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Daycare Enrollment Age and Child Development*

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Abstract

A large share of young mothers return to work before their child turns one year. Exploiting exogenous variation in daycare vacancy rates, we estimate the causal effects of enrollment age in universal daycare on child development for children younger than two years. We find modest effects of postponing daycare enrollment on early childhood outcomes. Children who enroll later have fewer visits to their primary care physician in their first years of daycare, but the effects vanish before preschool. Children who enroll later are also more likely to have insufficient language proficiency at age five and thus need additional language support.

JEL codes: I00, J13, J24

Keywords: Daycare, child development, health, cognitive skills

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The availability of high-quality childcare that enables parents to enroll their children in a learning environment while returning to the labor market lies at the heart of concerns about establishing a healthy economy such as the US Build Back Better framework[1]. A growing body of papers demonstrate that high quality universal preschool for children aged 3–6 has lasting effects on children's outcomes e.g. Cornelissen et al. (2018); Duncan et al. (2022); Havnes and Mogstad (2011); Herbst (2017); Cascio (2021); Garciá et al. (2021). However, in the OECD countries, an increasing number of mothers return to the labor market when their child is one year old or younger, and this situation has sparked the debate about the consequences of starting daycare at an early age.

This paper contributes to the scarce literature on non-parental daycare for 0-2-year-olds along several important dimensions. First, using unique administrative data on waiting lists for daycare, we are able to identify causal effects of enrollment age, which is the policy relevant margin in most countries, rather than just enrollment vs. parental care per se. The waiting list system generates random variation in the age of enrollment in formal daycare arrangements, and this variation allows us to investigate the causal effects of actual age at enrollment. Second, our large register-based dataset includes all children born 2009-15 residing in the City of Copenhagen (N=33,573 children) and their parents. Third, we consider objective measures of both health care use and cognitive outcomes, focusing on visits to primary care physicians (PCPs), hospitalizations, language tests in preschool, and age of starting school. Fourth, because the quality differences between home care and non-parental care become important, we investigate the effects of daycare both for children with higher and lower educated parents in the Danish setting where daycare quality is high compared with many other OECD countries (Gromada and Richardson, 2021; Bauchmüller et al., 2014; Datta Gupta and Simonsen, 2010; Esping-Andersen et al., 2012; Gørtz et al., 2018)

Parents face a tradeoff between enrolling their child in non-parental care and prolonging parental care. On the one hand, returning to the labor market improves potential long-term

[1]The Build Back Better Framework, The White House.

economic benefits through higher labor market attachment and earnings that may enhance child development in the long run (Dustmann and Schönberg, 2012; Rasmussen, 2010; Rossin, 2011). On the other hand, when parents prolong parental care, this may be beneficial to the child's development due to parents' time investment at a potentially vulnerable age where children are thought to be sensitive to changes in their surroundings. For example, Nystad et al. (2021) have shown that the transition from home to daycare is particularly demanding for very young children (below 14 months): They found that children who began daycare when they were younger than 14 months had a greater increase in their stress hormone (cortisol) level 4-6 weeks after enrollment than children who are older at enrollment.

For child development, the quality of non-parental care relative to parental care is critical. Fort et al. (2020) have shown that such quality differences partially explain the somewhat mixed results of the effects of daycare for 0-2-year-olds. They argue that results from Norway (Drange and Havnes, 2019), Germany (Felfe and Lalive, 2018), and Canada (Kottelenberg and Lehrer, 2017) show more *positive* effects of early enrollment because the sample of parents studied was less affluent (i.e., the general educational level is lower) compared to other samples, and thus the quality of daycare was likely to be higher than parental care. Results from Italy, using a sample of parents that are high-educated and relatively affluent, show *negative* effects of early enrollment, presumably because parental care is better than the non-parental care at hand (Fort et al., 2020). Other likely explanations of these divergent results include quality differences between daycare institutions in these different countries (Gromada and Richardson, 2021) and the fact that, on the margin, the enrollment ages under investigation differ significantly.

As age of enrollment in daycare is likely to be endogenous, we exploit excess demand of daycare slots in Copenhagen – the capital of Denmark – in a Two-Stage Least Squares (2SLS) setup. The city's daycare office administrates the allocation of vacant daycare slots for the Copenhagen city area, and parents register their preferred date of enrollment and sign up for two daycare centers of their choice at this office. Once registered, the child is on a waiting

list for these specific facilities. Because many daycare facilities are oversubscribed in the City of Copenhagen and all parents sign up for two facilities, this waiting-list system generates exogenous variation in actual enrollment age. We calculate the monthly vacancy rate in each daycare center as the number of children leaving the facility relative to the total number of slots in the facility for the period 2009-2016. In the first stage, we use these vacancy rates in the two chosen centers to predict enrollment age for each child on the waiting list. In the second stage, we use the predicted values of enrollment age to estimate the causal effect of daycare enrollment age on subsequent child health and cognitive development. Moreover, to minimize quality differences between different daycare centers, we include center fixed effects in the model.

Denmark is ideally suited for analyzing the causal effects of daycare enrollment. First, selection into daycare is only a minor issue. Two-thirds of all Danish children less than three years old participate in full-time formal care (30+ hours per week) (Eurostat, Statistics, 2020), and with only 3.4% of children in informal care, Denmark holds the second lowest share of children in informal care among the OECD countries (Gromada and Richardson, 2021). Second, contrary to, for example, the U.S. system, a generous parental leave system reduces selection into 'forced' or necessary early return to the labor market. This system allows 11.5 months of subsidized or fully paid leave after birth to be divided between the parents. Third, no recall-bias exists in the data. For all registered children, we combine detailed information from the waiting list system on preferred enrollment date and preferred facility with administrative records data such as birth date (to calculate exact enrollment age), hospital and physician records, school enrollment, parental background and child health at birth.

Our 2SLS estimates reveal that being older at enrollment compared with being younger at enrollment decreases PCP visits by 0.5 visits during the first nine months in non-parental care. However, this effect on PCP visits is only temporary, as children who enroll earlier experience fewer PCP visits later in life when they enroll in preschool (around age three).

In total, we find no permanent effects on PCP visits beyond the age of three. Moreover, we find no statistically significant (and close to zero) effects on hospitalization during the first three years of life.

For cognitive outcomes, we find that enrollment age increases the probability of being tested and having insufficient language proficiency at age five. We also find a negative but not statistically significant effect on the probability of postponed entrance to kindergarten (thus reducing the probability of "redshirting").

Overall, we find no clear evidence that early enrollment is harmful for the child beyond a temporary health shock, which is likely due to light infections caused by the child's exposure to many other children. In contrast, we find slightly positive effects of early enrollment in daycare, as early enrollment decreases the probability of insufficient language proficiency at age five. These results align with recent evidence from a Swedish study that investigates the impact of a major daycare reform in 2002 which increased daycare attendance from 70% to 85% (van den Berg and Siflinger, 2021). The Swedish study found a strong and immediate increase in physical health conditions (e.g., ear infections) that faded out as children grow older. They also found a significant reduction in mental disorders for 4–7-year-old children, which was explained by an increase in the children's language and motor skills.

In contrast to several papers (van den Berg and Siflinger, 2021; Fort et al., 2020; Felfe and Lalive, 2018), our results show no differences between the outcomes of children with mothers with a college degree compared to that of mothers with no college degree. Thus, our results suggest that if quality of non-parental care is high, there are no significant drawbacks of early enrollment, even for children from more affluent families.

The paper proceeds as follows. Section 1 outlines the institutional background. Section 2 discusses the empirical strategy. Section 3 describes the data. Section 4 presents the results, and Section 5 concludes and contextualizes the findings.

1 Institutional Background

Our identification strategy hinges on exogenous variation in enrollment age in the daycare system in the City of Copenhagen. As enrollment age is related to the Danish parental leave system and the local daycare options, we outline both in this section.

1.1 Parental leave

The generous parental leave system minimizes potential selection effects of early or later enrollment in daycare and the take-up of informal care options. Most parents are entitled to subsidized parental leave until the child is 11.5 months old.[2] Moreover, parents on leave earn holiday savings paid by the employer. Thus most parents can extend their subsidized (or fully paid) leave period to 12-13 months, take up unpaid leave until the child turns 1.4 years, and are able to return to their current job after their leave.

Despite the generous parental leave system in Denmark, the system does not offer full pay, and some parents choose to shorten their parental leave period. For most parents, the parental leave subsidy is equivalent to half the parent's earnings, but many companies offer full pay for parts of the period.[3] For example, public sector workplaces – where around two in three women work – offer at least six months of full pay after birth. As parents can make use of parental leave right up until the child turns nine, there are no economic incentives to maximize the leave options right after birth.

1.2 Daycare in Copenhagen

Our study focuses on data from Copenhagen, but the Copenhagen daycare system resembles the organization and provision in other municipalities in Denmark, as national regulations for the provision of formal daycare arrangements minimize both quality differences in care

[2]The Government earmarks most leave for the mother. After birth, the mother has the right to 3.5 months of maternity leave, while the parents can share the final 8 months of leave. If parents receive any other forms of social support, they do not receive additional parental leave benefits.

[3]The maximum monthly parental leave subsidy wais approximately EUR2500 EUR/month in 2021.

and selection into daycare. Parents choose between two types of formal daycare arrangements: center-based or family-based daycare. Both types of care yield similar prices and the government subsidizes both, especially for low-income families.[4] Thus the take-up rate of formal daycare is almost similar for low-income (70%) and high-income (76%) families.

Center-based daycare is either daycare for children aged six months to three years old (referred to as nurseries) or facilities that house both daycare center and preschool for children aged six months to five years old (also referred to as age-integrated facilities). In both types of facility, the staff typically consists of a mix of early childhood educators (Bachelor-degree level), early childhood educator assistants (with two years of training) and assistant with no formal training. The child-adult ratio was around 3.1 children per adult in the period we study, and each group consisted of 11-13 children. In Copenhagen, most children enroll in center-based care.

In family daycare, one child-minder takes care of three to five children at home. There are no official educational requirements for becoming a child-minder, but potential childminders go through a screening process (e.g., no criminal record, experience working with children), and the family home must meet certain space and safety requirements. Child-minders are subject to regular visits from an authorized daycare manager who oversees the children's wellbeing and development. In Copenhagen, approximately 4% of all children enrolled in formal care were enrolled in family daycare during our period, which is a somewhat lower share compared to the rest of the country, where 33% of children were enrolled in family daycare (Statistics Denmark, 2021).

1.2.1 The waiting list system

The City of Copenhagen daycare office is responsible for allocating children to all formal daycare facilities in the municipality based on a waiting list system. Parents are encouraged to register their child in this system before the child turns four months to obtain maximum

[4]The user fee for a slot in center-based daycare for children aged 0–2 was EUR370 EUR/month in Copenhagen in 2007 and EUR440 EUR/month in 2021 (Statistics Denmark, 2021).

Table 1: Type of facility

	Nursery	Age-integrated	Family daycare
Nursery	10.9	14.7	0.1
Age-integrated	21.4	52.3	0.3
Family daycare	0.1	0.2	0.0

NOTE— The table shows the distribution of parents' first and second choice of facility.

seniority on the waiting list. Parents register which two facilities they prefer and their preferred enrollment date.[5] Based on this registration, the daycare office places children on the waiting list for each of the two preferred centers.[6] A combination of date of birth and preferred enrollment date determines a child's ranking on the waiting list of the individual daycare center. Parents have access to the waiting lists of the two facilities they have signed up for. Nevertheless, as all children register for two facilities and waiting lists thus may seem lengthy, parents often find it difficult to use the information on the waiting list to predict their own child's potential date of enrollment.

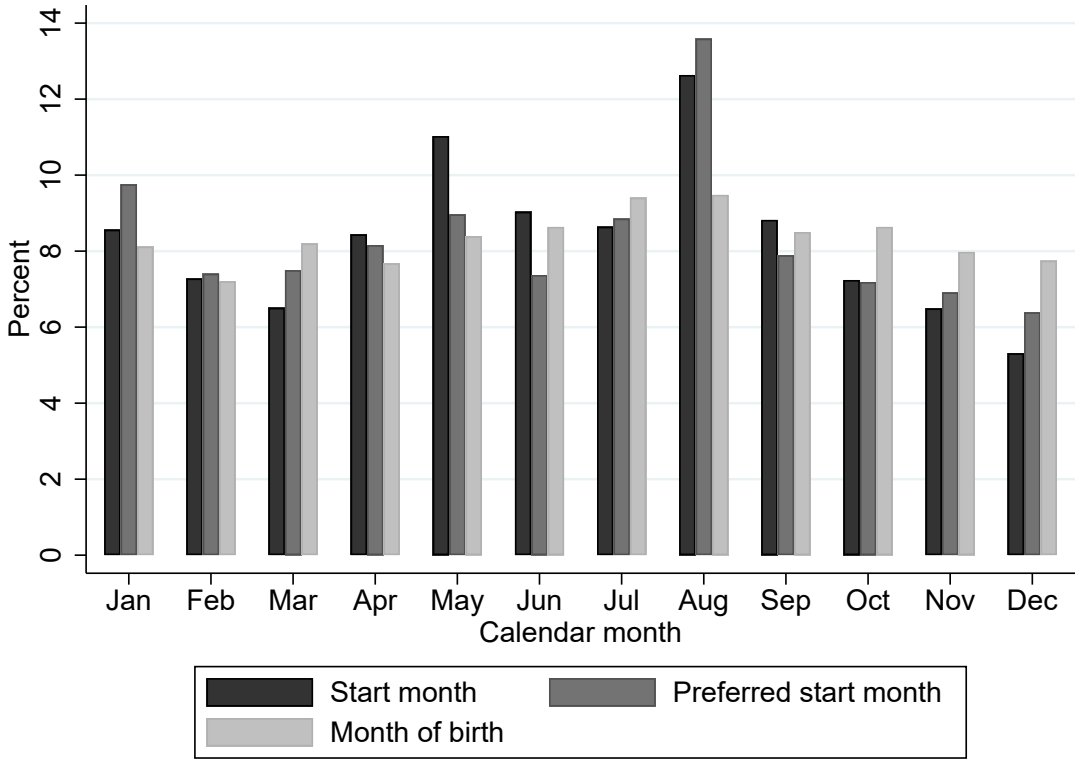
Table 1 shows parents' choice of daycare type. A total of 11% choose two nurseries, more than 50% choose two age-integrated facilities, and around 35% choose a nursery and an age-integrated facility. Less than 1% choose family daycare in Copenhagen.

For mainly three reasons, the waiting list system generates exogenous variation in enrollment age. First, most facilities are oversubscribed, which leads to excess demand. Second, most slots become available in the summer months when the older children move from preschool to school. This means that parents who prefer an enrollment date during the winter months are less likely to receive a vacant slot that matches their preferred enrollment date compared with parents who have preferred an enrollment date in the summer months leading up to the beginning of the school year. Third, in Copenhagen, children from the same preschool will often be referred to different schools, and as public and private schools have

[5]If parents prefer family daycare, they sign up for a district/ area, not a specific child-minder.

[6]Upon registration, several pieces of information about the daycare facilities is available, including the current age at enrollment. Parents are also encouraged to visit daycare centers before signing up to obtain additional information (Batsaikhan et al., 2021).

Figure 1: Distribution of start month, preferred start month, and month of birth across calendar month



NOTE— The figure plots the distribution of calendar month of first enrollment, preferred month of first enrollment, and month of birth for the children in the sample.

different school-enrollment dates, the schooling decisions of older cohorts generate additional variation in the vacancy rate in the specific daycare center. Consequently, parents cannot exercise complete control over the actual enrollment date, but the majority of parents receive an offer within eight weeks of their preferred enrollment date.

Figure 1 illustrates the enrollment patterns and number of births by month. The darkest bars show month of enrollment. Relatively more children enroll in May and August, reflecting higher vacancy rates due to school enrollment, while fewer children enroll in October, November and December. The grey bars show the density of preferred month of enrollment. Although preferred enrollment also spikes in August, the overall pattern is somewhat different compared to that of actual enrollment – suggesting a mismatch between preferred and actual enrollment. Finally, the light grey bars show an almost constant distribution of birth

months during the year with only a marginally larger number of births during the summer months. The birth months and preferred enrollment months do not follow the same pattern, and although there are more births during the summer, these births cannot explain the August spike in preferred enrollment.

1.2.2 Can parents game the system?

Although we argue that the waiting list system generates exogenous variation in the actual enrollment date, parents in principle have some possibilities to optimize their daycare situation. For example, if parents need a daycare slot at a certain date, they can change one of their preferred centers on the waiting list to the 'guarantee list'. This is a specific waiting list that obligates the daycare office to find a slot within two months with the caveat that parents cannot choose a specific location. Typically, a slot is offered within a 4-5 km radius from the home. Thus parents face uncertainty in terms of potentially having to commute longer distances across the city during rush hour, and they lose the option of choosing between family-based and center-based care. As we show later on, this choice has no direct implications for our identification strategy as our instrument uses the vacancy rate at the preferred and not the actual facility of enrollment.

Parents also have other possibilities of changing their stated preferences, but they all come at a cost and offer no guarantees of an earlier date of enrollment. While parents may change their facility of preference, such a reshuffling of stated preferences will place them at the bottom at the waiting list of the new center. Furthermore, even though they can turn down an offer, they risk that the next offer is equally 'unattractive'. Moreover, the daycare office will postpone their preferred date of enrollment if the parents turn down the slots they are offered systematically. A final option is to hire a private child-minder, which is also subsidized and primarily used as a temporary solution when the parental leave expires. In our data, 62% of the children are given a slot in one of the two chosen daycare institutions, 17.5% are given a slot in another center-based daycare, 2.8% in a family-based daycare, and

17.7% in a private daycare arrangement. We include all children registered in the waiting list system regardless of any changes in their preferences or the type of daycare they end up in, as these changes offer no guarantees that the actual enrollment date aligns with their preferred date of enrollment.

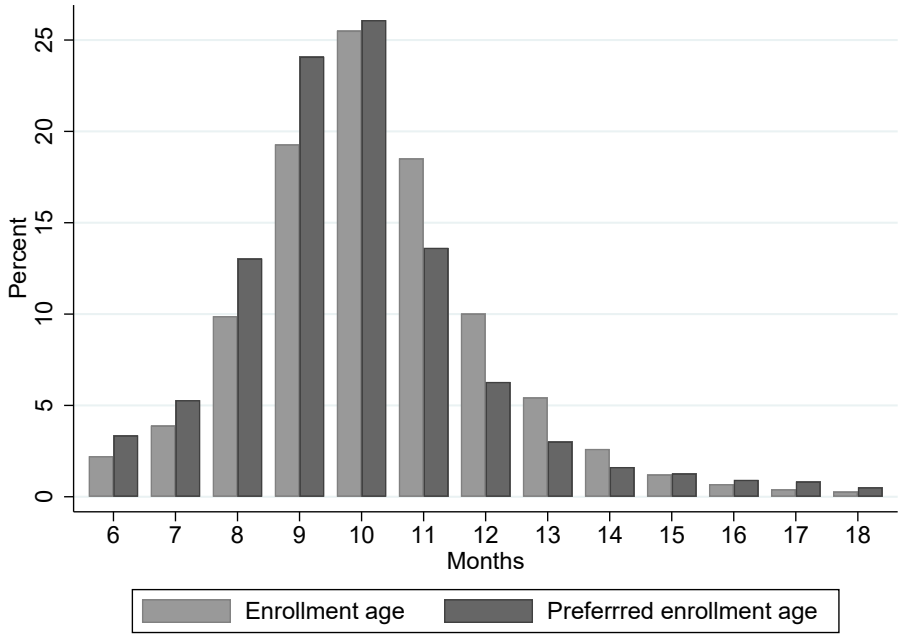
1.2.3 Preferred versus actual enrollment age

Our identification strategy relies on the existence of excess demand for daycare, such that children are enrolled later than what their parents prefer. This is illustrated in Figure 2, which shows the distribution of actual and preferred enrollment age. On the one hand, while approximately 21% of the sample prefer an enrollment age of around 6-8 months, only 16% are offered a slot at that age. Moreover, while around 50% of the sample prefer to enroll their child when the child is 9-10 months old, only 40% enroll their child at that age. On the other hand, while 29% prefer to enroll their child after 11 months, 44% of the children end up actually being enrolled at that age. Similarly, Appendix Figure A1 shows the distribution of the difference between actual and preferred enrollment age. Figure 2 and Appendix Figure A1 thus illustrates that spots are on average offered later than parents' stated preferences in the waiting list system.

While the waiting list system generates exogenous variation in actual enrollment age, the difference between actual and preferred enrollment age is likely to decrease by preferred enrollment age. This is shown in Figure 3, which illustrates the correlation between preferred and actual enrollment age. The figure shows a downward trend, where parents who prefer daycare enrollment when their child is 6-8 months old wait approximately 4-7 weeks before their child is enrolled in daycare, parents who prefer enrollment after 10-12 months are likely to receive a daycare slot within two weeks of their preferred enrollment date, while parents who prefer enrollment after 13-16 months are likely to enroll their child 4-6 weeks earlier. Figure 3 thus illustrates that excess demand is present if the preferred start age is below 11 months, but not binding for children above 12 months, who on average receive an offer before

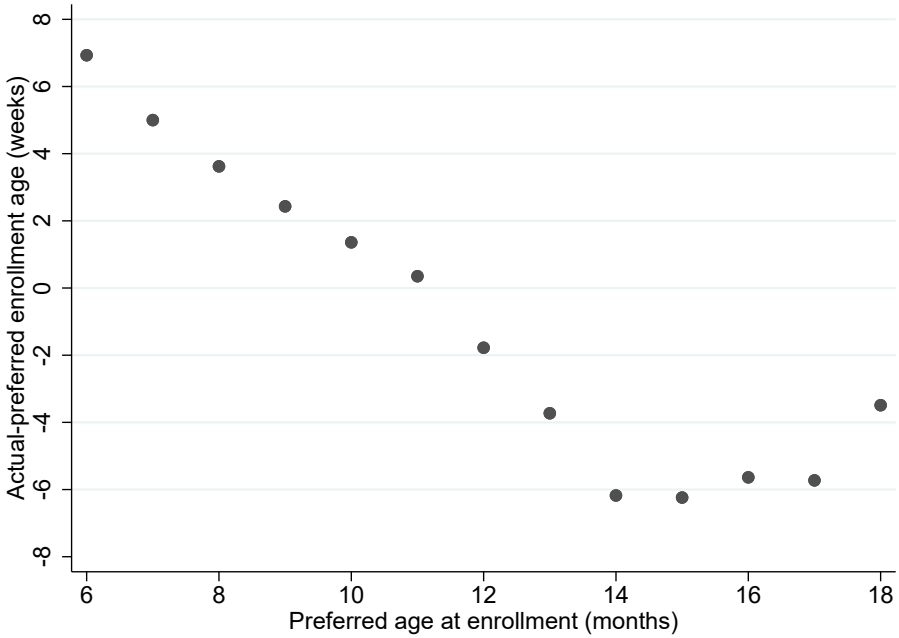
their preferred start age.

Figure 2: Distribution of enrollment age and preferred enrollment age



NOTE— The figure plots the distribution of age at first enrollment and the preferred age at enrollment measured in months.

Figure 3: Difference between actual and preferred enrollment age across preferred enrollment age



NOTE— The figure plot the average difference between the actual enrollment age and the preferred enrollment age by preferred enrollment ages.

2 Empirical Strategy

As discussed earlier in this paper, parents face a trade-off between early and later daycare enrollment.[7] To account for the endogenous nature of enrollment age, we use a 2SLS model summarized in the following two equations:

$$y_{ict} = \beta a\hat{g}e_i + x'_{ict}\delta + \omega_c + \varepsilon_{ict} \tag{1}$$

[7]The direction of this bias is difficult to predict. For example, parents with a high preference for labor market participation will be more prone to enroll their child at an earlier age. If these parents are high-ability parents, early enrollment may be inferior to parental care in the home. Thus for these parents, a simple OLS strategy underestimates the correlation between being older at enrollment and child development. Similarly, we are likely to underestimate the effect of being older at enrollment if parents postpone entry into daycare in case their child is fragile or in poor health. However, the OLS correlation can also generate upward biased results. We underestimate the effects of age at enrollment if families with unobservable characteristics that contribute to e.g. worse health of the children are more likely to select into early enrollment. This could be the case if lower ability parents are more likely to return to the labor market earlier due to higher budget constraints.

$$age_{ict} = f(vac^{\tilde{c}}_{-1})\gamma + x'_{ict}\delta + \omega_c + \epsilon_{ict} \tag{2}$$

In equation (1), y_{ict} is child health or cognitive development for child i at center c and time t. This outcome is likely correlated with individual child characteristics, defined as the vector x'_{ict}. This vector includes indicators for infant health (birth weight, gestational age, PCP visits prior to enrollment), child demographics (gender, birth year and birth month dummies, birth order, and parental migration status). ε_{ict} is the individual specific error term. $\hat{age}_i$ defines the explanatory variable of interest – age of enrollment.

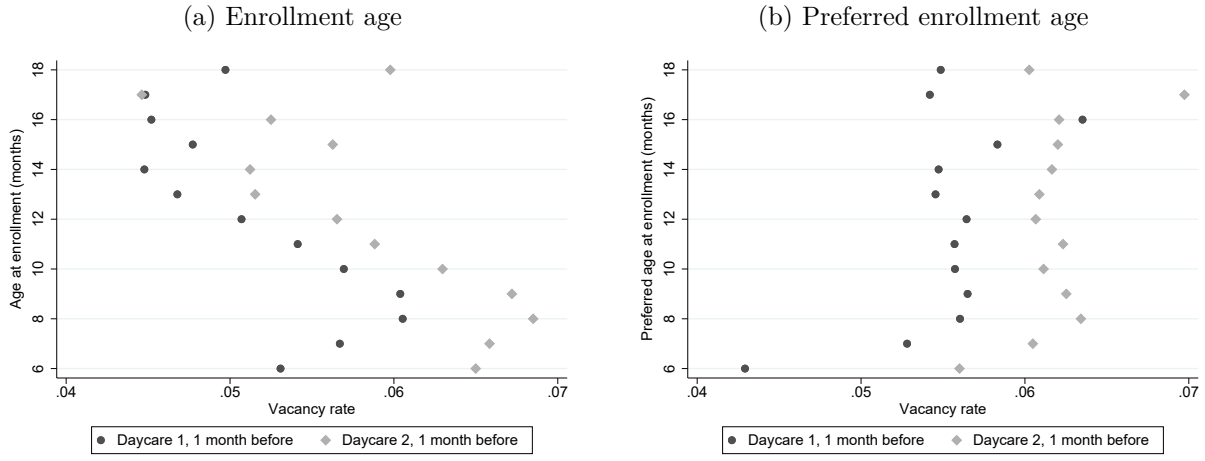
Equation (2) is the first stage in our 2SLS model, and the facility vacancy rate $vac^{\tilde{c}}_{-1}$ then serves as the instrument for the predicted value of enrollment age – $\hat{age}_i$ – in (1). We explain the instrument in detail in the next section. Otherwise, equation (2) includes the same covariates as equation (1). Central for equations (1) and (2) is the center fixed effect ω_c, referring to the first enrolled daycare facility. This center fixed effect captures fixed quality differences such as outdoor facilities, quality of management and staff, size, and average vacancy rates as well as other variables that are fixed during our period. As we control for center fixed effects, identification effectively relies on intra-facility variation in vacancy rates over time.

2.1 Instruments

We instrument enrollment age by the vacancy rates in the two preferred daycare facilities. To construct these instruments, we use information on exit dates and the total number of daycare slots in each center. Specifically, we construct a monthly panel of center level ratios between the number of children leaving each facility and the total capacity of slots in the facility. For each child, we generate the vacancy rates from each of the two preferred facilities, and we generate these vacancy rates one month prior to their preferred (not actual) month of enrollment (i.e., for each child we use two instruments).

To validate these instruments, we show that the vacancy rates correlate with actual, but

Figure 4: Vacancy rates by actual enrollment age (a) and preferred enrollment age (b)



NOTE— Panel (a) plots age at enrollment in months against the average vacancy rates. We measure vacancy rates one month before the preferred enrollment date in the two facilities that parents choose. Similarly, panel (b) plots preferred age at enrollment against the average vacancy rates.

not preferred, enrollment age and perform a formal test of this correlation. Figure 4 shows the correlation between vacancy rates on the vertical axes and actual enrollment age (panel a) and preferred enrollment age (panel b) on the horizontal axes, respectively. Panel (a) shows a clear negative correlation between enrollment age and vacancy rates one month prior to the preferred enrollment date. Children registered at an institution at a time with a lower vacancy rate are older at enrollment compared to children enlisted at a higher vacancy rate. The darker and lighter colored dots show that the correlations are similar for both preferred institutions. Equally important, panel (b) shows that the vacancy rates are uncorrelated with preferred enrollment age. Thus panel (b) signals that parents are not able to predict the vacancy rates over time.

In addition to Figure 4, Table 2 tests whether the vacancy rates at the two preferred facilities correlate with predetermined child and parental characteristics. Specifically, we test whether child gender, birth weight, gestational age, number of PCP visits prior to enrollment as well as parental migration status, educational level, and valid information on the father jointly predicts each of our two instruments. Most importantly, the F-test for these two regressions shows that pre-determined characteristics are jointly statistically insignificant.

Table 2: Balancing test of parental education, child characteristics, and vacancy rates

	(1) Institution 1	(2) Institution 2
Boy	0.0015*	0.0003
	(0.0008)	(0.0008)
Birth weight	-0.0000	-0.0000
	(0.0000)	(0.0000)
Gestational age	0.0000	-0.0000
	(0.0000)	(0.0000)
# PP visits, t=-0.25	-0.0008***	-0.0004*
	(0.0003)	(0.0002)
Parents immigrated	-0.0008	-0.0001
	(0.0017)	(0.0017)
Both parents basic education only	0.0000	0.0015
	(0.0020)	(0.0020)
At least one college educated parent	-0.0000	0.0014
	(0.0012)	(0.0011)
No father id	-0.0007	-0.0031*
	(0.0019)	(0.0018)
Observations	33573	33573
F(9,358)	1.58	1.15
Prob > F	0.13	0.33

NOTE— * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Each column presents estimates from separate regressions. Both regressions include controls for birth order, year of birth, month of birth and institution fixed effects. Standard errors clustered at institution level in parentheses.

Figure 3 in section 1 also provides valuable information about the compliers in this natural experiment. The figure shows that the instrument is likely to affect children across a broad range of preferred enrollment ages. On average, the difference between actual and preferred enrollment age is only close to zero for parents with a preferred enrollment age of 10-12 months. Approximately 23% of the sample receive a slot more than two weeks before their preferred enrollment date, 40% close to their preferred enrollment date (within two weeks), while 37% receive a slot more than two weeks after their preferred enrollment date (see Appendix Figure A1: Density plot of difference between actual and preferred enrollment).

3 Data

The dataset consists of 33,573 children born 2009-2015 residing in the City of Copenhagen and their parents. The data combines various high-quality administrative data sources. First, data includes information on a broad set of socio-demographic characteristics, infant health, health care use, and school enrollment collected and maintained by Statistic Denmark. Second, it includes administrative data from daycare applications and waiting lists, preschool language tests as well as data on size (total number of children enrolled) of each daycare center, all from the City of Copenhagen administrative office. Through the unique person identifier, we match the various datasets at the individual level, and the final dataset contains information on actual and preferred enrollment age, number of slots per daycare facility, parental background, demographic information, child health at birth, number of PCP visits, inpatient hospitalization, language tests for the children enrolled in preschool, and children's age at enrollment into school.[8]

[8]All residents in Denmark receive a personal identifier just minutes after they are born. These personal identification number are used in all contacts with doctors, hospitals, schools, daycare centers, tax authorities etc. Statistics Denmark provides access to these data to researchers—in anonymized form. Importantly, the population registers also contain a link between parents and their children. This allows us to construct a rich set of child outcomes and family-level background variables.

3.1 Sample

We use information from all children registered at the City of Copenhagen daycare office with valid information about actual and preferred enrollment dates and actual and preferred daycare facility. The external validity of our results decreases if our sample of children differs to some degree from children in parental care or children dropped from the sample. Unfortunately, we cannot calculate the exact number of children in parental care or private care in the City of Copenhagen, because mobility between the City of Copenhagen and the surrounding areas generates a certain mismatch between the annually recorded residence data and weekly daycare registration data. Instead, we compare our sample to children aged 0-3 born in the greater Copenhagen area, that is, children born in the City of Copenhagen and the surrounding municipalities. This sample includes children in formal care, private care, and parental care. We find only small differences between our sample and the rest of the families in the greater Copenhagen area. For infant health and birth year, the sample is similar, but our sample has a smaller share of ethnic minority parents (8% vs. 13%), a smaller share of families with basic schooling as their highest level of education (2% vs. 5%), and a marginally higher share of families with at least one college-educated parent (7.4% vs. 6%). This suggests a small overweight of more affluent and native Danish families in our sample (See Appendix Table A1).

3.2 Variables of interest

The longitudinal nature of the register data allows us to investigate if enrollment age has immediate or persistent effects on health and developmental outcomes. Our first outcome is number of PCP visits. The second outcome is a dummy for hospitalizations defined as number of registered inpatient contacts at the hospital. Our third outcome stems from the mandatory language proficiency screening at age five. This language test score defines an assessment of the child's vocabulary and communicative skills, the day that the test is taken. The test used in Denmark is developed by Danish and international researchers (Bleses, Jensen, Makransky,

Dale, Højen and Vach) and inspired by several existing language proficiency tests such as the MacArthur-Bates Communicative Development Inventory test (Bleses et al., 2017).

The Danish proficiency test consists of three to seven different sub-tests such as word knowledge, language comprehension, rhymes, and letter knowledge. These sub-tests all reflect important communicative development skills related to reading later in life Ministry(of Education, 2019). The test is conducted in a one-to-one session between the child and the preschool teacher or another professional. The test consists of a series of pictures, and the child answers by pointing at the picture. For example, the preschool teacher says 'horse' and the child must find the horse among the different pictures. For each child, a total score is calculated on the basis of these questions and this total score is age and gender adjusted, i.e., compared to a large random sample of children of same gender and same age (in months). The age-and-gender-adjusted score can be divided into three meaningful categories. The first category is 16-100% correct answers. This category resembles the 'normal' language proficiency level where children just need the general language training in the preschool. The second is 5-15% correct answers, which resembles children in need of a focused language intervention. The third category is below 5% correct answers, which signals children in need of a highly focused language intervention. From this test, we construct two dummy variables. As daycare centers only test children showing some language difficulties, the first variable takes the value one if the child is tested, otherwise zero. The second variable takes the values one if the child has less than 16% correct answers, otherwise zero.

The final outcome is a dummy for redshirting, that is, the variable takes the value one if parents delay schooling enrollment by one year, otherwise zero. In Denmark, compulsory schooling begins in August of the year in which the child turns six. However, compliance with this rule is not mandatory and possibilities exist either to hold the child back one year or to enroll the child one year earlier (Gørtz et al., 2018). Individual assessments of the child and dialogues between the parents and the representatives of the regional school authority determine this decision. We observe school entry for six of the seven birth cohorts (2009-2014

cohorts).

Our primary variable of interest is enrollment age defined as the difference between birth and enrollment date. We instrument enrollment age by the center vacancy rates on month prior to preferred enrollment, measured at the two chosen daycare facilities.

3.3 Descriptive statistics

Table 3 presents descriptive statistics for the full estimation sample according to type of daycare facility: center-based care[9] and family-based care including enrollment in the subsidized private option. Overall, the table shows some, albeit, minor differences between the families and children in the two types of daycare. To consider these differences, we use within-care type fixed effects in our estimation strategy.

Panel A in Table 3 shows that on average, children enroll in center-based care when they are around 10.8 months old, and they are 14 days younger when they enroll in family-based daycare. Preferred enrollment age is 10.1 months when parents register their child for center-based daycare, but 11 months when parents register their child for family-based care. Thus on average parents who register for center-based care are more likely to wait longer, while parents who register for family-based care on average get a slot three weeks earlier.

Panel B shows that there are only minor differences in birth order, gestational age, and birth weight between children enrolling in center-based or family-based care, with a small tendency of parents choosing family-based care if children have low birth weight. A higher percentage of lower educated parents enroll their children in center-based care, similarly a higher share of ethnic minority parents and families with unknown father registration enroll their children in center-based care. Nonetheless, the percentage of families with at least one college-educated parent is almost similar in the two care types.

[9]We collapse centers for 0-3 and 0-6 year-olds in this table.

Table 3: Summary statistics by type of daycare

	(1) Center-based care	(2) Family daycare or private sub.	(3) Diff.
Panel A: Variable of interest			
Age at first enrollment	10.81	10.31	0.497***
	(1.94)	(1.71)	(19.45)
Preferred enrollment age	10.15	11.07	-0.926***
	(1.73)	(2.71)	(-34.72)
Panel B: Covariates			
Month of birth	6.66	6.21	0.453***
	(3.32)	(3.55)	(9.93)
Year of birth	2012.07	2011.27	0.793***
	(2.01)	(1.82)	(29.70)
Boy	0.51	0.52	-0.00799
	(0.50)	(0.50)	(-1.18)
Birth order	1.44	1.43	0.0119
	(0.62)	(0.61)	(1.42)
Low birth weight	0.03	0.06	-0.0228***
	(0.18)	(0.23)	(-8.94)
Gestational age (days)	279.44	278.44	0.999***
	(10.80)	(12.12)	(6.66)
Both parents basic education only	0.07	0.04	0.0235***
	(0.25)	(0.20)	(7.27)
At least one college educated parent	0.72	0.80	-0.0804***
	(0.45)	(0.40)	(-13.60)
No registered father	0.05	0.04	0.00916***
	(0.22)	(0.20)	(3.08)
Parents immigrated	0.09	0.05	0.0415***
	(0.28)	(0.21)	(11.30)
Panel C: Outcome variables			
Tested at age 5	0.37	0.33	0.0401***
	(0.48)	(0.47)	(5.93)
Age 5 low language score	0.06	0.03	0.0243***
	(0.23)	(0.17)	(7.87)
Late for grade	0.03	0.03	-0.00107
	(0.17)	(0.17)	(-0.41)
Observations	26696	6877	33573

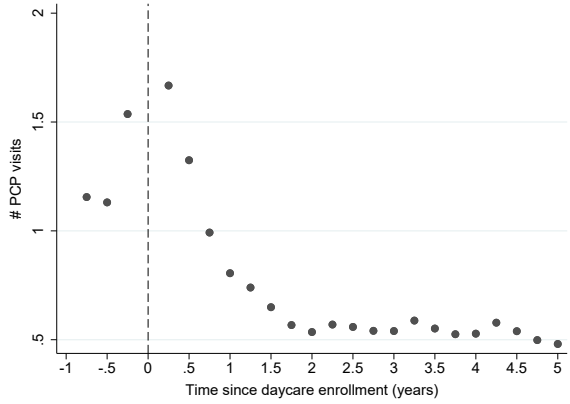
NOTE— The table shows mean values and standard deviations in parenthesis for the variable of interest (panel A), covariates (panel B) and outcome variables (panel C). Column (1) shows summary statistics for children in center-based care. Column (2) shows summary statistics for children in family daycare or private substitute. Column (3) shows the differences in means between (1) and (2). * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Panel C shows that approximately one-third of all children take the language-proficiency screening test at age 5; 3-6% of children show inadequate language proficiency. In preschool, more children formerly enrolled in center-based care are tested and have inadequate language skills. Three percent of the children delay school enrollment by a year.

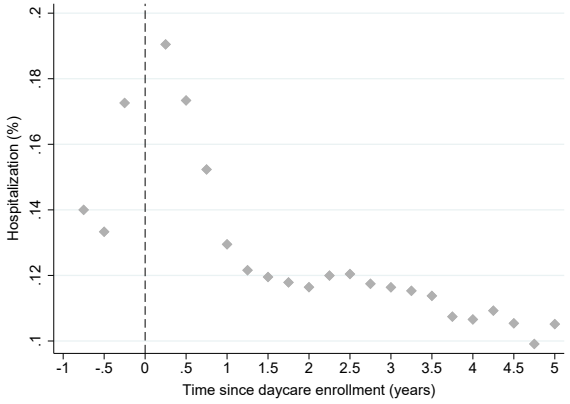
In addition to Table 3, Figure 5 shows the average number of PCP visits (a) and the percentage of children hospitalized (b) per quarter of a year running from birth to five years after enrollment in daycare. The vertical dotted line indicates the quarter of a year for first-time enrollment. The figure shows that the average number of PCP visits and the percentage of children hospitalized are higher around enrollment but decreases over time.

Figure 5: Quarterly PCP visits and hospitalization rate

(a) PCP visits



(b) Hospitalizations (%)



NOTE— Panel (a) plots quarterly number of PCP visits while panel (B) plots the quarterly percentage of children hospitalized. The vertical dotted line define time at enrollment in non-parental daycare.

4 Results

In this section, we present the empirical results from our analysis of the marginal effects of age of enrollment in daycare on child health, language proficiency, and school entry. We start by presenting the first-stage estimates of the relationship between vacancy rates and enrollment age, and then we show the second-stage estimations on child outcomes and the heterogeneous effects across parental education and child gender.

We also present a set of sensitivity analyses to test the robustness of our results. First, we investigate the effects for firstborn versus later-born children, as parents have different knowledge (and skill sets) with later born children. Second, we test whether our results are similar if we only use the sample of children enrolling into center-based care, as there is a clear quality difference between center-based and family-based daycare. Third, we test whether our health outcomes are sensitive to enrolling in daycare during the flu season.

4.1 First-stage results

Table 4 shows estimates from four separate first-stage regressions, where column (1) shows the first stage and column (2) shows a placebo first-stage estimation. The model contains a set of child and parent characteristics, a set of year-of-birth and month-of-birth dummies, and institution fixed effects (estimates not shown in Table 4).

The results indicate that the vacancy rates in the two preferred institutions measured one month prior to the preferred enrollment date determine age at first enrollment. First-stage results in column (1) show a strong negative correlation between both instruments and age at first enrollment, indicating that a one percentage point increase in the vacancy rates reduces age at first enrollment by 0.36-0.54 months, that is, 11-15 days. In addition, the first-stage F-test statistic is above 14, indicating that the instrument is reasonably strong.

To test whether serial correlation in the vacancy rates confounds our first-stage estimates, we perform a placebo first-stage test in column (2). Similar to column (1), column (2) shows the regression of age at first enrollment on the vacancy rates in the two chosen daycare facilities, but we measure the vacancy rates much earlier – when the child is four months old.[10] Column (2) shows that the vacancy rates measured at daycare sign-up (when the child is four months old) do not predict age at first enrollment, as the estimates are smaller than in column (1), not statistically significant, and the F-test is very low (1.4). Thus, serial correlation in the vacancy rates does not seem to confound our first stage estimates.

[10] At this age, almost all parents have registered their preferences for daycare.

Table 4: First-stage regressions

Vacancy rate measured	(1) First stage one month before	(2) Placebo first stage at age 4 month
Daycare 1	-0.356**	-0.196
	(0.140)	(0.145)
Daycare 2	-0.541***	-0.180
	(0.129)	(0.191)
First stage F-test	14.83	1.42
Observations	33573	33573

NOTE— The table shows estimates from two separate first-stage regressions. Column 1 shows the first-stage estimates of age at first enrollment regressed on the vacancy rates in the two chosen daycare institutions measured one month before the preferred enrollment month. Column 2 shows the estimates of a placebo first-stage regression of age at first enrollment on the vacancy rates in the two chosen daycare intuitions measured when the child was four months old. Standard errors clustered at the level of enrollment institution are shown in parentheses.* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

4.2 Second-stage results

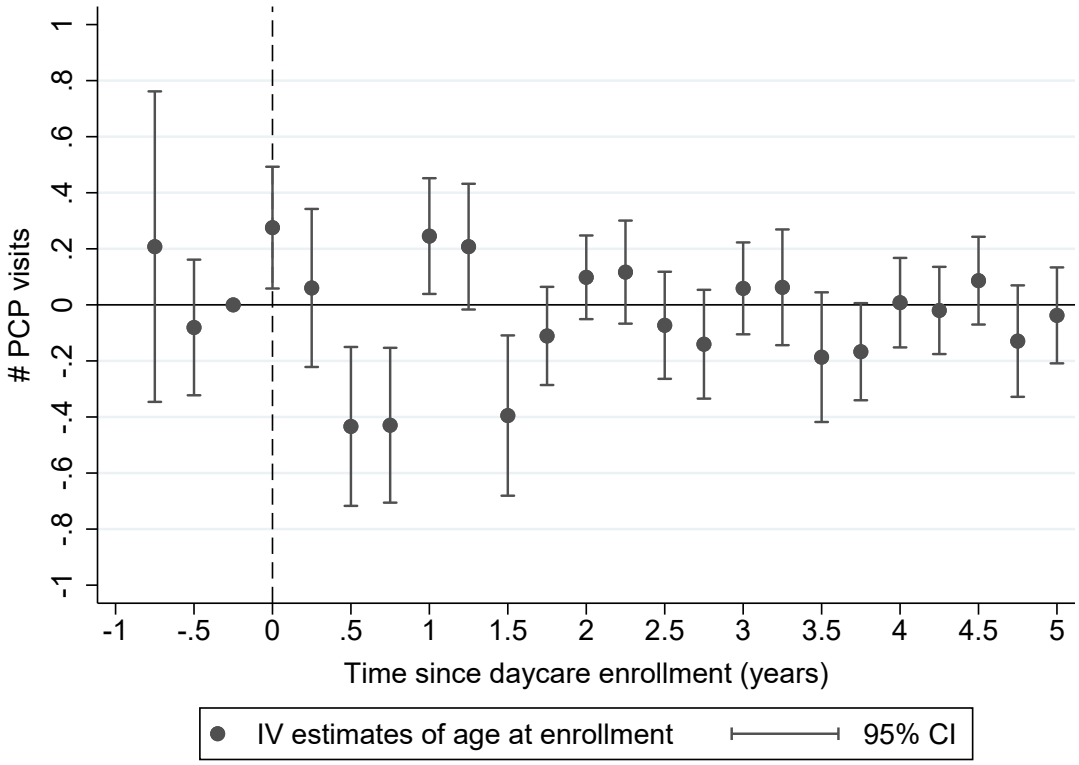
We next turn to the second-stage results. Figure 6 plots IV estimates of enrollment age on the number of quarterly PCP visits, running from birth to five years after enrollment. The vertical dotted line in the figure indicates the quarter of the year the child enrolls in daycare. As expected, enrollment age has no significant effect on the number of PCP visits before enrollment. However, after enrollment the effect of age at first enrollment is negative. This suggests that children who are relatively older at the time of their first enrollment have fewer PCP visits six months, nine months, and 1.5 years after enrollment in daycare compared to their younger playmates. 1.75 years and more after enrollment, the effects are close to zero throughout. [11]

Similarly, Figure A2 plots IV estimates of age at enrollment on the probability of inpatient hospitalization. The results indicate that enrollment age has no significant effects on more serious diseases that may require hospitalization.

We then turn to the effects of enrollment age on cognitive outcomes. Table 5, panel A

[11] In addition to Figure 6, Appendix figure A3 shows the OLS estimates of the effects of enrollment age on PCP visits. For PCP visits, we find negative age effects of enrollment age, and the estimates are similar in size but more precisely estimated. From two years after enrollment, the effects are close to zero.

Figure 6: The effects of daycare enrollment age on quarterly PCP visits



NOTE— The figure plots IV estimates of enrollment age on the number of PCP visits. Each 'dot' represents a separate regressions, and the 95 percent confidence interval. The vertical dotted line indicates the quarter of the year the child enrolls in daycare.

shows the second stage effects on outcomes associated with preschool language proficiency screening and redshirting. For testing at age five, we find that age at first enrollment has a positive and statistically significant effect on both being tested and showing lower language proficiency. Specifically, our results suggest that being one month older than other children when enrolling into daycare increases the probability of being tested by 6.3% and of having a low level of language proficiency by 3.4%, although the effect on being tested is only statistically significant at the 10 percent level [12]. For redshirting, we find a negative but statistically insignificant effect of enrollment age. Table 5, panel B shows the OLS results; these are in general smaller than the IV estimates.[13]

[12]We also test the effect of enrollment age on language proficiency at age three. Fewer children are tested at age three, and our first stage estimates are mostly weak in our analysis. Therefore, we exempt these results from the paper.

[13]We find similar results if we reduce the sample to children enrolled within 12 weeks of preferred enrollment

Overall, we find both positive and negative effects of being older at first enrollment. Children who enroll later are less likely to visit their PCP during the first six or nine months after enrolling in daycare, but these children are also more likely to have some language difficulties at age five compared to their playmates at the daycare facility.

Table 5: Effects of daycare enrollment age on test taking, language scores and redshirting

	(1) Age 5: Tested	(2) Age 5: Low score	(3) Late for grade
Panel A: IV			
Age at first enrollment	0.063*	0.034**	-0.020
	(0.038)	(0.017)	(0.016)
First stage F-test	20.19	20.19	17.65
Panel B: OLS			
Age at first enrollment	0.004***	0.004***	-0.000
	(0.002)	(0.001)	(0.001)
Observations	29066	29066	23757

NOTE— IV estimates. Column (1) outcome is a dummy-variable for child tested for language proficiency at age five, column (2) outcome is a dummy-variable for a low score on the test, column (3) outcome is a dummy for being late for grade (redshirting). Standard errors (in parentheses) clustered at enrollment level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

4.3 Heterogeneity by maternal education and child gender

In this section, we examine whether the effects of enrollment age are heterogeneous by maternal education and child gender.

4.3.1 Effects of enrollment age by maternal education

In order to assess the effects of formal daycare on child development, it is essential to assess the quality of non-parental care relative to parental care. Thus it is possible that the consequences of entering formal daycare will differ across parents with different educational levels. Fort et al. (2020) e.g. argues that differences in the educational levels across different estimation samples may partially explain the somewhat mixed results found in the existing

age (see Appendix Table A2).

literature. Another potential explanation is the quality differences between daycare institutions in different countries given by, for example, different child-to-adult ratio and number of educated personnel (Gromada and Richardson, 2021).

As a proxy for a potentially higher quality and more stimulating home environment, we use a dummy for mothers with a college or a university degree and interact this dummy with enrollment age. Figure 7 shows the effects of enrollment age on PCP visits by maternal education. The lighter colored dots show the effects of enrollment age for mothers with less than a college degree, while the darker colored dots show the interaction term between enrollment age and college-educated mothers. For PCP visits, the interaction term is close to zero suggesting that the effect of enrollment age for children of college- or university-educated mothers is similar to that of children of mothers with less than a college degree. For children of mothers with less than a college degree, we find – similar to the main results – that increasing enrollment age decreases PCP visits six months, nine months, and 1.5 years after enrollment.[14]

Panel A in table 6 shows the effects of enrollment age by maternal education for the cognitive outcomes. We compare children from families where the mother has at least a college degree to families where the mother does not have a college degree. For the three cognitive outcomes, being tested at age 5, language proficiency score and being late for grade, we find almost no difference by maternal education. Thus our results suggest that if the quality of the daycare is high, early daycare enrollment benefits all children equally, regardless of the educational level of their parents.

4.3.2 Effects of enrollment age by gender

Previous literature suggests that the effects of daycare enrollment and schooling may vary across gender, and boys may benefit more than girls from access to high-quality daycare (Felfe and Lalive, 2018; Gørtz et al., 2018). We therefore explore whether the effects of enrollment

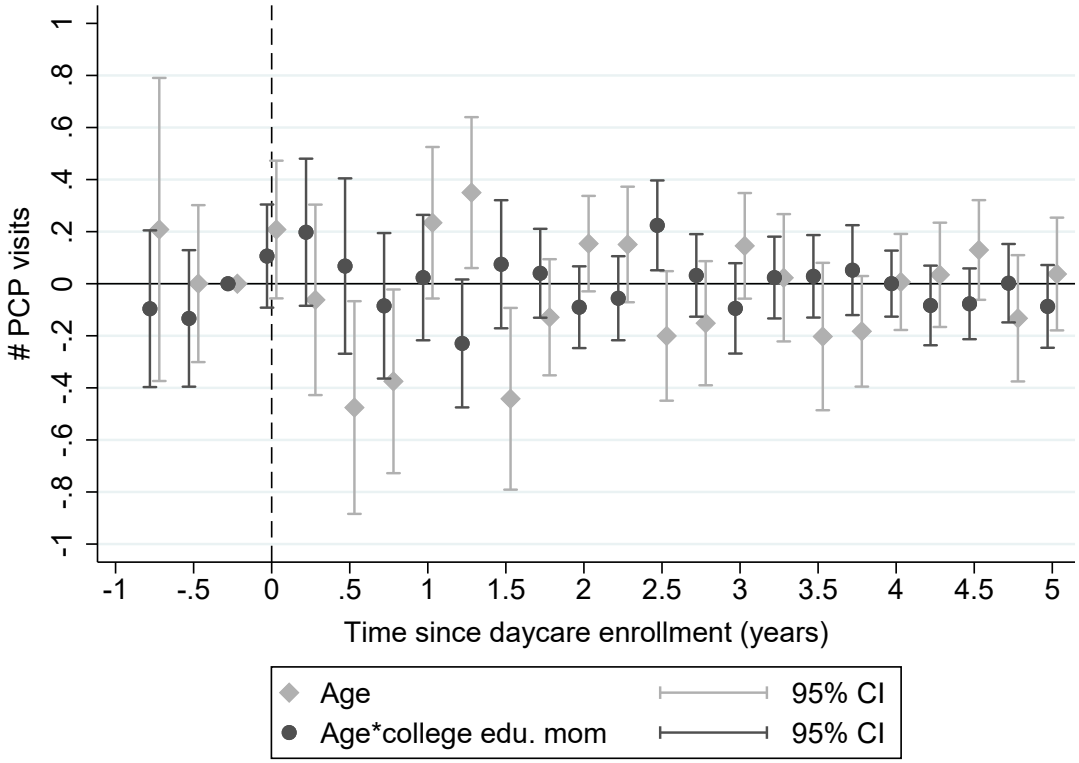
[14]Similar to the main results, we also find no effects of enrollment age on inpatient hospitalization by maternal level of education.

age into daycare vary by gender. Figure 8 shows that the effects on PCP visits do not vary significantly across girls and boys.

In addition, panel B in Table 6 shows the relative impact on cognitive outcomes of enrollment age by gender. Age at enrollment has a marginally higher effect on boy's probability of being tested at age 5 compared to that of girls' probability of being tested. A likely explanation is that boys' language proficiency level is generally lower than girls' language proficiency level. Thus we would anticipate that more boys are tested. For the (gender-adjusted) language proficiency level, we find no evidence of age at enrollment having a different impact on boys' relative to girls' language proficiency level. Thus in contrast to previous findings, we find little evidence that boys benefit more than girls from high-quality daycare.[15]

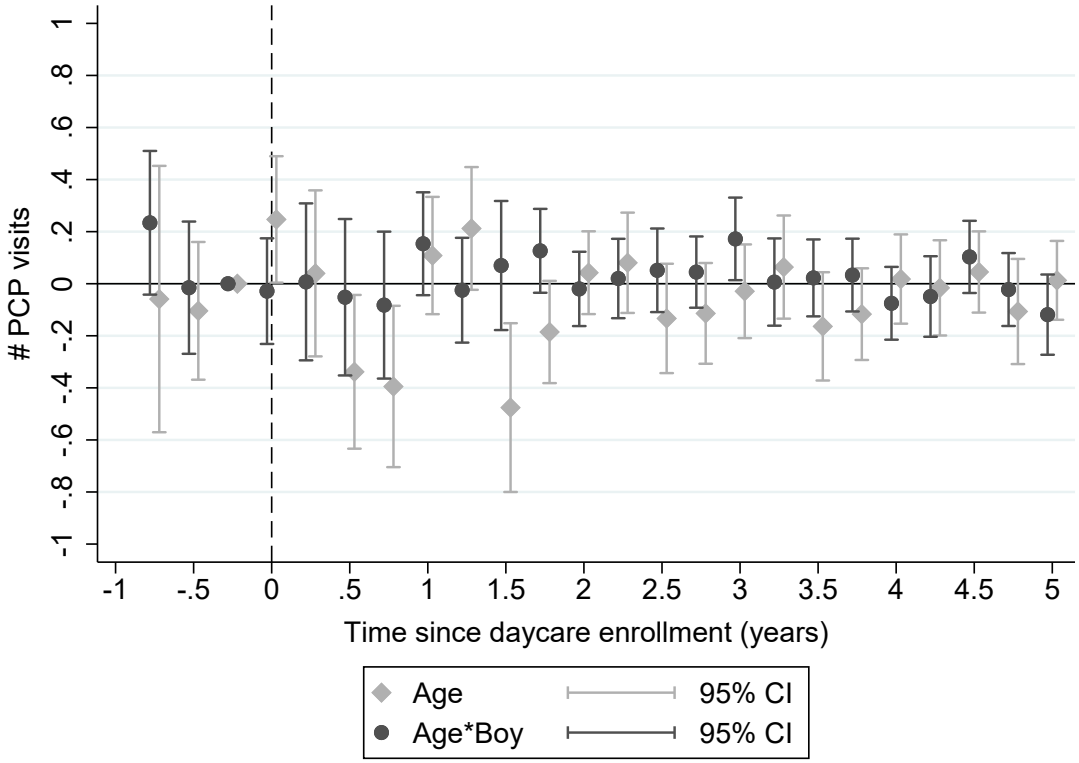
[15]We also investigate whether the effect of enrollment age is different for ethnic minority children than for other children. Similar to boys, ethnic minority children are more likely to have a lower level of language proficiency in early childhood. Thus we would expect that ethnic minority children may benefit more from early enrollment compared to non-minority children. However, we find no clear evidence that age at enrollment is more important for ethnic minority children than ethnic Danes. As only 9 percent of the children are ethnic minorities, this could be the reason for our statistically insignificant results.

Figure 7: The effects of enrollment age on quarterly PCP visits, by maternal education



NOTE— The figure plots IV estimates of age at first enrollment on number of PCP visits per quarter of a year. The dotted vertical line indicates the quarter in which children first enroll non-parental daycare. For each quarter of a year, we perform a regression with an interaction term between enrollment age and maternal education. The lighter gray dots are the main age effects and the black dots are the results from the interaction terms.

Figure 8: The effects of enrollment age on quarterly PCP visits, by child gender



NOTE— The figure plots IV estimates of age at first enrollment on number of PCP visits per quarter of a year. The dotted vertical line indicates the quarter in which children first enroll non-parental daycare. For each quarter of a year, we perform a regression with an interaction term between enrollment age and child gender. The lighter gray dots are the main age effects and the black dots are the results from the interaction terms.

Table 6: The effects of daycare enrollment age on test taking, language scores and redshirting by maternal education and child gender

	(1) Age 5: Tested	(2) Age 5: Low score	(3) Late for grade
Panel A: Maternal education			
Age at first enrollment	0.076	0.036	-0.003
	(0.048)	(0.026)	(0.019)
Age*Mom college	-0.020	-0.001	-0.020
	(0.039)	(0.021)	(0.014)
Mom college degree	0.182	-0.030	0.196
	(0.417)	(0.223)	(0.154)
First stage F test	9.60	9.60	7.42
Panel B: Child gender			
Age at first enrollment	0.016	0.020	-0.026*
	(0.044)	(0.019)	(0.014)
Age * Boy	0.076*	0.017	0.018
	(0.041)	(0.019)	(0.015)
Boy	-0.801*	-0.179	-0.173
	(0.436)	(0.208)	(0.161)
First stage F test	10.92	10.92	13.43
Observations	29066	29066	23757

NOTE— This table shows the effects of enrollment age by maternal education (panel A) or by child gender (panel B). Each column represents one regression. The parenthesis show robust standard errors clustered at enrollment level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

4.4 Summary of results

Overall, we find no clear evidence that early enrollment is harmful for the child beyond a temporary health shock, which is likely due to intensive exposure to many other children. We also find some positive cognitive effects of early exposure to daycare, which can be caused by many factors. For example, the exposure to more dialogue. Our results align with recent results found in Sweden that estimate the health effects of daycare exposure from age one. This study found that daycare exposure has an immediate and strong negative effect on physical health (ear problems, infections, respiratory diseases, and PCP visits) after enrollment, but a positive effect on mental health at age 4-7 (van den Berg and Siflinger, 2021). The authors argue that a reduction in developmental problems drives their positive results on mental health. The positive result of the cognitive test also aligns with results

found in Norway, where an admission lottery lowered the enrollment age by four months (from aged 19 months on average). The authors of the Norwegian study found that earlier enrollment leads to better test scores at age seven (Drange and Havnes, 2019). However, in contrast to these two recent studies as well as a German study (Felfe and Lalive, 2018), we do not find heterogeneous effects in terms of stronger effects of early exposure for children from less affluent families. Also in contrast to Felfe and Lalive (2018) and Gørtz et al. (2018) we find no evidence that boys benefit more from access to high-quality daycare than girls.

4.5 Sensitivity tests

We now assess the sensitivity of our main results. First we investigate the effects of enrollment age for potential special circumstances for siblings. Second, we test whether our results are driven by quality differences between type of daycare. Third, we test if our results are driven by the flu season.

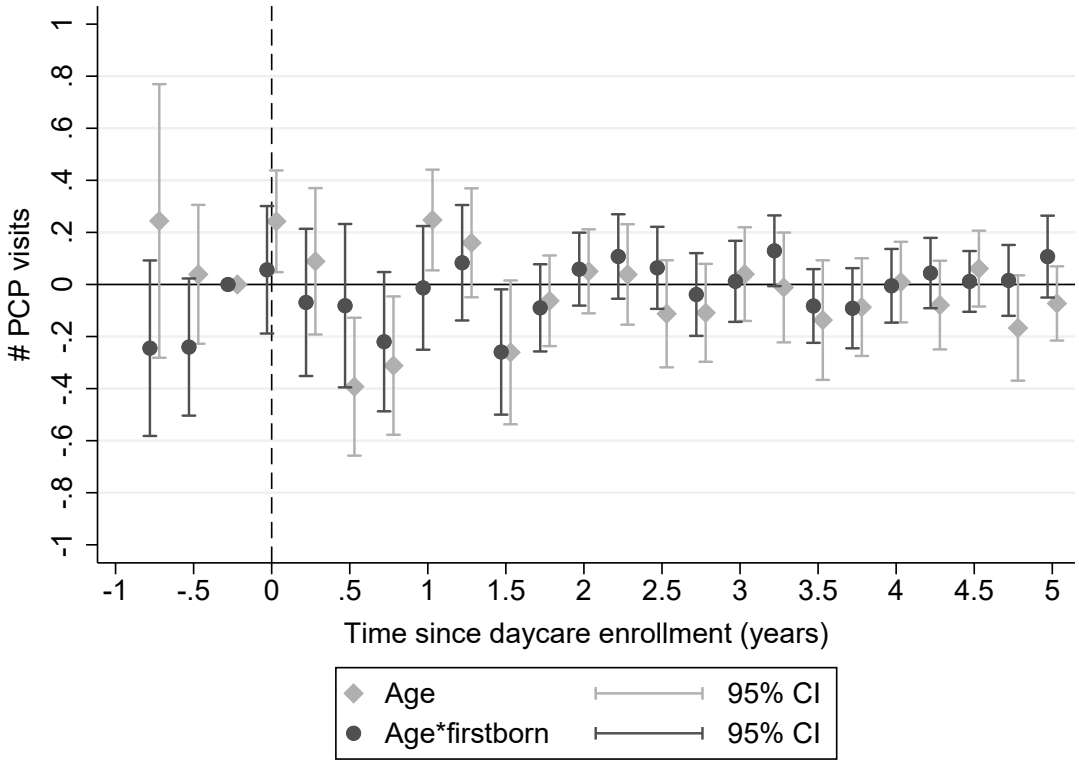
4.5.1 Siblings

Although the daycare allocation office does not guarantee that siblings can enroll in the same daycare center in the period we analyzed, anecdotal evidence suggests that the daycare office tries to allocate siblings to the same daycare center. Thus parents are more likely to have direct contact to their preferred daycare center when it is time to enroll younger siblings, and this contact may help smooth the transition from parental care to daycare for these younger siblings. Therefore, we examine whether enrollment age has a stronger impact on child health and cognitive outcomes for the firstborn compared to younger siblings.

Figure 9 shows the effect of enrollment age on PCP visits by firstborn and later born children. We find some evidence that the number of PCP visits is different for firstborn and later born children nine months and 1.5 years after enrollment, with the strongest effect for firstborn children. However, the differences are small and only marginally statistically significant. Similar to Figure 9, Table 7 confirms the effect of enrollment age on cognitive

outcomes and redshirting. We find no statistically significant differences between the effects of entrollement age for firstborn and laterborn children on testing at age five, but not at age three. We find no differences for redshirting.

Figure 9: The effects of enrollment age on quarterly PCP visits by firstborn and laterborn children



NOTE— The figure plots IV estimates of age at first enrollment on number of PCP visits per quarter of a year. The dotted vertical line indicates the quarter in which children first enroll in non-parental daycare.

4.5.2 Type of daycare facility

Second, we test whether our results are sensitive to excluding children who enroll in family-based daycare or private care. Clear differences exist between center-based and family-based daycare such as size and the educational level of the caregivers. We therefore drop the 20 percent of children that enroll in family-based care or private care and re-estimate our results. For PCP visits, we find that enrollment age has a marginally stronger effect when children

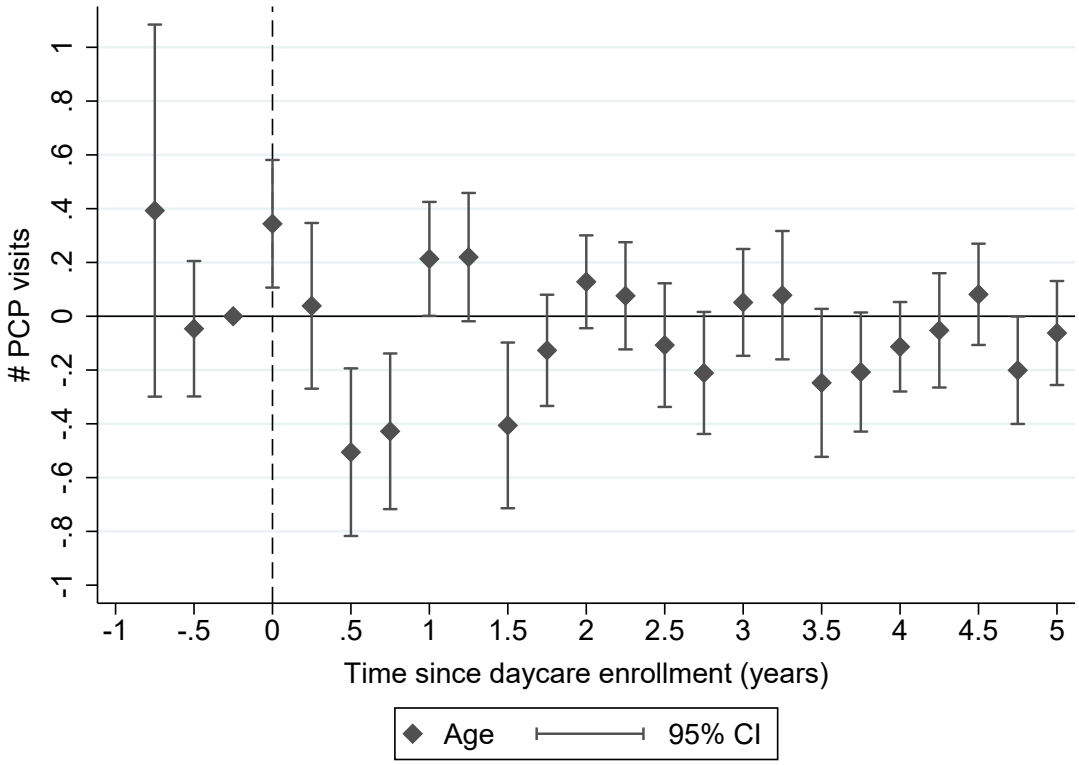
Table 7: The effects of enrollment age on test taking, language scores and redshirting, by firstborn and laterborn children

	(1) Age 5: Tested	(2) Age 5: Low score	(3) Late for grade
Age at first enrollment	0.066	0.047**	-0.022
	(0.046)	(0.021)	(0.017)
Age * Firstborn	-0.004	-0.020	0.006
	(0.042)	(0.020)	(0.014)
Firstborn	0.031	0.199	-0.066
	(0.452)	(0.212)	(0.146)
Observations	29066	29066	23757
First stage F test	10.36	10.36	10.36

NOTE— IV estimates. Enrollment age interacted with dummy for being firstborn. Column (1) outcome is a dummy-variable for child tested for language proficiency at age five, column (2) outcome is a dummy-variable for a low score on the test, column (3) outcome is a dummy for being late for grade (redshirting). Standard errors (in parentheses) clustered at enrollment level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

enroll in center-based care (see Figure 10). Given that group size is generally larger in center-based care compared to family-based care, children in center-based care are generally more exposed to infection, and this is a potential explanation of this result. For cognitive outcomes, Table 8 shows similar results compared with the main results in table 5 although the effects of enrollment age are marginally smaller, indicating that center-based care institutions are more likely to compensate for later daycare enrollment.

Figure 10: The effects of enrollment age in center-based daycare on quarterly PCP visits



NOTE— The figure plots IV estimates of age at first enrollment in center-based daycare on number of PCP visits per quarter. The dotted vertical line indicates the quarter in which children first enroll in daycare.

4.5.3 Flu season

Third, especially the health consequences of enrollment age may depend on summer or winter enrollment, as the risk of contracting e.g. a cold or an ear infection is greater during the 'flu season'. Figure 11 plots the effects of enrollment age on quarterly PCP visits by flu season.[16] We find some evidence that our main results are driven by the spring and summer season (the non-flu season). In addition, we also find that the interaction terms between the flu-season and enrollment age are positive and statistically significant in many cases. This suggests that the effect of enrollment age is close to zero during the flu season. A potential explanation is that most children get infected during the flu season regardless of enrollment age. For test taking, language proficiency and redshirting, our main results in Table 5 mimic

[16]The dummy for flu season is defined as October through March versus the rest of the year.

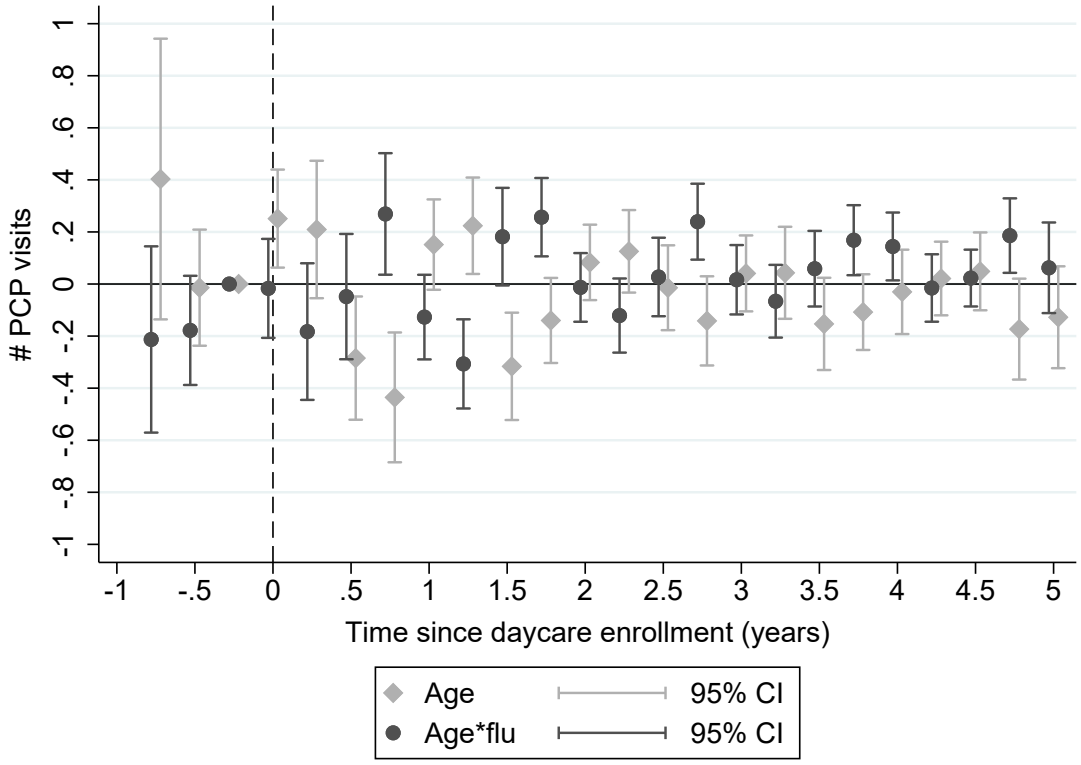
Table 8: Effects of enrollment age on cognitive outcomes for children in center-based care

	(1) Age 5: Tested	(2) Age 5: Low score	(3) Late for grade
Age at first enrollment	0.090**	0.036**	-0.025
	(0.042)	(0.018)	(0.018)
Observations	22626	22626	18126
First stage F test	16.41	16.41	14.24

NOTE— IV estimates on sample of children in center-based care. Column (1) outcome is a dummy-variable for child tested for language proficiency at age five, column (2) outcome is a dummy-variable for a low score on the test, column (3) outcome is a dummy for being late for grade (redshirting). Standard errors (in parentheses) clustered at enrollment level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

the effects of enrollment age during the summer season. The effects of enrollment age on late for grade is also marginally statistically significant, suggesting that children that are older at first enrollment have a lower probability of delaying school enrollment (see first row, Table 9).

Figure 11: The effects of daycare starting age on quarterly PCP visits, by season



NOTE— The figure plots IV estimates of age at first enrollment on number of PCP visits per quarter of a year. The dotted vertical line indicates the quarter in which children enroll non-parental daycare for the first time.

Table 9: The effects enrollment age on cognitive outcomes by season

	(1) Age 5: Tested	(2) Age 5: Low score	(3) Late for grade
Age at first enrollment	0.061	0.034**	-0.026*
	(0.039)	(0.017)	(0.014)
Age*Flu season	0.010	0.001	0.017
	(0.038)	(0.018)	(0.014)
Flu season	-0.101	-0.001	-0.182
	(0.409)	(0.197)	(0.157)
Observations	29066	29066	23757
First stage F test	14.31	14.31	12.36

NOTE— IV estimates. Enrollment age interacted with dummy for flu season. Column (1) outcome is a dummy-variable for child tested for language proficiency at age five, column (2) outcome is a dummy-variable for a low score on the test, column (3) outcome is a dummy for being late for grade (redshirting). Standard errors (in parentheses) clustered at enrollment level. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

5 Conclusion

An large number of mothers return to the labor market when their child is one year old or younger, and this situation has sparked a debate about early-age daycare. In this paper, we assess the causal effects of enrollment age in daycare for children aged 6 through 18 months old in Denmark, a context with an unusually high level of daycare attendance, minimal selection into informal care, and generally high-quality daycare.

Our paper makes several important contributions to the scarce literature on non-parental daycare for the youngest children. First, the paper addresses head-on the concern that the timing of return to work and choice of daycare is not random. In order to obtain causal effects of the age of daycare enrollment, we develop an identification strategy that relies on excess demand of daycare slots in the City of Copenhagen. When parents choose universal (and subsidized) daycare, they register their daycare preferences and preferred enrollment dates at the municipal daycare office, which administers the allocation of all vacant daycare slots for the Copenhagen area in accordance with a waiting list system. Our 2SLS setup uses monthly vacancy rates at the two preferred daycare centers measured one month before preferred enrollment date as an instrument for enrollment age. This approach allows us to estimate the effects of daycare start age at the intensive margin rather than at the extensive margin (formal daycare or not). Second, exploiting our rich register data, we are able to consider a wide range of objective measures of both health and cognitive outcomes. Third, our high-quality data allows us to explore heterogeneity in the results across socioeconomic traits of parents.

Our empirical investigation provides a number of interesting insights, suggesting both positive and negative effects of early enrollment. We show that children who enroll later have fewer PCP contacts during the first 1.5 years in daycare and thus may experience fewer (minor) health conditions in the year they enroll in daycare. However, these effects only occur in the first year after enrollment, and there are no permanent effects on PCP contacts over the next three years. Moreover, the effects on hospitalizations are close to

zero, suggesting modest infections and no wide-reaching consequences of daycare start age on the child's health. Furthermore, we find that being younger at enrollment tend to improve language skills when the child reaches preschool age, as later enrollment not only increases the probability of language proficiency testing at age 5 by 6.3% (statistically significant at the 10% level), but also increases the probability of scoring low on this test by 3.4 %. Later or earlier daycare enrollment, however, does not have any significant effects of the probability of delaying school start (redshirting).

Overall, our results suggest that early enrollment is not harmful to young children when outcomes such as health care use and cognitive outcomes are in focus. We find a temporary and modest increase in PCP visits, but no persistent effects on health care use in the first five years of a child's life, and we document some positive effects on preschool-age cognitive outcomes of early enrollment. Moreover, in contrast to other papers, we find no differences between children from more and less affluent families (measured, e.g., based on the mother's level of education) or differences between boys and girls. Our results not only speak into the ongoing debate about the pros and cons of early enrollment in daycare, but also contribute to the discussion on medium-term implications of early return to the labor market, as we estimate the marginal effect of enrollment age at exposure for the youngest children. A salient explanation for the relatively modest effects of early daycare enrollment for children from both less as well as more affluent families may be found in our focus on the Scandinavian setting in which quality of formal daycare is high in comparison to many other OECD countries.

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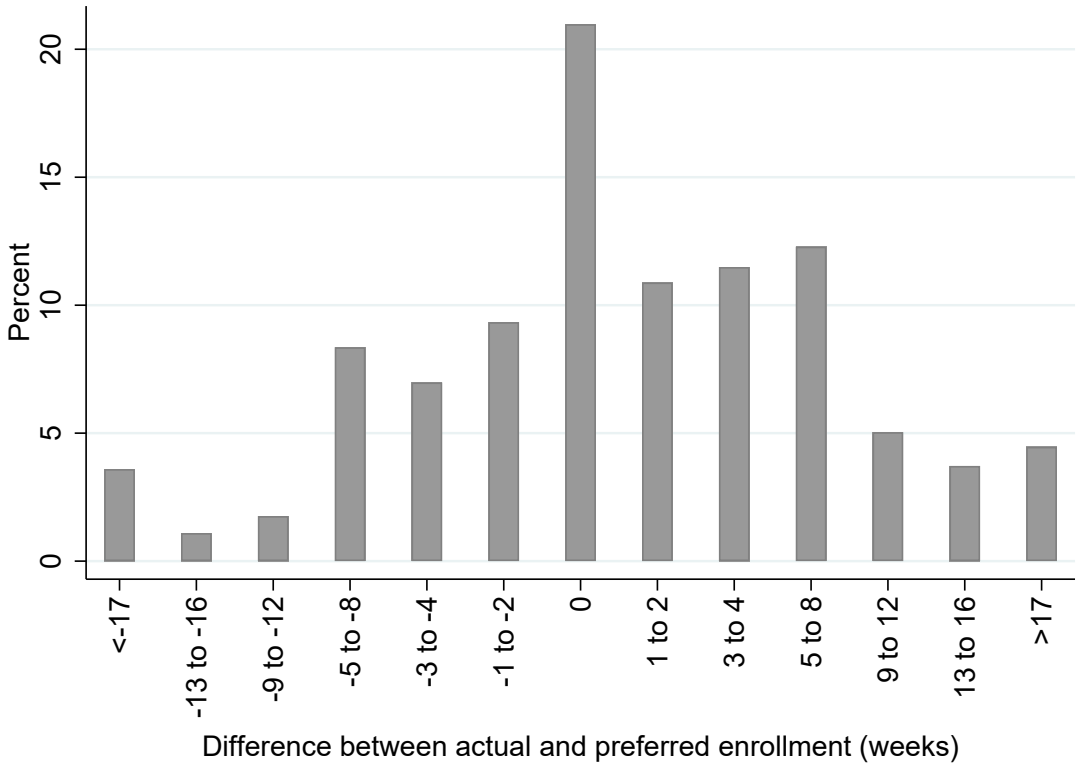
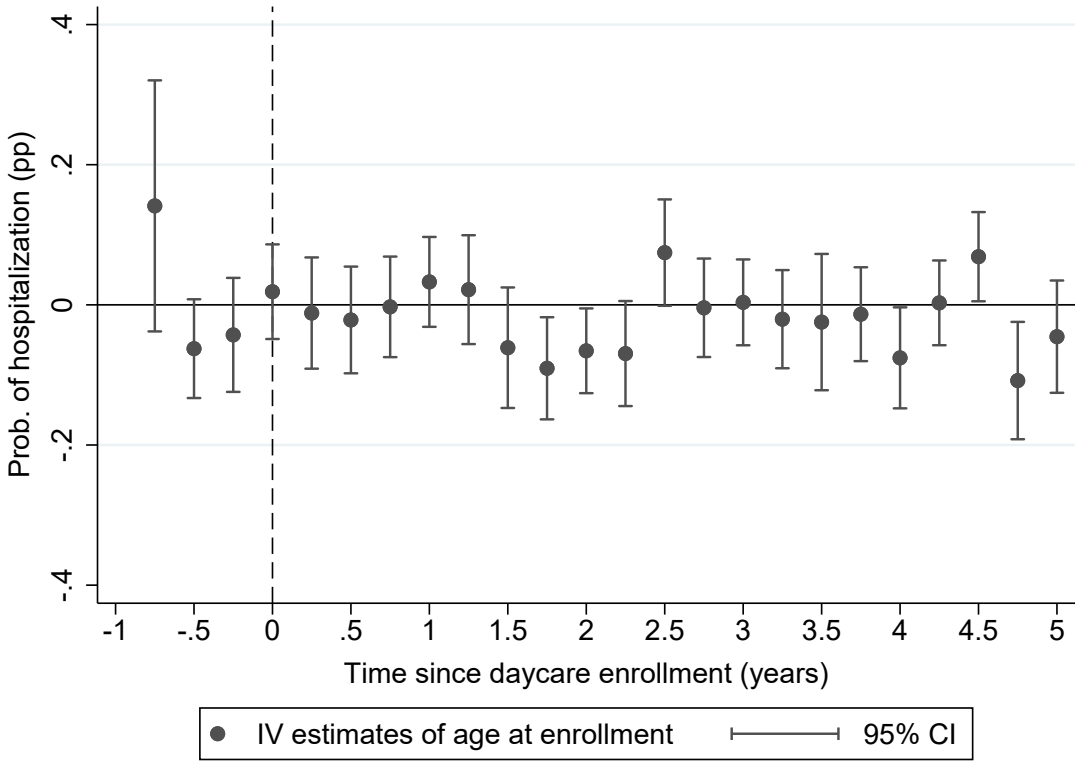
A Appendix

Figure A1: Distribution of the differences between actual and preferred enrollment age



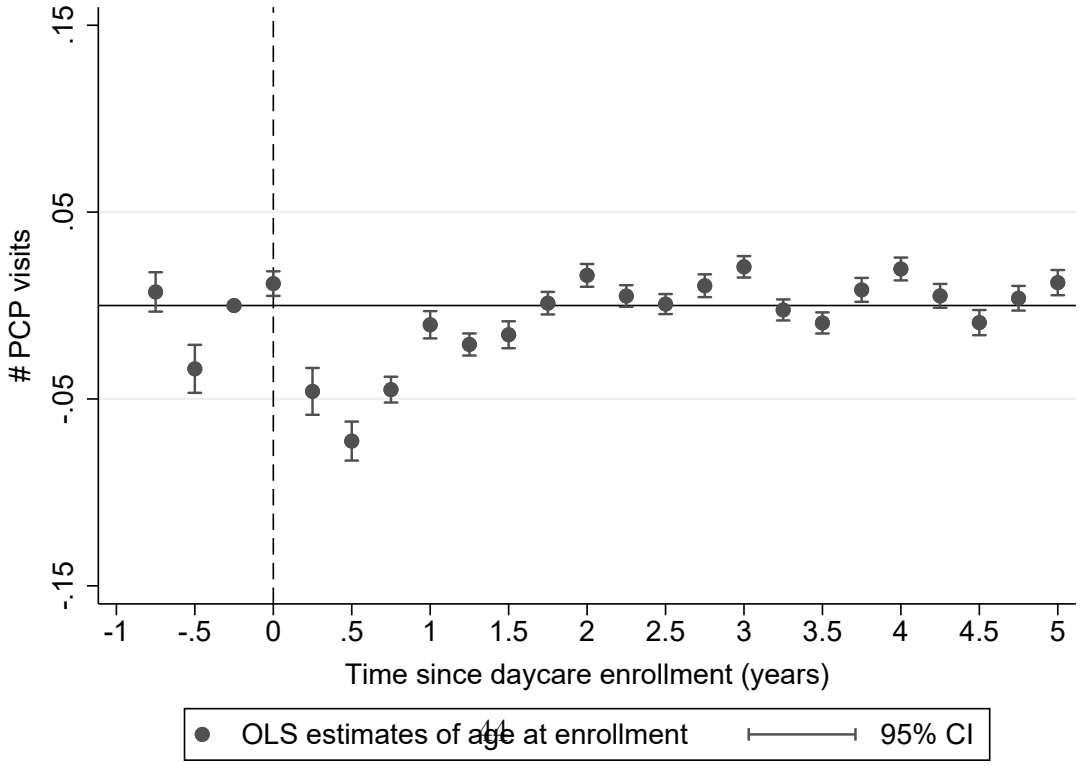
NOTE— The figure plot the difference between the actual enrollment age and the preferred enrollment age in intervals of weeks. Data on the left hand side of zero are from children who start before their preferred enrollment age, while data on the right hand side of zero indicate children who start after their preferred enrollment age.

Figure A2: The effects of daycare enrollment age on quarterly hospitalization



Note— The figure plots IV estimates of enrollment age on the probability of hospitalization. The vertical dotted line indicates the quarter the child enrolls in daycare. Each dot is from a separate regression.

Figure A3: OLS estimates of daycare enrollment age on quarterly PCP visits



Note— The figure plots OLS estimates of start age on the number of PCP visits. The vertical dotted line

Table A1: Sample selection - Greater Copenhagen

	(1) Greater Cph.	(2) Not in sample	(3) Sample	(4) Diff.
Year of birth	2011.93	2011.96	2011.90	0.0554***
	(2.00)	(2.01)	(2.00)	(3.73)
Boy	0.51	0.51	0.51	0.000582
	(0.50)	(0.50)	(0.50)	(0.16)
Low birth weight	0.04	0.05	0.04	0.00923***
	(0.20)	(0.21)	(0.19)	(6.07)
Birth weight	3461.67	3456.50	3467.76	-11.27***
	(534.28)	(550.03)	(515.04)	(-2.84)
Gestational age (days)	278.43	277.77	279.22	-1.450***
	(12.09)	(12.81)	(11.14)	(-16.19)
Both parents basic education only	0.04	0.05	0.02	0.0255***
	(0.19)	(0.22)	(0.15)	(18.06)
At least one college educated parent	0.66	0.60	0.74	-0.143***
	(0.47)	(0.49)	(0.44)	(-41.17)
No registered father	0.05	0.05	0.05	0.000592
	(0.22)	(0.22)	(0.22)	(0.36)
Parents immigrated	0.11	0.13	0.08	0.0529***
	(0.31)	(0.34)	(0.27)	(22.95)
Observations	73114	39541	33573	73114

NOTE— * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table A2: Robust to only including enrolled +/- 12 weeks of preferred enrollment age

	(1) Age 5: Tested	(2) Age 5: Low score	(3) Late for grade
Panel A: IV			
Age at first enrollment	0.081*	0.038*	-0.017
	(0.049)	(0.021)	(0.020)
First stage F test	17.66	17.66	17.47
Panel B: OLS			
Age at first enrollment	0.003*	0.003***	-0.001
	(0.002)	(0.001)	(0.001)
Observations	25927	25927	21102

NOTE— * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.