

Note. $N = 168$.
*$p < .05$

Relative age, being in grade 1 or 2, having skipped a grade, and having repeated a grade together explained 2.4% of the variation in total ADHD symptoms. The observed results were not significant at the $p < .05$ level (see Table 4). This analysis shows that relative age is no significant predictor for total ADHD symptoms. Even if the analyses are repeated for only the highest and lowest scoring 5% on total ADHD symptoms, the results remain non-significant. $H1_a$ is therefore not supported.

Table 4

Linear Regression Results with Predictor Variable "Relative Age" ($H1_a$)

	B	**Std. Error**	***t***	**Sig.**
Model 1				
Relative age	-.050	.125	-.397	.692
Model 2				
Relative age	.017	.161	.104	.917
Presently in grade 1 or 2	-.464	.425	-1.091	.277
Skipped a grade	-.065	.580	-.112	.911
Repeated a grade	.461	.268	1.720	.087

Note. $N = 168$. None of the predictor variables reached statistical significance at the $p < .05$ level.
*$p < .05$

Hypothesis $H1_b$. For Hypothesis $H1_b$, *The effect found in $H1_a$ decreases with the progression of school grades*, the same analysis has been run for each school grade apart from the other grades.

From these analyses, it can be concluded that the interaction between relative age and grade is no significant predictor of total ADHD symptoms. Results can be found in Table 5.

Table 5

Linear Regression Results with Predictor Variable "Relative Age x Grade" ($H1_b$)

	B	Std. Error	*t*	Sig.
Model 1				
Relative age x Grade	-.016	.030	-.551	.583
Model 2				
Relative age x Grade	-.002	.033	-.056	.955
Presently in grade 1 or 2	-.429	.363	-1.181	.239
Skipped a grade	-.043	.581	-.074	.941
Repeated a grade	.463	.267	1.732	.085

Note. $N = 168$. None of the predictor variables reached statistical significance at the $p < .05$ level.
$^{*}p < .05$

In short, including a child's current grade in the original linear regression model results in an increase of significance, but there is still no statistical significance at the $p < .05$ level. With the school grade of a child taken into consideration, the predictor variables explain 2.4% of the variance. In conclusion, $H1_b$ cannot be accepted.

Hypothesis $H_{exploratory}$. Because the analysis of $H1_b$ did not find a trend of ADHD symptoms over ascending grades, the exploratory hypothesis will not be studied further.

Discussion

This study investigated if there is a predictive effect of relative age within a primary school grade on total perceived ADHD symptoms. The primary focus of the study was identifying factors affecting the perception of ADHD symptoms, which could lead to an incorrect ADHD diagnosis. The research was conducted on a simple random sample of children spread out over varying grades and different primary schools throughout the Netherlands. One of the hypotheses was that relatively young pupils show more total ADHD symptoms than their peers. Investigating this topic could be useful, as relative age could be taken into consideration during the diagnostic process of ADHD in the future, hopefully resulting in less incorrect diagnoses and unneeded medication use. To test this hypothesis, linear regression was used. Results were not significant, indicating that, for this sample, relative age is no predictor of total ADHD symptoms. As it is known from previous research that ADHD symptoms diminish with increasing age (Wüstner et al., 2019; Döpfner et al., 2015), it was also hypothesised that the predicting effect of relative age on total ADHD symptoms would decrease with the progression of grades. No trend was found for the effect of the grade a child is in, combined with relative age, on total ADHD symptoms. It is noteworthy that there were no significant results found in this sample, as existing literature strongly suggests that these effects should be present (Morrow et al., 2012). For both hypotheses there is the limitation that all data, both predictor and outcome variables, are collected at one point in time. Usually, with regression analysis, the data of these variables is collected at different points in time, in order to detect possible causality. In this study, cross-sectional data has been used, meaning that only the possibility of causality can be indicated by looking at different ages, but it cannot be certain.

In this research design, 38.1% has repeated a grade and 5.4% had skipped a grade. However, it was unknown which grade it was the children have skipped or repeated, or whether this was a preschool grade or a non-preschool grade. As 38.1% is a big part of the sample, it can be expected that not all of these cases repeated a preschool grade, therefore negatively influencing the analyses. When children repeat a grade, they become relatively older than their peers in their new grade and, therefore, are expected to score less high on total ADHD symptoms. However, ADHD symptoms may cause such problems, that they pose a reason to repeat a grade. This results in a child being relatively older in a new grade, but still scoring high on total ADHD symptoms. This could weaken the analysis results. Information on which children have an official ADHD diagnosis and which do not, and which grade a child has skipped or repeated, could control for this issue in future similar research designs.

It is also possible that the analyses do not show any significant results due to the sample not being representative for the general population of children in primary school grades. Firstly, it is known from previous literature that there is a relationship between the presence of ADHD symptoms and age (Wüstner et al., 2019; Döpfner et al., 2015). This was not found in the current dataset, indicating a bad representation of the general population. Secondly, past research has shown gender differences in ADHD subscales hyperactivity and inattentiveness. Hyperactivity is commonly more present in boys than girls, and they show equal levels of inattentiveness. Girls tend to be more inattentive than hyperactive (Øie et al., 2018). However, in this current dataset boys show more inattentive behaviour than girls, and boys and girls are somewhat equally affected by hyperactivity symptoms (see Table 2). As the biggest decline in hyperactivity symptoms is known to have happened by adolescence, it might be interesting to stretch the age range to eighteen years old in order to detect a bigger effect. In conclusion, it is possible that the results found in this current study were negatively influenced by the sample not being representative for the general population.

However, when assumed that scoring *moderate* or *severe* on the SNAP-IV (Swanson, 1983) subscales could indicate an ADHD diagnosis, 1.2% of the sample would be diagnosed based with the *hyperactive/impulsive* subtype, 6.0% with the *inattentive* subtype, and 0.6% with the *combined* presentation of ADHD. Together, this makes the ADHD prevalence in the participating sample 7.7%. The known prevalence of ADHD in the general population is 5% (American Psychiatric Association, 2013), which makes the ADHD prevalence of the sample quite representative for the general population.

An explanation for the small percentage of hyperactivity symptoms in the sample could be that ADHD is hereditary in first-degree biological relatives (American Psychiatric Association, 2013). This means that there is a high probability that children with ADHD have a parent with ADHD. As this current study not only required the SNAP-IV (Swanson, 1983) to be filled out by a parent, but also forms of consent to be signed on time, it is possible that parents with ADHD forgot to do so. A consequence may be that data is missing on children showing ADHD symptoms. This could explain the small prevalence of hyperactive ADHD symptoms in this current sample compared to the general population.

Not only could there have been problems filling out the SNAP-IV (Swanson, 1983), but this questionnaire itself could also pose as a limitation in this current study. This research investigates factors influencing perceived ADHD behaviour, which may result in faulty diagnoses. The SNAP-IV (18) (Swanson, 1983), however, is no diagnostic tool, but a screening tool. When filled out by a professional or a teacher, it could be a reliable predictor of diagnoses. However, when it is filled out by a parent, how it was used in this current study, it does not show good reliability (Hall et al., 2020). There might be children in this sample that struggle with ADHD symptoms, that are seen by teachers at school, but by parents at home. One reason for this may be that parents compare their child's behaviour with that of their own or that of their other children, resulting in nuanced interpretations of ADHD-like behaviours. Another reason could be that parents do not have enough resources to compare their child's behaviour to peers, like professionals and teachers do. In short, the SNAP-IV (Swanson, 1983) is not the most reliable questionnaire to use when investigating possible influential factors of incorrect ADHD diagnoses, as it is no diagnostic tool, and it shows less reliability when filled out by parents.

This current study tried to identify influential factors in perceived ADHD behaviour, which can result in faulty diagnoses. The SNAP-IV (Swanson, 1983), however, remains a screening tool rather than a diagnostic tool. This means that this current study can only draw conclusions about ADHD symptoms and not about diagnoses. High scores on this questionnaire could not be compared to the state of diagnosis concerning the child, as it was unknown which children had previously received an ADHD diagnosis. Another factor that may be contributing to not statistically significant results, is that the computed variable for relative age was solely based on dates of birth and made assumptions. Knowing when a child started in preschool, how long a child has spent in preschool, and at what age and what day a child started in school is more accurate than calculating this score based on assumptions. Another variable that might have negatively influenced the observed results is not knowing whether a child had repeated or skipped a grade, and if yes, which grade this applied to. When replicating this study, it is highly recommended to include these variables. This could improve the identification of relative age as an influential factor in ADHD diagnoses.

In conclusion, this study shows no predicting effect of relative age on total ADHD symptoms. Due to various limitations, the research sample may not be representative for the general population. Also, the used screening tool, the SNAP-IV (Swanson, 1983), may not be reliable when using parent self-report data. Furthermore, a lack of information on the participating children's diagnostic status, their time spent in preschool, whether they have skipped or repeated a grade, and if so, which grade, decreases the validity of this study. Because previous literature proposes strong effects of age on ADHD symptoms, future research on relative age and ADHD might still have positive impact on the diagnostic process of ADHD, preventing faulty diagnoses due to age-related behavioural differences.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). https://doi.org/10.1176/appi.books.9780890425596

Döpfner, M., Hautmann, C., Görtz-Dorten, A., Klasen, F., Ravens-Sieberer, U., & BELLA Study Group. (2015). Long-term course of ADHD symptoms from childhood to early adulthood in a community sample. *European child & adolescent psychiatry*, *24*, 665-673. https://doi.org/10.1007/s00787-014-0634-8

Driessen, G., Leest, B. D., Mulder, L., Paas, T., & Verrijt, T. (2014). Zittenblijven in het Nederlandse basisonderwijs: Een probleem?

Elder, T. E. (2010). The importance of relative standards in ADHD diagnoses: evidence based on exact birth dates. *Journal of health economics*, *29*(5), 641-656.

Erdfelder, E., Faul, F., & Buchner, A. (1996). GPOWER: A general power analysis program. *Behavior research methods, instruments, & computers*, *28*, 1-11.

Faheem, M., Akram, W., Akram, H., Khan, M. A., Siddiqui, F. A., & Majeed, I. (2022). Gender-based differences in prevalence and effects of ADHD in adults: A systematic review. *Asian journal of psychiatry*, *75.* https://doi.org/10.1016/j.ajp.2022.103205

Greven, C. U., Asherson, P., Rijsdijk, F. V., & Plomin, R. (2011). A longitudinal twin study on the association between inattentive and hyperactive-impulsive ADHD symptoms. *Journal of Abnormal Child Psychology*, *39*, 623-632.

Hall, C. L., Guo, B., Valentine, A. Z., Groom, M. J., Daley, D., Sayal, K., & Hollis, C. (2020). The validity of the SNAP-IV in children displaying ADHD symptoms. *Assessment, 27*(6), 1258-1271. https://doi.org/10.1177/1073191119842255

Ingram, Hechtman, L., & Morgenstern, G. (1999). Outcome issues in ADHD: Adolescent and adult long-term outcome. *Mental Retardation and Developmental Disabilities Research Reviews the Official Journal of the Society for Developmental Pediatrics.*, *5*(3), 243–250.

Massuti, R., Moreira-Maia, C. R., Campani, F., Sônego, M., Amaro, J., Akutagava-Martins, G. C., ... & Rohde, L. A. (2021). Assessing undertreatment and overtreatment/misuse of ADHD medications in children and adolescents across continents: A systematic review and meta-analysis. *Neuroscience & Biobehavioral Reviews*, *128*, 64-73.

Morrow, R. L., Garland, E. J., Wright, J. M., Maclure, M., Taylor, S., & Dormuth, C. R. (2012). Influence of relative age on diagnosis and treatment of attention-deficit/hyperactivity disorder in children. *Cmaj*, *184*(7), 755-762.

Øie, M., Hovik, K. T., Andersen, P. N., Czajkowski, N. O., & Skogli, E. W. (2018). Gender differences in the relationship between changes in ADHD symptoms, executive functions, and self- and parent-report depression symptoms in boys and girls with ADHD: A 2-year follow-up study. *Journal of Attention Disorders*, *22*(5), 446-459. https://doi-org.ezproxy.leidenuniv.nl/10.1177/1087054716664407

Stijntjes, F., Hassink-Franke, L., Kruishoop, A., Beeres, M. P. J., Eekhof, H., & Van Manen, S. (2014). NHG-Standaard ADHD bij kinderen. *Huisarts Wet*, *57*(11), 584-594.

Swanson, J. M. (1981). The SNAP Rating Scale for the Diagnosis of the Attention Deficit Disorder.

Ten Have, M., Tuithof, M., van Dorsselaer, S., Schouten, F., Luik, A. I., & de Graaf, R. (2023). Prevalence and trends of common mental disorders from 2007-2009 to 2019-2022: Results from the Netherlands Mental Health Survey and Incidence Studies (NEMESIS), including comparison of prevalence rates before vs. during the COVID-19 pandemic. *World Psychiatry*, *22*(2), 275-285.

Van der Veen, I., & Karssen, M. (2019). Kans op en effecten van kleuterbouwverlenging: Voor jonge en oudere kinderen en verschillen naar sociale en etnische achtergrond. *Kohnstamm Instituut*.

Wüstner, A., Otto, C., Schlack, R., Hölling, H., Klasen, F., & Ravens-Sieberer, U. (2019). Risk and protective factors for the development of ADHD symptoms in children and adolescents: Results of the longitudinal BELLA study. *PloS one*, *14*(3)

Appendix A

Flow charts representing the process of creating the variable *relative age*

When the date at which a child starts in preschool is known, the number of days remaining in that first, incomplete, academic year can be calculated by subtracting the starting date from the last day of the academic year, which is assumed to be the last Friday of June. This process is illustrated in figure A1.

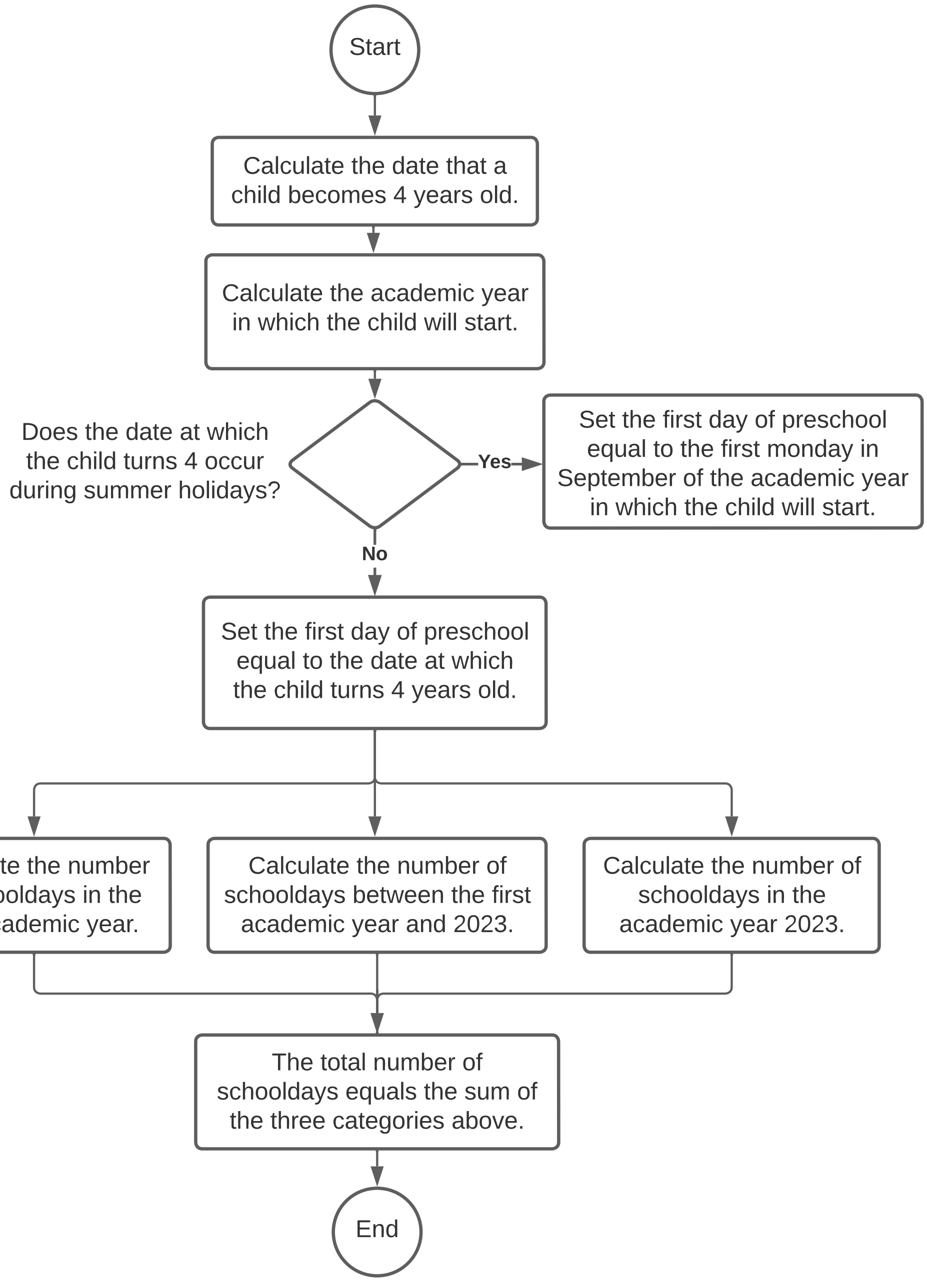

Figure A1. Flow chart representing calculations of the total number of days spent in school.

Assuming that the child has been attending school since his or her first day until the present, the number of days in the academic years following the first year up to and including 2022-2023 are added. In this current academic year, 2023-2024, there have been 106 days until the date of analysis, which is 18/12/2023. In conclusion, the total number of days spent in school can be calculated by adding the number of days of these three components: the remaining days of the starting academic year, the complete years after the starting year up to and including the school year 2022-2023, and the days in academic year 2023-2024 until the date of analysis.

The process of calculating the precise duration of a child's enrolment in preschool can be viewed in Figure A2. In cases where a child is presently enrolled in preschool, the duration is equal to the previously determined total days spent in school.

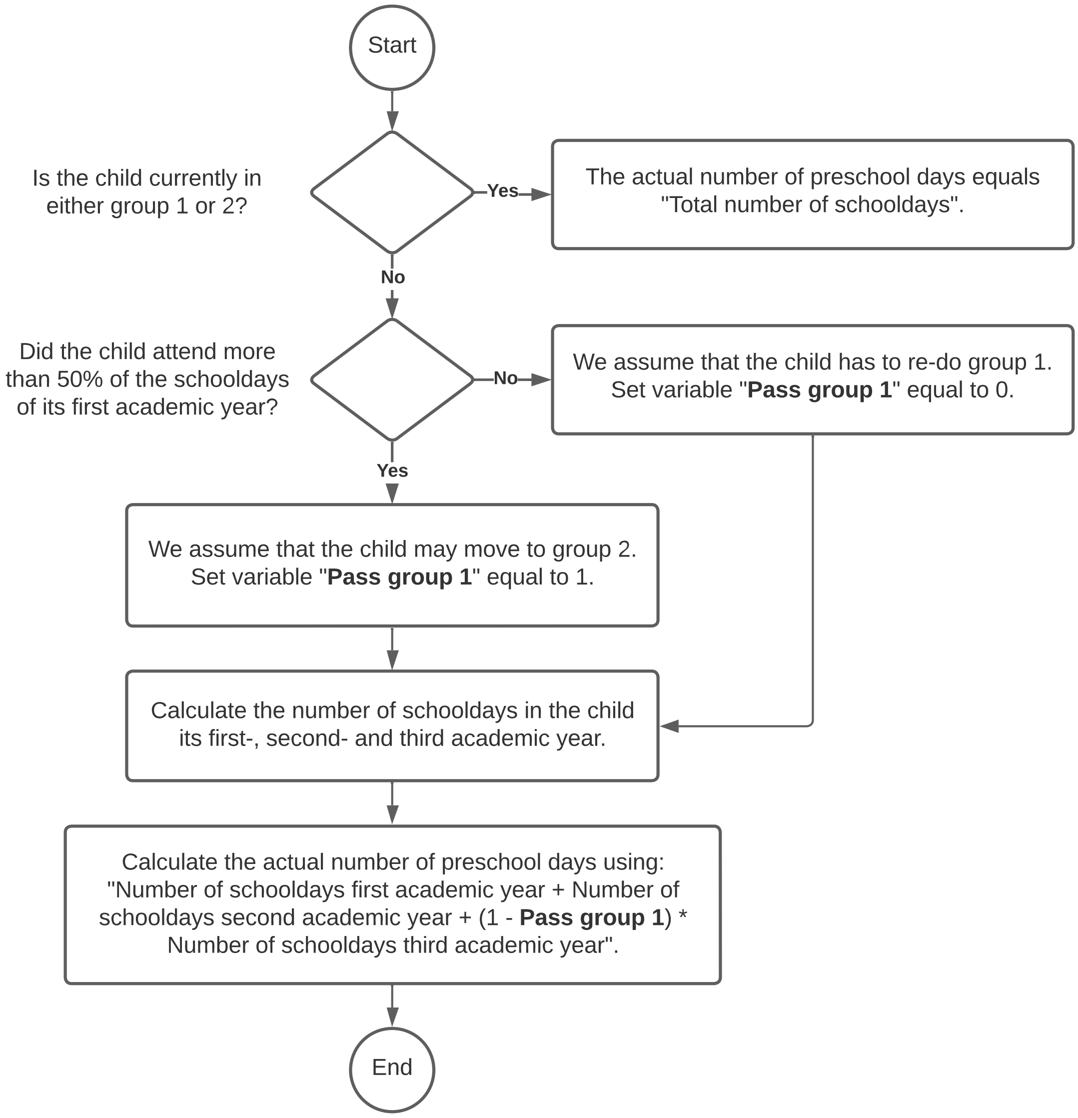

Figure A2. Flow chart representing calculations of the actual number of days spent in preschool.

It is important to note, as outlined earlier, that this study assumes children start preschool on the exact date of their fourth birthday or, in cases where their birthday falls during the summer recess, on the first Monday of September following their birthday. Consequently, children only attend the remaining days of the academic year after their enrolment. This leads to varying attendance rates during the initial year of preschool. In reality, grade progression does not only depend on the number of attended preschool days, but rather on perceived readiness by parent and teacher. In this study, however, it is assumed that a child progresses to grade 2 with an attendance rate of 75% or higher in their starting year, necessitating a repetition of grade 1 if the attendance falls below 75%. Due to the absence of available data regarding grade skipping or repetition, it is assumed that this cannot happen in grades 1 and 2, but only in school grades 3 through 8.

Next, the expected number of days spent in preschool will be determined. This process can be followed in Figure A3.

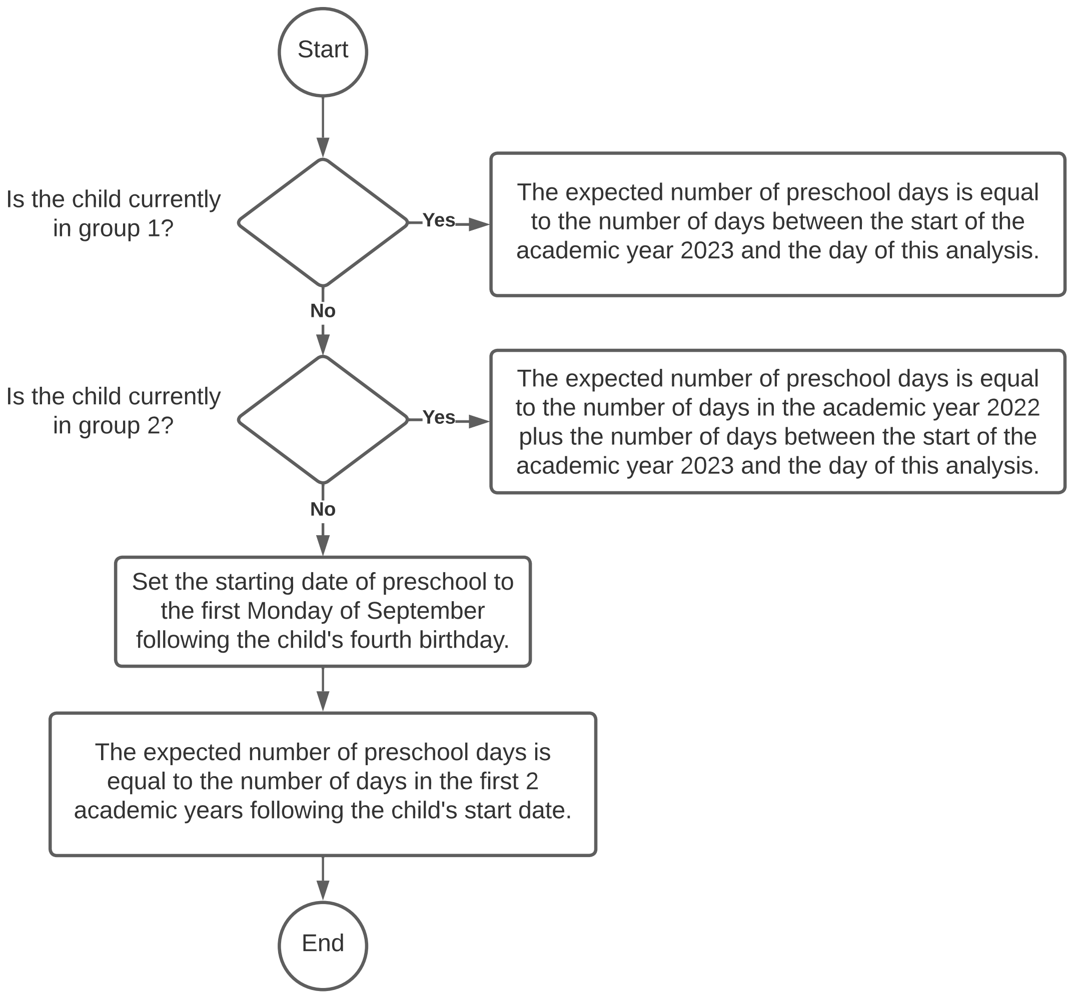

Figure A3. Flow chart representing calculations of the expected number of days spent in preschool.

In cases where a child is currently in grade 1, the expected number of preschool days is equal to the number of days between the start of academic year 2023-2024 and the date of analysis (18/12/2023). When a child is presently in grade 2, the expected number of preschool days is equal to the number of days in the academic year 2022-2023 plus the number of days between the start of academic year 2023-2024 and the date of analysis. When a child has already completed preschool and is currently in school, grades 3 through 8, the expected number of preschool days is set to the first two school years following the child's fourth birthday, as a child ideally attends precisely two preschool years.