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Nina Drange and Marte Rønning

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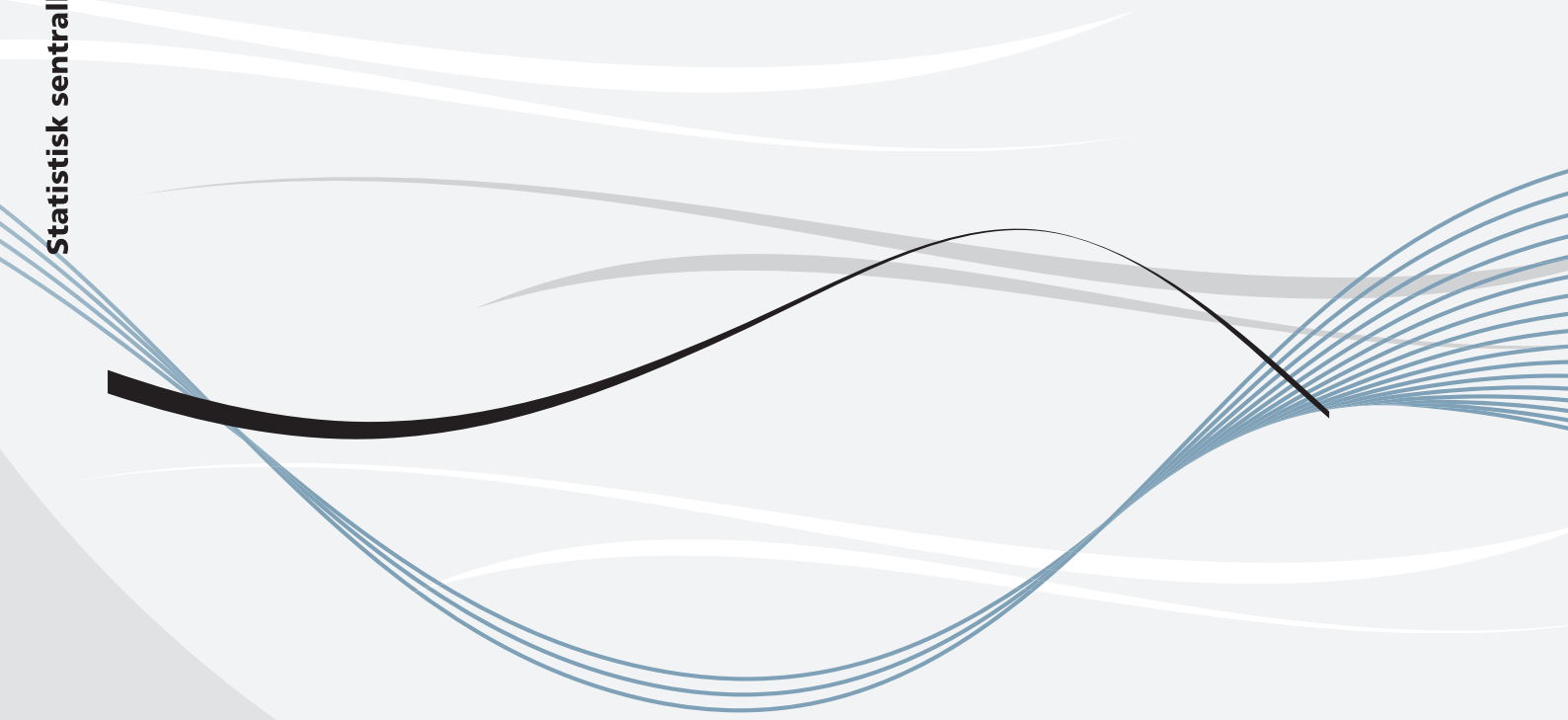

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Child care center staff composition and early child development

Abstract:
We estimate effects of child care center staff composition on early child development. During the years our data covers, child care centers in Oslo were oversubscribed, and child care slots were allocated through a lottery. This allow us to explore how staff education, experience and stability, as well as proportion of male and immigrant staff, affect the cognitive development of children whose parents initially applied for the same center(s), but where children got offers from different institutions. We find that children who get their first offer of child care enrollment in a child care center with a higher share of male staff, perform better on tests in language and mathematics in the early years of school.

Keywords: Child care quality, child development

JEL classification: I21, J13

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Address: Nina Drange, Statistics Norway, Research Department. E-mail: ndr@ssb.no

Marte Rønning, Statistics Norway, Research Department. E-mail: mro@ssb.no

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Sammendrag

Det er nå godt dokumentert at barnehage av god kvalitet kan forbedre livene til barn fra familier med lav sosioøkonomisk status. Vi vet imidlertid mindre om hvilke av komponentene ved en barnehage som forbedrer barns utvikling. I lys av den store økningen av små barn i barnehagen i de fleste OECD-land i løpet av det siste tiåret, samt størrelsen på subsidiene myndighetene i landene ofte betaler, synes det å være av stor betydning at vi forstår bedre hva det er som gjør at barnehagen bidrar til å bedre barns utvikling.

I denne analysen undersøker vi hvordan aspekter av strukturell kvalitet i barnehagen påvirker barns kognitive utvikling. Nærmere bestemt ser vi på om personalets utdanning, erfaring og stabilitet, samt andelen menn og andelen ansatte med innvandrerbakgrunn i barnehagen påvirker den kognitive utviklingen til barn hvis foreldre søkte om plass i samme senter, men hvor barna fikk tilbud om å starte i forskjellige barnehager.

Foreldre som tilbyr et hjemmemiljø som fremmer positiv utvikling, vil trolig velge barnehager som gjør det samme. Det er vanskelig, trolig umulig, å finne et nøyaktig mål på barnets hjemmemiljø. For å troverdig estimere effekter av kvalitet i barnehagen, må vi derfor ta hensyn til at ulike foreldre velger forskjellig.

Et unikt datasett fra Oslo kommune som inneholder søknader til barnehager og detaljerte opplysninger for barnehagebruk, gir oss mulighet til å kontrollere for foreldrenes preferanser for barnehagekvalitet. I perioden 2005-2007 var det flere som ønsket plass i Oslos barnehager enn det var tilgjengelige plasser, og barnehageplassene ble tildelt gjennom et lotteri for barna som ikke hadde prioritet. Mens de fleste barn som ønsket å starte i barnehage til slutt fikk plass, endte flertallet opp med å starte i en annen barnehage enn den familien hadde rangert høyest. Dette gjør at vi kan sammenligne utviklingen til barn hvis foreldrene søkte om samme barnehage, men der barna endte opp med å få tilbud i barnehager av med ulik sammensetning blant de ansatte på grunn av lotteriet.

Vi måler kognitiv utvikling med et samlet mål for testresultater i første, andre og tredje klasse, når barna er mellom 6 og 9 år. Våre funn tyder på at barn som går i en barnehage med en høyere andel mannlige ansatte, gjør det bedre på språk og regne-testene i småskolen. Vi finner ikke dekning for at personalets utdanning, erfaring, stabilitet eller andelen med innvandrerbakgrunn blant de ansatte i barnehagene påvirker barnas kognitive utvikling.

En forklaring på funnene våre kan være at mannlige ansatte samhandler med barna på en annen måte enn kvinnelige ansatte. En annen forklaring kan være at mannlige ansatte velger seg til barnehager som er mer egnet til å fremme barns utvikling på måter vi ikke klarer å måle. Vi undersøker om observerbare forskjeller mellom mannlige og kvinnelige ansatte kan forklare funnene våre, men vi finner ingen støtte for dette.

1 Introduction

It is by now well-documented that intensive and high-quality child care improves lives of deprived children (Almond and Currie, 2011; Baker, 2011; Ruhm and Waldfogel, 2012; Blau and Currie, 2006). However, which of the components in a child care program that enhances child development, is still largely unanswered (Blau and Currie, 2006). Given the surge in enrollment of children in child care across most OECD countries during the last decade, as well as the amount of subsidies paid by many governments, it appears to be of high importance that we understand better how different aspects of child care quality may contribute to improved child outcomes.

In the child care center the child is exposed to a number of factors that could possibly affect development. The literature typically distinguishes between structural quality such as the child/teacher ratio, the share of educated teachers and group size, and process quality, reflecting the interaction between the child and its caregivers (Blau and Currie, 2006). We take advantage of administrative data in this current analysis, and will thus pay attention to certain aspects of structural quality.[1] More specifically, we will explore how staff qualifications, experience and stability, as well as proportion of male and immigrant staff, affect the cognitive development of children whose parents initially applied for the same center(s), but where children got offers from different institutions. While structural quality indicators can be easily measured, evidence of their importance for child development is mixed. Bauchmuller et al. (2014) find positive associations between child outcomes and certain structural quality measures such as staff-per-child ratio, male share of staff and a higher share of staff with formal child care teacher training. Blau (1999), on the other hand, finds that child care characteristics have little association with child development on average, particularly for the youngest children.

Well-identified causal studies of child care quality are scarce, but more attention has been given to what works in school. Evidence from the classroom suggests that although there seems to be substantial differences among teachers in their ability to impact child achievement, neither a graduate degree nor additional years of experience past the initial years can explain the value added (Rivkin et al., 2005). An important distinction between the classroom and the child care center is, however, that while teaching in schools often require a basic teaching degree, the staff without a child care teacher education in the Norwegian child care centers often do not have any education beyond high school (and even high school is not a requirement). Thus, variation in the share of trained teachers in the child care center setting could on the one hand be more important than variation

[1] Of course, structural quality might be strongly correlated with process quality. The child care teacher education should for example provide the teacher with tools to plan and implement age-appropriate learning activities in the child care center. If educated child care teachers are better equipped to plan and tailor learning objectives to the children and to interact with children and families, then increasing the share of child care teachers in a center would presumably increase process quality.

in years of education among teachers in school. On the other hand, the Norwegian child care center has a focus on informal learning trough play, and hence formal qualifications may matter less in such a setting. If effects of staff experience resembles what has been found for studies from the early years in school, it should be positive for the first years, but decreasing over time (Rivkin et al., 2005).

According to role model theory, the gender of the child care teacher could influence child outcomes. Similarly could teacher gender matter if female/male teachers have different expectations to boys and girls. Studies by Dee (2005, 2007) from the US suggest that that the gender of the teacher can explain differing school performance for boys and girls. While both girls and boys benefit from having a male mathematics teacher, girls benefit and boys perform worse if the English teacher is female. Taking advantage of a dataset that allows for student fixed-effects, Dee (2007) concludes that changing an English teacher from female to male would reduce the gender gap substantially among 13 year-olds. It is not clear that results from such older children in the US can illuminate gender differences in outcomes for children attending preschool in Norway. We know, however, that preschool teachers are predominantly women, and it appears interesting to investigate further if child development is affected differently depending on whether a child is offered a slot in a center with a high vs low share of male staff.

Role model theory also suggests that a teacher with the same race could be beneficial for child outcomes. It has also been hypothesized that teachers could be more responsive to the needs of children who share their racial or ethnic background (Dee, 2004). Dee (2004) finds indeed that both black and white students benefit from being assigned an own-race teacher during early grades.

When we want to assess the causal relationship between child care quality and child outcomes, we need to account for the likely selection into child care centers of differing quality. Parents who provide a home environment fostering positive child development, will plausibly select child care centers that do so as well. If control variables for parental background do not adequately account for differences in home environment, OLS estimates will be biased. Obtaining an accurate measure for the home environment of the child is difficult, possibly impossible. To credibly estimate causal effects of child care quality, we need to account for this selection. A unique dataset from the municipality of Oslo containing applications to child care centers and detailed records for child care use throughout childhood, allow us to plausibly control for parental preferences for child care center quality. During the years our data cover, child care centers in Oslo were oversubscribed, and child care slots were allocated through a lottery. While most children who wanted to attend a child care center would eventually enroll, the majority ended up enrolling in another center than they actually preferred. This allow us to compare the development of children where their parents initially applied for the same center(s), but where the children ended up getting assigned to centers of differing quality due to the

oversubscription. We have access to data on characteristics of child care center employees, as well as to certain structural measures of the child care center. Cognitive development is a pooled measure of test scores in first, second and third grade, when children are 6–9. Our findings suggest that children who receives an offer of enrollment in a child care center with a higher share of male staff, perform better on tests in both language and mathematics in the early years of school.

The paper proceeds as follows. We first discuss existing literature in Section 2. We proceed to elaborate on the institutional background in Section 3, before Section 4 describes our data. Section 5 presents and discusses our empirical approach. Section 6 presents our main results, while Section 7 concludes.

2 Literature

To the best of our knowledge there are few studies that adequately account for selection issues related to child care quality and child development. Blau (1999) takes advantage of a rich data set (the National Longitudinal Survey of Youth) with extended information of the home environment of the child and characteristics of the child care arrangement. Controlling for unobserved heterogeneity trough extensive background characteristics as well as for mother fixed effects, Blau finds that child care inputs experienced during the first three years of life have little impact on child outcomes. During the subsequent three years, smaller group size has a small, positive effect on subsequent outcomes.

A study considering the US Head Start program finds evidence for improved test scores in reading and vocabulary when Head Start spending is higher (Currie and Neidell, 2007). Holding spending constant, however, the authors find little support that reallocating resources to particular inputs affect child development. Higher pupil-teacher ratio has little impact, as has the pupil-staff ratio or the share of qualified teachers.

Bauchmuller et al. (2014) use Danish data to investigate the role of preschool quality for children's school performance at the end of primary school. They argue that the allocation of child care slots in Denmark to a certain extent is based on chance: A child will not necessarily attend the child care center the parents prefer. Given that the parental preferences are unknown, though, the authors refer to their findings as associations and not effects. The study shows that a higher staff-per-child ratio, a higher share of male staff and a higher share of staff with formal child care teacher training are associated with improvements in test results in Danish by the end of compulsory schooling. The associations are mainly driven by boys. Their results also suggest that ethnic minority children gain significantly less from a higher share of ethnic minority staff than children without such background.

While the child care quality literature is rather scarce, there is a much larger literature reporting effects of different aspects of quality during early school years. Although findings

for school children cannot necessarily inform the child development production function in the child care center, we might still think that what works in kindergarten also gives us a hint of what could work during earlier years. The gold standard in this literature is the controlled experiment. Given the complexity of the quality issue, changing one input while holding the others constant ease the interpretation of the results. Project STAR was implemented in certain kindergartens in Tennessee during the mid 80s. Kindergarten students and their teachers were randomly assigned to classes of differing size: Small, regular sized and regular sized with a full time teacher's aide. Krueger (1999) performs a careful re-analysis of the STAR data, and finds that performance on standardized tests increased during the first year students attended small classes, and increased somewhat in the subsequent years as well. Teachers aides and measured teacher characteristics had little effect.

In a study from Ecuador, Araujo et al. (2016) explore how randomizing two cohorts of kindergarten students to teachers within schools affect test scores and executive function[2]. A unique feature of this study is that all teachers were filmed teaching for a day, and subsequently the video material was coded using the Classroom Assessment Scoring System (CLASS). In addition, a battery of background information on children and teachers was collected. Findings suggest that teachers vary substantially in effectiveness, and that children assigned to teachers without experience, learn less on average. Other characteristics of teachers like tenure, IQ, personality traits and inhibitory control and attention, do not consistently predict test scores (Araujo et al., 2016). The study also shows that teacher behaviors measured by the CLASS coding, are significantly associated with learning in math, language and executive function.

Some studies from school settings suggest that gender of the teacher can explain differing school performance for boys and girls (Dee, 2005, 2007; Antecol et al., 2015). Dee (2007) shows that while both girls and boys benefit from having a male mathematics teacher, girls benefit and boys perform worse if the English teacher is female. Dee (2007) concludes that changing an English teacher from female to male would reduce the gender gap substantially among 13 year-olds. For primary school children, Antecol et al. (2015) take advantage of data on random assignment of teachers across classrooms and schools. They find that girls assigned to female teachers suffer from lower test scores in math by the end of the academic year. Boys' results are not affected by the gender of the teacher. In college, Hoffmann and Oreopoulos (2009) find similar but smaller effects of a same-sex teacher on student performance and likelihood to drop a course. It is not clear that results from school and college settings can illuminate gender differences in outcomes for children attending child care centers with differing gender composition among the staff. We know, however, that child care teachers are predominantly women, and it appears interesting to

[2]This is a joint measure of children's inhibitory control, working memory, capasity to pay attention and cognitive flexibilty (Araujo et al., 2016).

investigate further whether the gender of the child care staff can affect child development.

3 Institutional setting

3.1 Child care in Norway

Child care in Norway is heavily regulated, with provisions on staff qualifications, number of children per adult and per teacher, size of play area, and educational orientation. Institutions are run by an educated child care teacher responsible for day-to-day management and educational content. The child care teacher education is a three year college degree, including supervised practice in a child care institution. Child care regulations specify that there should be at least one educated child care teacher per 7-9 children aged below three, and at least one per 14-18 children aged 3–6. Municipal regulations specify that there all in all should be one adult per three children below three, and one adult per six children aged 3–6. There is no educational requirements for the additional staff. The teacher per staff ratio given that the child care center meets the regulations, will hence be 1 teacher per 3 employees. Few public child care centers in Norway accept children who are younger than one year.

In Oslo, about 60 percent of child care institutions are public, whereas the remaining centers are privately operated. Both public and private institutions require municipal approval and supervision to be entitled to federal subsidies that cover around 80 percent of costs. Moreover, each enrolled child with a minority background triggers an additional subsidy to accommodate language learning. Parental copayment is capped since 2003 at around 2400 NOK per month. Child care institutions are typically open from around 7.30 am to 5 pm.

In terms of educational content, a social pedagogy tradition has dominated child care practices in Norway since its inception in the 1970s. According to this tradition children should develop social, language and physical skills mainly through play and informal learning.[3] The informal learning is typically carried out in the context of day-to-day social interaction between children and staff, in addition to specific activities for different age groups.

Relevant for the years our data covers, The Ministry of Education issued an overall plan for the Norwegian child care centers in 2006 (Norwegian Ministry of Education, 2006). This plan covered six main focus areas, as well as a list of more specific themes and related activities that should be implemented in the child care center. While this plan is not particularly concrete in its description of learning goals and age specific activitives,

[3]The social pedagogy tradition to early education has been especially influential in the Nordic countries and Central-Europe. In contrast, a so-called pre-primary pedagogic approach to early education has dominated many English and French-speaking countries, favoring formal learning processes to meet explicit standards for what children should know and be able to do before they start school.

it still gives an overview of what the child care center should emphasize in its pedagogical and practical work with the children. The main focus areas were listed as 1) care and nurture, 2) play, 3) learning, 4) social competence, 5) language competence and 6) the child care center as a cultural arena. As for the more concrete themes and activities, there is a clear emphasis on learning through play and through interactions with other children and the adults in the center. There is also a specific emphasis on physical activity and the development of motor skills through both indoor and outdoor play.

3.2 Applications and admissions to child care in Oslo

Oslo is divided into 15 city districts with its own local administrations. During the years our data covers, allocation of child care slots took place inside the city district of residence. Available slots could be allocated to children from other city districts if there was undersubscription in that particular district. The municipality administration handled the allocation of child care slots in collaboration with the city district administrations.

A majority of the slots became available in August due to the transition of the six year-olds from the child care centers to 1st grade. Parents who wanted their children to enroll in a child care center (both public and private) in August had to apply before March 1. In the application they could rank up to seven child care centers. Children turning one year after September 1 the application year were not considered in the main allocation round, but would have to wait and see whether slots were still available after all children who turned one year prior to September 1 had been assigned a slot. Some groups were awarded priority, such as children with a sibling in a particular center, children of single mothers, disabled children and occasionally children with immigrant background.

In public institutions, allocations of slots to children with no priority were decided in a computer-generated lottery. According to representatives from the municipality, this lottery ensured that each child care center with available free slots was matched randomly with children of the appropriate age (for the free slot) who had ranked it as one of their prioritized centers.[4] Drange and Havnes (2017) show that background characteristics are balanced across samples of lottery winners and losers, suggesting that the randomization was successful.

In this set-up, the child could get a slot in any of their seven (or less, depending on the individual application) ranked child care centers with a similar probability, given that the centers ranked had similar oversubscription rates. The first ranked center had, however,

[4]The information about the lottery is based on online information of the public admission as well as a meeting with representatives from the municipality that handle the admissions (summary from this meeting is available upon request). We do not have access to the exact logarithm the computer was running. It should be noted, however, that the results from the lottery were considered public information and had to be given to parents who requested it. Moreover, the allocation of child care slots was a popular topic for the local newspapers (see for instance Aftenposten aften 27.04.2005). Thus, the transparency should secure that public slots were indeed allocated through the lottery mechanism.

a particular status that allowed parents to accept an offer in a lower ranked center, but at the same time uphold their application for the center of their first rank. This implied that children had an additional draw in this particular institution, possibly increasing the likelihood of enrollment here. While private and public child care centers had the same application deadline and children could apply for a mix of public and private centers, their intake rules would differ somewhat. Every private child care center in Oslo received lists with detailed information on all children who had applied for a slot in that particular (private) center their respective ranking of the center. Subsequently the respective private institutions handled their own admissions.

Children not admitted at all in the main allocation round was registered on a waiting list, and would only get an offer if already admitted children declined the slot they were offered. Parents could accept or reject the first offered child care center. In the latter case, the offer was transmitted to the highest ranked child on the application list. Parents who rejected an offer from an institution on their choice list, were out of the lottery.

Due to substantial oversubscription during these years, the majority of children got an offer from another center than their most preferred one. This is documented in Table 1. About 29 percent got an offer from their first ranked center, whereas about 14 percent got an offer from their second ranked center. As much as 31 percent of the children in our sample were offered a center outside their choice set. Some parents ranked less than seven centers,[5] and this may explain why the fraction getting their first ranked center was somewhat higher than the fraction getting their second and third. It could also be the case if parents were more likely to rank big centers higher on their list.

Table 1: Allocation of children to child care centers: Fraction of children who get an offer from their n'th choice

Choice	Frequency	Percent
None	670	30.93
1st choice center	621	28.67
2nd choice center	292	13.48
3rd choice center	202	9.33
4th choice center	120	5.54
5th-7th choice center	261	12.05

4 Data

4.1 Dataset and variables

To conduct the analysis we employ data from several sources that can be linked through a personal identifier. Firstly, we have access to a unique data set from the municipality

[5] In the period we are looking at, about 50 percent of the applicants ranked seven centers, and about 70 percent ranked at least five. Eight percent of applicants ranked one center only.

of Oslo containing individual records of all institutional child care use (for children born between 2004-2007) as well as test scores from 1st to 3rd grade for cohorts born from 2004 onwards.[6] This data set also includes full information on application dates and parental preferences for child care centers. Every application ever submitted for a child is registered in the data, as is every offer of a slot the child ever gets and identifiers on the up to seven centers the parents may rank in each application.

Children can attend a child care center in another city district than the one they reside in, but as long as the center is situated in Oslo the enrollment will be included in our data. If the child attends a child care center in another city we will not be able to register the enrollment. However, this is uncommon and will only involve a few children. As described in Section 3.2, private child care centers have their own admission. Children with a private institution ranked first on their application are therefore excluded from our analysis. We also exclude children with priority as they are not participating in the lottery. And, in order to avoid that experience with previous child care centers affect parents' ranking of centers, we will focus on the first time the parents apply for a child and the first center the child gets an offer in. This leaves us with a sample consisting of 2161 children enrolled in 382 child care centers from 2005-2010 . We sample child care characteristics from the first offered center which was randomly assigned to the children in the lottery conditional on parental preferences.

The staff working in the different child care centers can be identified from Statistics Norway's Employer-employee register (AAreg). This register includes information on the staff's experience and workload. From the population-, income- and education registries, we collect information on staff characteristics such as gender, birthday and education. To construct quality measures, we average staff's characteristics (per year) across institutions. We focus on the share of child care teachers, mean staff experience, the share of male child care staff, the share of staff with immigrant background and the share of days per year where staff has been absent due to sick leave.[7] Moreover, every year the child care centers receiving public subsidies (this includes almost all existing centers) must report vital statistics to Statistics Norway. Remaining characteristics at the child care center level, such as the number and age of children enrolled, are collected from this registry. Since we know which center the child got its first offer from, we can link this information to each child.[8]

[6]Due to a restrictive storage policy in the municipality, data on children born in January and February 2004 were deleted from the application data base before we got access to it. We are therefore not able to include these children in our sample.

[7]Note that we only count spells of sick leave of more than 10 days in this definition.

[8]About 30 percent of the child care centers in Oslo are so called family child care centers, and few of these centers report to the Employer-employee register. These centers are typically consisting of up to five children, situated in a private home and are run by an assistant under weekly supervision of a child care teacher. Since we in most cases do not have information about their teachers, children attending these child care centers are excluded from the analysis (about 10 percent of the children).

Information on the background characteristics of the children and their families is obtained from registers provided by Statistics Norway. The covariates are measured in the year before the child was born to secure that they are not endogenous to the treatment. Important control variables are mothers and fathers education, (net) family income, immigrant background and mother's continent of origin.[9] We also control for whether parents were young (defined as being below 22) when they had their first child. Furthermore we include a dummy for the child's gender, birth cohort and quarter of birth. And lastly, we control for application year, city district, zip code and whether the child's first offer is public or private.

Norwegian children have nationwide tests in language and mathematics during their first, second and third year in school. We employ the results from these tests to construct child cognitive outcomes. The tests are meant to identify the weakest pupils in order to secure that the school allocates resources to underperforming children. Hence most children score close to the maximum points. Due to the skewed distribution of these tests we generate two outcome variables in each subject. The first is simply the pooled (grade 1 to 3) average achievement level in language and mathematics, while the second is a dummy variable which equals one if the child scores above the 25th 50th and the 75th percentiles respectively.[10] In the analysis we standardize the grades within cohorts and grades.

4.2 Summary statistics

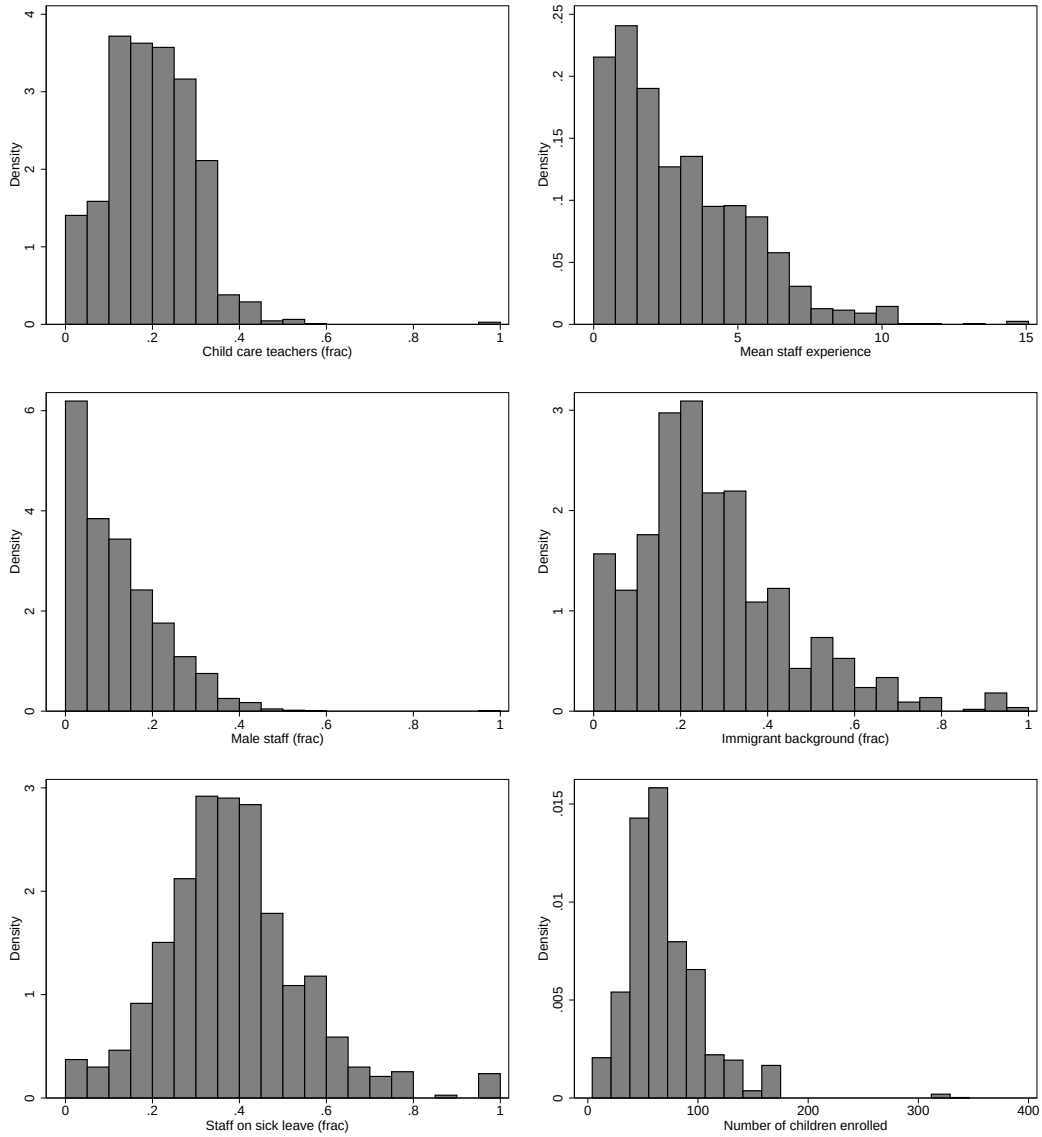
In Figure 1 we report the distribution of the structural quality measures. Across all measures reported we find considerable variation. Upper figure to the left shows the fraction of child care teachers among staff. Reflecting the regulation on child care teachers per staff mentioned in Section 3, there should be a minimum of 1 teacher per 3 care takers. We see that quite a few centers do not meet this requirement, and only a few have a share of teachers above the minimum. In the upper right figure we report the distribution of average experience of staff in the child care center. As we see from the figure, most child care centers have a rather unexperienced staff with average experience being below five years. In the middle left figure we display the share of male staff. A strikingly large share of centers do not have any men among its staff. Few centers have a share of male staff above 20 %. In the middle right figure we report the distribution of share of staff with immigrant background. The vast majority does have some staff with immigrant background, but there is a considerable variation across centers. The share of staff with at least one sick leave spell during the year, is displayed in the bottom left figure. This distribution seems to be more bell-shaped than the other child care characteristics. Lastly,

[9] We include a dummy for whether both parents are born outside of Norway, as well as dummies for the mother's country/continent of origin.

[10] Third grade results are not yet available for the 2007 cohort.

in the bottom right figure, we consider child care center size (measured by the number of children enrolled in a center). We see that there are few very big centers, and few very small ones, but still a considerable variation in size.

Figure 1: Distribution of child care center characteristics



Summary statistics for background characteristics of children are reported in Table 11. Figures showing the distribution of the outcome variables is reported in Figure 2. We see clearly that the test scores are skewed far to the right, and that most children score high on these tests. However, there is still some variation, particularly in the bottom of the distribution.

4.3 Application behavior

To get a better picture of what parents value in a child care center, we report the mean of our staff composition measures listed after parents rankings in Table 2. We keep in

mind that the ranking in itself is not important, except for the first center, where families get two draws. However, while we know how the allocation mechanism worked, it is not clear if parents had the same information, although the status of the first center likely was known to most people. In the last row of the table we report mean characteristics of the first offered center for comparison. We see that observed characteristics of the child care center do not seem to differ a lot across the ranked centers, on average. This is in line with what we would expect, given that ranking in itself should not matter. Higher ranked centers are, however, somewhat more likely to be bigger, as seen in the second to last column. While the mean size of a first choice center is about 69 children, the seventh choice center mean size is about 55. This may be one reason why children are more likely to get an offer from their first ranked center than their second ranked center. Parents also seem to care about travel time when ranking centers. In the last column, we see that travel time (in meters) increases with ranking. First choice centers are located on average about 900 meters from the home, whereas seventh choice centers are located about 1360 meters away. In the last row, the average staff characteristics of the offered center are presented. They resemble the characteristics of the ranked centers to a large extent.

We proceed to explore whether family background matters for which child care characteristics families value. This is reported in Appendix Table 12, where we present coefficients from eighteen different models where we regress characteristics (average tenure, share of staff with child care teacher education, share of male staff, share of staff with an immigrant background, share of staff on sick leave, distance to child care center) of the n'th ranked center (n=1,2,3) on the background characteristics we include in our analysis (gender of the child, parental education, immigrant background and log of family income). In the upper left panel, we see that families with boys are more likely to apply for child care centers with more tenured staff compared to families with girls. Similarly, immigrant parents are also much more likely to apply for such centers. In the right panel in the middle, we consider how parents value staff with immigrant background. It seems like parents that are immigrants themselves are more likely than parents without such background to apply for centers with a higher share of immigrant staff. This may be due to a wish for child care staff with similar experiences to yours and your childs', in line with the role model theory discussed in Dee (2004). We recall that this study finds that both black and white students benefit from being assigned an own-race teacher during early grades. However, it may also simply be that since children tend to attend centers close to their homes, the clustering of immigrants in certain city districts in Oslo may explain this pattern if staff is more likely to work close to their home than on the other side of the city.

Table 2: Characteristics of ranked centers

	Tenure (in years)		Share of staff with preschool-teacher ed		Share of male staff		Share of staff with immigrant backgr		Share of sick leave days		Number of children		Distance in (meter)	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
1st choice	3.46	(2.29)	.213	(.088)	.110	(.094)	.242	(.150)	.096	(.057)	69	(28)	899	(1706)
2nd choice	3.50	(2.31)	.212	(.096)	.110	(.097)	.238	(.152)	.093	(.056)	62	(27)	1085	(1827)
3rd choice	3.55	(2.29)	.207	(.096)	.118	(.103)	.243	(.163)	.095	(.058)	60	(26)	1165	(1749)
4th choice	3.43	(2.27)	.205	(.102)	.118	(.102)	.246	(.171)	.097	(.057)	58	(25)	1181	(1550)
5th choice	3.41	(2.22)	.207	(.105)	.126	(.109)	.238	(.163)	.095	(.058)	56	(25)	1282	(1573)
6th choice	3.40	(2.27)	.209	(.099)	.121	(.104)	.243	(.176)	.096	(.066)	55	(26)	1364	(1605)
7th choice	3.29	(2.19)	.211	(.102)	.124	(.106)	.239	(.175)	.091	(.065)	55	(26)	1363	(1389)
1st offered	2.97	(2.35)	.200	(.097)	.115	(.102)	.253	(.161)	.095	(.059)	69	(34)	1327	(1850)

5 Empirical strategy

As illustrated above, if not taking into accont that parents can choose the child care center in which to enroll their child, identifying causal effects of center quality is challenging. However, as already mentioned, throughout the period our data covers, child care centers in Oslo were oversubscribed and slots were allocated in a lottery. While most families who applied for a child care slot eventually would enroll their child in a child care center, many children were not admitted to their most preferred center. We take advantage of the fact that there is a lot of variation in whether a child gets a slot in any of the centers preferred by the parents. As described in 3.2, slots in public institutions are allocated in a randomized computer lottery based on the list of preferences in the child's application. The random nature of the allocation of slots given certain known preferences, allow us to compare outcomes of children whose parents had the same preferences, but who got offers from different child care centers due to the outcome of the admission lottery. In order to identify whether test scores in first, second and third grade differ between children who due to the lottery got offers of enrollment from centers with varying staff composition, we estimate the following equation:

$$Y_{ij} = \alpha + \beta quality_j + \delta preferences_i + X_i + \varepsilon_i \tag{1}$$

Y_{ij} measures test scores for child i in first, second or third grade whose first offered child care center was child care center j. $\beta quality_j$ is a vector of quality aspects of the first child care center the child got an offer from. As a measure of quality we will include the share of educated child care teachers, mean staff experience, the share of male child care staff, the share of staff with immigrant background and the share of staff that has been on sick leave during the year. $\delta preferences_i$ is a lottery-specific risk set included to account for the fact that children apply to different institutions with varying characteristics and different numbers of applicants and available slots. The controls for parental preferences are collected from this first application ever submitted by the parents, and we construct a choice set where all child care centers are included as separate dummies that take the value 1 if that particular center was one of the ranked centers in the application form, and 0 if not. Hence for most children there will be about seven child care center dummies with the value 1. We also include dummies for how many child care centers parents have listed. We will report estimations with and without the risk set included for the main results.

As we recall from Section 3.2, families may get an extra draw in their first ranked child care center after receiving a lower-ranked offer. Thus, listing institutions that are expected to have low oversubscription on the first rank will increase the likelihood of getting an offer in this particular institution. To account for such possible strategic behavior, we will pay close attention to this in our estimations by including separate controls for the first

choice center in certain specifications.

Finally, X_i is a vector of covariates measured the year before the child is born, as well as year and cohort fixed effects described in detail in 4.1. We also include control for center size and the share of minority children in the center. ϵ_i is a random error term. We will correct standard errors for clustering at the child care center level.

For the empirical specification above to yield causal effects we rely on oversubscription so that some parents through the lottery are assigned a slot in another institution than their preferred choice. As already seen, Table 1 indicates that the demand for most child care centers is larger than the supply, and about a third of the children ends up in another center than any of the centers their parents preferred. Note that in this set-up we do not necessarily compare children who get a slot in their first choice institution to children who get a slot in a lower ranked institution. Some of the low ranked institutions may be of high quality. Hence we compare children who get offers from high vs low quality institutions regardless of whether it was their first, second or never ranked choice, holding parental preferences constant.

While the city administration has ensured us that the lottery was randomized by a computer algorithm, there is always the possibility that the randomization failed, or that manipulation occurred between the randomization and the sending out of offer letters. To investigate if we can trust the randomization of child care offers, we turn to Table 3 where we regress parental background on staff characteristics and distance in the first center the child gets an offer in. All models include the same controls as in the main specification. Overall, there is little that suggests that resourceful parents are more likely to get an offer from a child care center of higher quality. However, and somewhat surprisingly, we see from the last column that families with boys seem to be somewhat more able to secure a child care center closer to their house. Given the number of coefficients we test in the table, one significant estimate is likely due to chance. All in all we find little reason to worry that the randomization is compromised.

Table 3: Relationship between parental background on staff characteristics

	Boy	Parental edu	Norwegian	Ln(hh income)
Pre-teacher education	-0.001	0.001	0.005	0.005
	(0.006)	(0.001)	(0.009)	(0.005)
Male	-0.001	-0.000	-0.001	-0.002
	(0.006)	(0.001)	(0.009)	(0.005)
Sick leave	-0.003	0.000	0.004	-0.002
	(0.004)	(0.001)	(0.006)	(0.003)
Immigrant backgr	0.009	-0.001	-0.013	-0.012
	(0.009)	(0.002)	(0.013)	(0.007)
Tenure	-0.112	-0.004	-0.065	0.052
	(0.122)	(0.029)	(0.216)	(0.098)
Distance	-342.510***	0.846	-13.131	68.538
	(115.651)	(27.431)	(192.538)	(96.240)
Choice set, 1, 2-7	Yes	Yes	Yes	Yes

Note: N = 2161. The models are estimated by OLS. Included in all specifications are also a constant term and the control variables described in Section 4.1. */**/*** denotes statistical significance at the 10/5/1 percent level.

We have also estimated the relationships between the rank of the offered center and background characteristics. If the allocation of children to child care centers (conditional on their preferred choices and number of listed centers) is random, there should not be any systematic differences between the child's background characteristics and which ranked child care center the child got an offer from. We generate a variable taking the values 6, 5, 4, 3 and 2 if the child gets an offer from the first, second, third, fourth or 5th-7th ranked center, and 1 if none of the ranked centers are offered, and estimate the relationship between the probability of getting an offer from a higher ranked center on a set of background characteristics. The estimated relationships are presented in Appendix Table 13. When we include dummies for each center listed by parents, as seen in Model 2 and 3, we find no support for a significant relationship between observable characteristics and getting a higher ranked center.

Parents may reject their first offer. This could happen for several reasons. Perhaps the parents have changed their minds about child care start for the child, or they may have decided to move. If they are sufficiently unhappy with the center their child was admitted to, they could potentially decline the slot and apply over again. Since unobserved parental characteristics are likely determining who is rejecting their first offer and continue to search for a better option, we focus on characteristics of the child care center in which the child was initially admitted (and not the first he/she started in). This implies that some of the children in our sample never start in the center we record them to start in. While this is not a threat to the validity of our empirical strategy, it may have implications for how we interpret the estimates. Reassuringly, a closer look at our sample reveals that as

many as 87 percent of the children in our sample are compliers, and accept the slot in the first offered center. If deniers are families that receive an offer in an institution of low quality, and these families go on to get a slot in a more preferred institution, it will lead us to underestimate the effect of a slot in high vs low quality institutions, since some of the children we record as ending up in a low quality institution, instead enroll in an institution of higher quality.

Finally, measuring the quality of an institution is not straighforward. We cannot, for instance, rule out that some of the staff composition measures such as the share of child care teachers or the share of male staff correlate with other unobserved features of a particular center. We can, however, pay close attention to this, and keep it in mind when interpreting the results. We will also perform robustness checks where we control for other observed features of a particular center. One such feature is peer composition characteristics. Since we know who actually enroll in the respective child care centers, we will run robustness checks where we include family income and parents educational attainment of peers in the center a child gets an offer from.

6 Results

6.1 Main results

Columns (1) - (3) in Table (4) report different variations of Equation (1). In the first column we disregard parental preferences for child care centers and estimate a simple version of Equation (1). In column two and three we condition on parental preferences by including dummy variables for preferred child care centers. Column two pools all the centers included in the choice set, whereas column three includes separate dummies for first ranked child care center and allow for a flexible combination of the remaining six centers. The specification reported in model (3) is imposing the stricter controls. In Table (4) we report the results as percent of the standard deviation. From the first rows we see that estimates of tenure are positive, but small and impresise, and decreasing. Turning to the share of educated teachers, we find little to support that test scores are higher if a child is offered to enroll in a center with a higher share of staff with a child care teacher degree, although estimates are positive (but not significant) for results in mathematics. Most strikingly is the pattern reported for the fraction of male staff in the child care center. Point estimates are positive and large for both language and mathematics, albeit with a lower level of significance for the latter. Results are consistent across all specifications. Neither the share of staff with immigrant background nor the share of sick leave days in the child care center seem to cause variation in child outcomes.

In these first reported results, we have included estimates for the control variables as well (for simplicity, these will not be included for the other outcomes). The background

characteristics of the child and its family do matter as we would anticipate. We see that girls perform better on the language test, whereas boys do better on the mathematics test. Parental income and education predict higher child test scores, whereas the estimate for immigrant background is negative for results on the language test, and positive for the mathematics test.

Table 4: Child care center staff characteristics and performance on standardized tests in 1st - 3rd grade.

	Language			Mathematics		
	(1)	(2)	(3)	(1)	(2)	(3)
Pre-school char						
Tenure	0.025	0.008	0.014	0.021	0.029	0.023
	(0.021)	(0.030)	(0.038)	(0.020)	(0.037)	(0.044)
Tenure squared	-0.006	-0.005	-0.006	-0.004	-0.005	-0.004
	(0.003)**	(0.004)	(0.004)	(0.002)*	(0.004)	(0.005)
Pre-teacher ed	-0.069	-0.042	-0.158	0.061	0.150	0.093
	(0.187)	(0.227)	(0.298)	(0.189)	(0.210)	(0.291)
Male	0.417	0.519	0.752	0.296	0.404	0.489
	(0.168)**	(0.216)**	(0.242)***	(0.178)*	(0.212)*	(0.261)*
Immigrant backgr	0.042	0.049	-0.027	0.184	0.159	0.193
	(0.122)	(0.162)	(0.201)	(0.118)	(0.159)	(0.193)
Sick leave days	-0.487	-0.565	-0.644	-0.362	-0.461	-0.571
	(0.309)	(0.372)	(0.464)	(0.311)	(0.394)	(0.492)
Log(nr. of children)	-0.042	-0.065	-0.025	-0.076	-0.081	-0.030
	(0.034)	(0.046)	(0.061)	(0.032)**	(0.049)*	(0.056)
Individual char						
Boy	-0.093	-0.047	-0.043	0.135	0.161	0.200
	(0.032)***	(0.045)	(0.055)	(0.032)***	(0.041)***	(0.052)***
Ln(family income)	0.096	0.084	0.105	0.100	0.105	0.097
	(0.028)***	(0.039)**	(0.050)**	(0.030)***	(0.039)***	(0.050)*
Parents schooling	0.045	0.050	0.052	0.058	0.066	0.077
	(0.078)	(0.098)	(0.114)	(0.008)***	(0.009)***	(0.012)***
Immigrant background	-0.047	-0.062	-0.033	0.139	0.082	0.096
	(0.078)	(0.098)	(0.114)	(0.082)*	(0.085)	(0.092)
Choice set (pooled)	No	Yes	No	No	Yes	No
Choice set (1, and 2-7)	No	No	Yes	No	No	Yes
R squared	0.203	0.426	0.573	0.196	0.465	0.596

Note: N = 2161. The models are estimated by ordinary least square. All specifications control for the variables described in Section 4.1. Standard errors are clustered at the child care center level . */**/*** denotes statistical significance at the 10/5/1 percent level.

Mean estimates can mask important heterogeneity if child care center staff composition may be more or less important for children depending on their ability and/or family background. While also keeping in mind that the distribution of the test scores is skewed and quite different from the often bell-shaped test scores considered in the literature, we want to consider how estimates vary across the test score distribution. Turning now to

Table 5, we report results from Equation 1 with the outcome being a dummy variable which equals one if pupil i scores above the 25th percentile.[11] Our estimates show the same pattern as in Table (4). In general, few of the included measures of staff composition seem to be important for child cognitive development in this lower part of the test score distribution. The exception is the substantial estimate of an increase in the share of male staff on language development. None of the included aspects of staff composition seems to be important for subsequent scores in mathematics, although point estimates are similar to estimates for language when we consider the male share of staff. These estimates are, however, impresise. We also see that estimates for sick leave days are negative across all spesifications, although with a level of significance that is too low to allow us to conclude.

Table 5: Child care center staff characteristics and performance above the 25th percentile in 1st - 3rd grade.

	Language, above 25 percentile			Mathematics, above 25 percentile		
	(1)	(2)	(3)	(1)	(2)	(3)
Child Care char						
Tenure	0.011	-0.002	-0.009	0.018	0.015	0.006
	(0.012)	(0.015)	(0.020)	(0.012)	(0.018)	(0.023)
Tenure squared	-0.002	-0.001	-0.000	-0.002	-0.002	-0.001
	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.003)
Pre-teacher ed	-0.059	-0.133	-0.147	-0.028	0.076	0.110
	(0.090)	(0.125)	(0.157)	(0.091)	(0.120)	(0.163)
Male	0.287	0.381	0.484	0.158	0.164	0.208
	(0.083)***	(0.110)***	(0.128)***	(0.089)*	(0.121)	(0.144)
Immigrant backgr	0.062	0.033	0.051	0.008	0.010	0.054
	(0.060)	(0.085)	(0.106)	(0.065)	(0.097)	(0.118)
Sick leave days	-0.152	-0.083	-0.095	-0.126	-0.189	-0.247
	(0.138)	(0.184)	(0.220)	(0.165)	(0.216)	(0.279)
Log(nr. of children)	0.006	-0.002	0.033	-0.021	-0.012	0.005
	(0.016)	(0.024)	(0.029)	(0.018)	(0.027)	(0.031)
Choice set (1-7)	No	Yes	No	No	Yes	No
Choice set (1, 2-7)	No	No	Yes	No	No	Yes
R squared	0.164	0.427	0.575	0.146	0.413	0.555

Note: N = 2161. The models are estimated by ordinary least square. All specifications include the control variables described in Section 4.1. Standard errors are clustered at the child care center level . */**/*** denotes statistical significance at the 10/5/1 percent level.

Findings are similar when we consider the effect of child care characteristics on scoring above the 50th percentile. Results are reported in Table 6. None of the estimates of effects of staff composition seem to matter much for whether children score above the 50 percentile, except for the positive effect of male share of staff. Estimates are stronger for results in language, but are now also close to significant for mathematics and quite stable across specifications.

[11] We have also constructed alternative measures for poor performance and results are stable.

Table 6: Child care center staff characteristics and performance above the 50th percentile.

	Language, above 50 percentile			Mathematics, above 50 percentile		
	(1)	(2)	(3)	(1)	(2)	(3)
Child Care char						
Tenure	0.004	-0.007	-0.002	0.022	0.004	0.010
	(0.012)	(0.021)	(0.024)	(0.012)*	(0.021)	(0.025)
Tenure squared	-0.001	-0.001	-0.002	-0.002	-0.000	-0.000
	(0.001)	(0.002)	(0.003)	(0.001)*	(0.002)	(0.003)
Pre-teacher ed	-0.065	-0.026	-0.086	0.038	-0.011	-0.098
	(0.113)	(0.146)	(0.185)	(0.116)	(0.136)	(0.178)
Male	0.452	0.477	0.653	0.266	0.271	0.235
	(0.112)***	(0.136)***	(0.167)***	(0.102)***	(0.138)*	(0.170)
Immigrant backgr	-0.002	-0.017	0.004	0.057	0.066	0.121
	(0.073)	(0.096)	(0.122)	(0.075)	(0.096)	(0.120)
Sick leave days	-0.163	-0.025	-0.231	0.005	-0.086	-0.066
	(0.181)	(0.233)	(0.275)	(0.167)	(0.205)	(0.270)
Log(nr. of children)	-0.016	-0.017	0.007	-0.030	-0.027	0.001
	(0.022)	(0.032)	(0.040)	(0.021)	(0.028)	(0.034)
Choice set (1-7)	No	Yes	No	No	Yes	No
Choice set (1, 2-7)	No	No	Yes	No	No	Yes
R squared	0.153	0.416	0.561	0.168	0.437	0.568

Note: N = 2161. The models are estimated by ordinary least square. All specifications include the control variables described in Section 4.1. Standard errors are clustered at the child care center level . */**/*** denotes statistical significance at the 10/5/1 percent level.

Lastly, we consider the upper part of the grade distribution, i. e. whether child care center staff composition is important for whether children is performing above the 75th percentile. Given the scewed distribution with a high share of children performing well on the tests, we should keep in mind that the nature of the test might not be well suited to estimate effects on child outcomes in the upper end of the distribution. The results reported in Table (7) do indeed confirm that staff characteristics are not important for outcomes among these children.

Table 7: Child care center staff characteristics and performance above the75th percentile.

	Language, above 75 percentile			Mathematics, above 75 percentile		
	(1)	(2)	(3)	(1)	(2)	(3)
Child Care char						
Tenure	0.007	0.006	0.006	0.017	-0.013	-0.011
	(0.011)	(0.016)	(0.020)	(0.011)	(0.017)	(0.018)
Tenure squared	-0.001	-0.001	-0.001	-0.002	0.001	0.001
	(0.001)	(0.002)	(0.002)	(0.001)**	(0.002)	(0.002)
Pre-teacher ed	-0.108	-0.093	-0.059	0.047	-0.065	-0.132
	(0.108)	(0.130)	(0.166)	(0.103)	(0.127)	(0.152)
Male	0.105	0.094	0.087	0.069	0.105	0.115
	(0.101)	(0.117)	(0.149)	(0.096)	(0.124)	(0.160)
Immigrant backgr	-0.037	-0.047	0.025	0.066	-0.017	-0.025
	(0.071)	(0.084)	(0.116)	(0.061)	(0.085)	(0.110)
Sick leave days	-0.197	-0.119	-0.203	-0.323	-0.233	-0.286
	(0.193)	(0.241)	(0.278)	(0.149)**	(0.197)	(0.250)
Log(nr. of children)	-0.013	-0.021	-0.018	-0.011	-0.030	-0.014
	(0.023)	(0.028)	(0.034)	(0.020)	(0.026)	(0.033)
Choice set (1-7)	No	Yes	No	No	Yes	No
Choice set(1, 2-7)	No	No	Yes	No	No	Yes
R squared	0.109	0.385	0.533	0.117	0.409	0.555

Note: N = 2161. The models are estimated by ordinary least square. All specifications include the control variables described in Section 4.1. Standard errors are clustered at the child care center level . */**/*** denotes statistical significance at the 10/5/1 percent level.

We have seen that cognitive outcomes of children do not seem to differ systematically depending on whether they are offered to enroll in a center where the staff has high vs low experience, where there is a high vs low fraction of educated teachers, where the share of immigrants among staff is high vs low or where the share of sick leave days among staff is high vs low. However, childrens subsequent test scores in language is higher in the bottom and middle part of the distribution (scoring above the 25th and 50th percentile) if the child is offered to enroll in a center with a high share of male staff. Findings are similar for mathematics, although slightly smaller and less precisely estimated. The estimate size suggests that if a child is offered to enroll in the center where the share of male staff is 1 rather than 0, the likelihood of the child scoring above the 25th and 50th percentile respectively increases by about 50 and 65 percentage points for language and about 25 percentage points for mathematics. While these estimates are large, being offered to enroll in a center where the the share of male staff is 1 rather than 0, is a rather theoretical excersise. When we consider Table 11 and Figure 1, we see that virtually none of the centers have a share of male staff above .5. However, the standard deviation of the share of male staff is .115. Thus, getting an offer of enrollment in a center with a one standard deviation higher share of male staff, implies that the likelihood of the child scoring above the 50 percentile would increase by about 7.5 percentage points for language and 2.7 for

mathematics.

6.2 Heterogeneity

As we discussed in Section 2, evidence from the classroom suggests that male teachers are particularly important for boys (Dee, 2005, 2007), but may also have a positive for girls' mathematics results (Dee, 2007; Antecol et al., 2015). For the child care center, Bauchmuller et al. (2014) find that boys benefit more from a higher proportion of male staff than girls, measured at language tests at the end of compulsory schooling. To explore whether a similar pattern may be present for our findings from the child care center, we go on to report results separately for boys and girls. In Appendix Table 15 and Table 14 we see that results for boys and girls are similar. Given the now smaller samples and the extensive set of control variables, we note that standard errors are large. Appendix Table 15 and Table 14suggest that in the child care center, male staff is important for the development of both boys and girls in both language and mathematics. This is in line with results from the school literature for mathematics, but our findings for the language results seem to be unique for the child care center. Interestingly, our findings are also different from the results in Bauchmuller et al. (2014). Language skills are measured about 10 years apart in the two studies. Hence, an explanation that would be in line with the differing results, would be if girls from child care centers with a low share of male staff are more likely to catch up than are boys from such centers.

A motivation for looking at how child test scores differs depending on whether children get an offer of enrollment from a child care center with a high vs low share of child care staff with immigrant background, is that it has been hypothesized that teachers could be more responsive to the needs of children who share their racial or ethnic background (Dee, 2004). As mentioned in Section 2, Dee (2004) finds for the US that both black and white children benefit from a same-race teacher, while results for Denmark in Bauchmuller et al. (2014) suggest that ethnic minority children gain significantly less from a higher share of ethnic minority staff than children without such background. In Appendix Table 16 and 17 we display results by immigrant background. Again, our extensive controls lead to a lack of presicion, but overall we see little evidence for a differing pattern across groups. Looking at the share of immigrant staff, we see that while the estimate is close to zero for children without immigrant background, it is negative and often large for children with such background, in line with findings in Bauchmuller et al. (2014). The lack of precision is, however, withholding us from drawing firm conclusions.

6.3 Robustness

We have seen that child cognitive development seems to be positive when a child gets and offer of enrollment from a child care center with a high share of male staff. However,

our main specification is run with several characteristics of the child care center at the same time, and we may worry that some of these characteristics are correlated and that results will differ if we change the specification. To ensure that results do not depend on our specific set-up, we go on to estimate separate regressions where we only include one of our staff characteristics of interest at the time. Apart from that, control variables and controls for parents ranking of centers stay the same. In Table 8 we report results from these separate regressions. Running staff characteristics one by one instead of including them all at once, seems to matter little for the estimates. The estimate of the fraction of male staff is substantial and similar in magnitude to the main spesification for language development at the 25th and 50th percentile, and estimates for mathematics are also similar.

Table 8: Robustness tests: Separate regressions for each outcome

Child care char:	Percent of SD	>=25th	>=50th	>=75th
		Language		
Tenure	0.017	-0.007	0.000	0.008
	(0.036)	(0.019)	(0.023)	(0.020)
Tenure squared	-0.006	-0.000	-0.002	-0.001
	(0.004)	(0.002)	(0.003)	(0.002)
Pre-teacher ed	0.005	-0.113	-0.042	-0.061
	(0.274)	(0.147)	(0.176)	(0.158)
Male	0.784	0.490	0.657	0.079
	(0.249)***	(0.131)***	(0.165)***	(0.149)
Immigrant backgr	-0.105	0.038	0.002	0.054
	(0.187)	(0.104)	(0.128)	(0.118)
Sick leave days	-0.690	-0.107	-0.255	-0.207
	(0.480)	(0.227)	(0.290)	(0.280)
		Mathematics		
Tenure	0.025	0.009	0.006	-0.016
	(0.042)	(0.023)	(0.026)	(0.018)
Tenure squared	-0.005	-0.001	0.000	0.001
	(0.005)	(0.002)	(0.003)	(0.002)
Pre-teacher ed	0.186	0.172	-0.118	-0.142
	(0.258)	(0.152)	(0.170)	(0.145)
Male	0.486	0.209	0.219	0.121
	(0.270)*	(0.147)	(0.172)	(0.160)
Immigrant backgr	0.044	-0.053	0.109	-0.014
	(0.179)	(0.110)	(0.114)	(0.103)
Sick leave days	-0.568	-0.245	-0.037	-0.323
	(0.520)	(0.293)	(0.283)	(0.255)

Note: N =2161. The models are estimated by OLS, with a separate regression for each outcome. Included in all specifications are also a constant term and the control variables listed in Section 4.1, as well as the risk set descibed in Section 5. Standard errors are clustered at the child care center level . */**/*** denotes statistical significance at the 10/5/1 percent level.

6.4 Mechanisms

The share of male staff seems to matter for child development, but the question of whether the reason for this is that male staff acts differently towards the children, or whether male staff selects into centers that are more capable of producing child development, still remains. If the reason is related to the latter, we might notice a difference among centers with high and low share of male employees along other observable dimensions. We go on to look at this in Table 9. The first columns of the table display characteristics of centers with a share of male staff below the median, whereas the two last columns report characteristics of centers with a share of male staff above the median. While the mean share of male staff differs substantially, other observable differences are small. It might seem that centers with a low share of male staff has a slightly more experiences staff. These centers are also on average slightly smaller. But overall, differences are small, and little stands out to support that centers with a higher share of male staff differ much along observable dimensions.

Table 9: Characteristics of centers with a low vs high share of male employees.

	Mean	St.dev	Mean	St.dev
	Low share male		High share male	
Tenure	3.47	(2.39)	2.78	(2.07)
Pedagogy training	0.27	(0.11)	0.27	(0.09)
Pre-school ed	0.20	(0.10)	0.20	(0.09)
Male	0.03	(0.03)	0.20	(0.09)
Immigrant background	0.25	(0.17)	0.25	(0.15)
Sick-leave	0.09	(0.07)	0.09	(0.05)
Nr. of children	59.95	(25.64)	66.73	(33.34)

Note: All characteristics are aggregated at the center-year level.

Another way of exploring whether male staff selects into "better" centers, could be to account for peer characteristics in the main specification. We keep in mind from Table 3 that nothing suggests that such selection occurs from the families' side, but male staff may still select into centers where children have a more resourceful background. If such selection indeed occurs among male staff, accounting for the share of children with college educated parents and the share of children with immigrant background should lead to a smaller effect estimate. We estimate a model with peer characteristics included,[12] and results are reported in Appendix Table 18. It is clear from the table that results barely move when peer characteristics are included, suggesting that selection of men into centers

[12]We construct measures of peer composition by averaging over background characteristics of children from a certain cohort in a certain year enrolled in a certain center. For example, for children born 2004, we will construct measures of peer quality by matching each center with its respective 2004 born enrolled children, and then averaging over parental education and immigrant background on the basis of these children.

based on observable background characteristics of children is not important for explaining our findings.

Lastly, male and female staff may differ along dimensions that are not picked up by our main spesification. Perhaps female and male staff differ when it comes to how much education they have obtained, how old they are or how many days they are absent from work. We look closer at this in Table 10 below, where we report observable characteristics for male and female staff at the individual level. In terms of years of schooling, there is basically no difference between male and female child care staff on average. Interestingly, we see that male staff has on average shorter sick leave spells than female staff. They are also younger than the female staff. The shorter sick-leave spells among male staff should already be accounted for in our results, given that sick leave is included in our main regressions. Findings from Section 6.3 showed that the effect of male staff was similar in a regression where it was the only included explanatory variable and in the main regression where sick leave and other staff composition measures were also included. This should indicate that sickness absence is unlikely to explain that male staff influence child development positively. Also, running our main regression with a control for average age in the center, does not affect the estimate, suggesting that age is also not a likely factor when we want to understand what it is that is different with men.[13]

Table 10: Background statistics of child care staff,by gender

	Female		Male	
	Mean	St.dev	Mean	St.dev
Years of schooling	12.38	(4.23)	12.47	(3.74)
Long term sick leave (days) - certified by GPA	20.80	(45.25)	11.88	(34.67)
Age	37.90	(12.01)	31.18	(10.78)

7 Conclusion

To credibly estimate causal effects of child care quality, we need to account for endogenous sorting of children into centers. Well-identified causal studies of child care quality are scarce. We aim to expand this literature by looking at whether cognitive outcomes of children during the early years in school differ systematically depending on the staff composition in the child care center where the child first gets an offer of enrollment (and in which the vast majority of children end up enrolling). We account for the possible selection into centers with differing staff composition by taking advantage of a unique dataset on applications to child care, detailed records for child care use and an allocation mechanism that randomly matched children to centers given their application list. During the years our data covers, child care centers in Oslo were oversubscribed. While most children who wanted to attend a child care center would eventually enroll, the majority

[13]Results from this specification are available from the authors upon request.

ended up enrolling in another child care center than they actually preferred. This allow us to compare the cognitive development of children where their parents initially applied for the same center(s), but where one child got an offer of enrollment in an institution with a different staff composition than the other. We use this set-up to study how test scores in first, second and third grade differ between children who due to the lottery got offers of enrollment from centers with different staff education, tenure and sickness absence, as well as share of male and immigrant staff. In line with findings in Krueger (1999), we find no indication that test scores differ depending on the share of teacher characteristics such as education. We do, however, find that children allocated to centers with a higher share of male staff perform better on tests in language and mathematics in the early years of school. Sub-sample analysis suggests that male staff may be important for the development of both boys and girls.

Looking closer at possible mechanisms, we find little evidence that centers with a high share of male staff differ along observable dimensions compared to centers with a low share of male staff. We do find, however, that male employees in the child care center are more likely to be somewhat younger and have a lower sickness absence than their female counterparts. However, since models with these explanatory variable included yield similar estimates, there is not much to suggest that lower age and sick leave can explain the male effect. Including peer characteristics, such as parental education and immigrant background in the center, does not change the estimates.

One explanation for our findings may be that male employees interact with the children in a different way compared to female co-workers. Another explanation may be that male staff selects into centers that are better along uobserved dimensions that we are unable to account for. We do a number of robustness tests where we explore whether observable differences among male and female workers may explain our findings, but we find no support for this. For parents who are to decide whether to enroll their child in a center with high vs low share of male staff, this distinction is probably not too important. The policy implications from our findings, will, however, differ depending on whether it is the share of male staff that promotes child development, or something unobservable that correlates with this share.

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Appendix

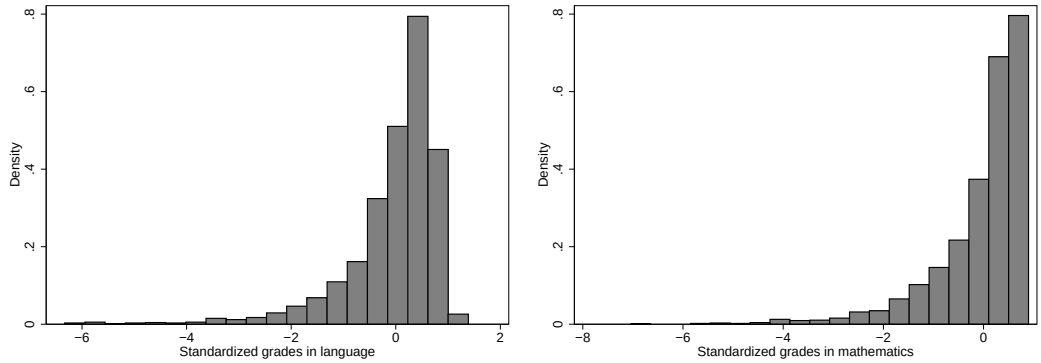

Figure 2: Distribution of Scores in Language and Mathematics

Table 11: Summary statistics of all included variables

	Mean	St.dev
Outcome variables		
Standardized grades in language	0.028	(0.841)
Standardized grades in mathematics	0.023	(0.858)
Performance >25th percentile in language	0.761	(0.427)
Performance >25th percentile in mathematics	0.753	(0.431)
Performance >50th percentile in language	0.511	(0.500)
Performance >50th percentile in mathematics	0.507	(0.500)
Performance >75th percentile in language	0.267	(0.443)
Performance >75th percentile in mathematics	0.257	(0.437)
Explanatory variables		
Child care center level (reported are averages)		
Tenure	2.968	(2.352)
Pre-school ed	0.200	(0.097)
Male	0.115	(0.161)
Immigrant background	0.253	(0.102)
Sick-leave	0.095	(0.059)
Nr. of children	69.09	(33.935)
Individual level (reported are averages)		
Boy	0.504	(0.500)
Net log household income (NOK)	12.255	(0.344)
Average parental years of education	14.604	(3.121)
Immigrant background	0.251	(0.434)

Table 12: The relationship between characteristics of ranked centers and family background

	Tenure (in years)						**Share of staff with preschool-teacher ed**					
	1st		2nd		3rd		1st		2nd		3rd	
Boy	0.247	(0.097)**	0.375	(0.108)***	0.070	(0.113)	0.004	(0.004)	0.001	(0.005)	-0.009	(0.005)*
Parental education	0.004	(0.021)	0.014	(0.023)	-0.026	(0.026)	0.002	(0.001)**	0.002	(0.001)**	-0.001	(0.001)
No immigrant background	-0.553	(0.154)***	-0.474	(0.180)***	-0.321	(0.177)*	0.006	(0.006)	0.009	(0.007)	0.013	(0.007)*
Ln(family income)	0.123	(0.071)*	0.155	(0.081)*	0.040	(0.083)	0.005	(0.003)*	0.010	(0.004)***	0.003	(0.004)
Young mother	0.298	(0.224)	0.116	(0.222)	0.031	(0.287)	-0.007	(0.008)	-0.009	(0.010)	-0.005	(0.013)
Young father	0.074	(0.330)	0.591	(0.429)	0.567	(0.442)	-0.011	(0.012)	0.011	(0.015)	0.021	(0.015)
	Share of male staff						**Share of staff with immigrant background**					
	1st		2nd		3rd		1st		2nd		3rd	
Boy	0.002	(0.004)	0.002	(0.005)	0.001	(0.005)	-0.002	(0.006)	-0.005	(0.007)	0.003	(0.008)
Parental education	0.001	(0.001)	0.002	(0.001)**	0.002	(0.001)*	-0.004	(0.001)***	-0.003	(0.002)*	-0.002	(0.002)
No immigrant background	0.011	(0.006)**	0.001	(0.007)	-0.011	(0.008)	-0.026	(0.009)***	-0.035	(0.011)***	-0.035	(0.012)***
Ln(family income)	-0.000	(0.003)	-0.005	(0.004)	-0.001	(0.004)	-0.016	(0.005)***	-0.015	(0.006)***	-0.016	(0.006)***
Young mother	-0.007	(0.008)	0.011	(0.011)	0.002	(0.011)	-0.013	(0.013)	0.032	(0.017)*	-0.004	(0.017)
Young father	0.003	(0.014)	-0.001	(0.015)	0.004	(0.017)	0.016	(0.022)	-0.018	(0.024)	-0.027	(0.026)
	Share of staff on sick leave						**Distance in meters**					
	1st		2nd		3rd		1st		2nd		3rd	
Boy	-0.001	(0.003)	-0.003	(0.003)	0.006	(0.003)**	58.878	(83.317)	107.155	(95.406)	78.483	(94.905)
Parental education	-0.001	(0.001)	-0.000	(0.001)	0.001	(0.001)	-21.562	(18.033)	-32.237	(20.909)	-19.133	(21.793)
No immigrant background	0.002	(0.004)	0.008	(0.004)*	0.001	(0.005)	29.523	(129.615)	226.626	(151.182)	236.619	(140.810)*
Ln(family income)	0.002	(0.002)	-0.004	(0.002)*	-0.001	(0.002)	-33.351	(58.195)	20.641	(68.367)	-18.158	(69.740)
Young mother	0.005	(0.005)	0.001	(0.006)	-0.004	(0.007)	63.085	(203.220)	193.140	(283.360)	-31.025	(213.604)
Young father	0.001	(0.009)	-0.006	(0.008)	-0.002	(0.011)	-224.991	(308.384)	-321.393	(355.151)	27.111	(350.984)
N	2070		1705		1552		1629		1444		1362	

Note: The models are estimated by OLS. Included in all specifications are also a constant term and dummy variables for the child birth year and quarter, application year, number of ranked centers, city districts and mother's continent of origin. */**/*** denotes statistical significance at the 10/5/1 percent level.

Table 13: The relationship between family background and the probability of getting a higher ranked center, by OLS

	(1)	(2)	(3)
Boy	0.123	0.051	0.038
	(0.086)	(0.108)	(0.128)
Parental education	-0.053***	-0.027	-0.007
	(0.020)	(0.024)	(0.029)
Norwegian	-0.011	0.111	0.181
	(0.136)	(0.174)	(0.204)
Ln(household income)	0.039	0.061	0.051
	(0.065)	(0.085)	(0.100)
Choice set, pooled	No	Yes	No
Choice set, 1, 2-7	No	No	Yes

Note: N = 2161. The models are estimated by OLS. Included in both specifications are also a constant term and the reminding control variables listed in Section 4.1. */**/*** denotes statistical significance at the 10/5/1 percent level.

Table 14: Subsample analysis: Stratifying on gender - Language

	Percent of SD		>=25th		>=50th		>=75th	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Tenure	-0.143	0.057	-0.073	0.059	-0.006	-0.023	0.008	-0.048
	(0.085)*	(0.132)	(0.045)	(0.064)	(0.051)	(0.082)	(0.041)	(0.068)
Tenure squared	0.007	-0.008	0.005	-0.006	-0.002	0.000	-0.002	0.006
	(0.009)	(0.014)	(0.005)	(0.008)	(0.005)	(0.010)	(0.004)	(0.008)
Pre-teacher ed	-0.909	0.142	-0.252	-0.019	-0.039	0.094	-0.601	-0.330
	(0.881)	(0.937)	(0.484)	(0.495)	(0.524)	(0.461)	(0.455)	(0.476)
Male	0.850	0.942	0.462	0.526	0.304	0.539	0.378	0.292
	(1.001)	(0.755)	(0.513)	(0.469)	(0.553)	(0.498)	(0.479)	(0.441)
Imm. backgr	-0.452	-0.001	-0.160	0.081	-0.254	0.039	-0.198	-0.249
	(0.560)	(0.634)	(0.264)	(0.350)	(0.318)	(0.375)	(0.282)	(0.330)
Sick leave days	-0.419	-0.264	-0.041	0.099	-0.251	0.009	-0.397	-0.668
	(1.293)	(1.098)	(0.727)	(0.659)	(0.793)	(0.701)	(0.683)	(0.626)
Log(children)	0.004	0.062	0.066	0.156	-0.002	0.092	-0.019	-0.001
	(0.141)	(0.191)	(0.076)	(0.103)	(0.088)	(0.122)	(0.077)	(0.109)
N	1090	1071	1090	1071	1090	1071	1090	1071

Note: N = 2161. The models are estimated by ordinary least square. All specifications control for the variables described in Section 4.1, as well as the risk set described in Section 5. Standard errors are clustered at the child care center level . */**/*** denotes statistical significance at the 10/5/1 percent level.

Table 15: Subsample analysis: Stratifying on gender - Mathematics

	Percent of SD		>=25th		>=50th		>=75th	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
Tenure	-0.120	0.081	-0.042	0.050	-0.044	-0.018	0.015	-0.094
	(0.093)	(0.121)	(0.053)	(0.062)	(0.056)	(0.073)	(0.046)	(0.077)
Tenure squared	0.008	-0.009	0.003	-0.003	0.003	0.006	-0.001	0.012
	(0.009)	(0.015)	(0.005)	(0.008)	(0.005)	(0.009)	(0.004)	(0.009)
Pre-teacher ed	-0.587	0.132	-0.123	-0.031	-0.272	-0.228	-0.428	0.055
	(0.866)	(0.767)	(0.449)	(0.430)	(0.541)	(0.499)	(0.534)	(0.482)
Male	0.405	0.506	0.442	0.232	-0.004	0.375	0.126	0.278
	(0.959)	(0.690)	(0.530)	(0.364)	(0.576)	(0.426)	(0.553)	(0.485)
Imm. backgr	-0.117	0.269	0.068	-0.114	-0.056	-0.551	-0.267	0.030
	(0.576)	(0.572)	(0.328)	(0.361)	(0.378)	(0.387)	(0.329)	(0.321)
Sick leave days	-0.418	-0.877	-0.229	-0.527	-0.157	-0.066	-1.195	-0.237
	(1.406)	(1.146)	(0.680)	(0.827)	(0.839)	(0.630)	(0.819)	(0.596)
Log(children)	-0.089	0.094	-0.006	0.071	0.012	0.026	0.017	0.042
	(0.159)	(0.207)	(0.089)	(0.117)	(0.096)	(0.134)	(0.083)	(0.102)
N	1090	1071	1090	1071	1090	1071	1090	1071

Note: The models are estimated by ordinary least square. All specifications control for the variables described in Section 4.1, as well as the risk set described in Section 5. Standard errors are clustered at the child care center level . */**/*** denotes statistical significance at the 10/5/1 percent level.

Table 16: Subsample analysis: Stratifying on immigrant background - Language

	Percent of SD		>=25th		>=50th		>=75th	
	Imm	Non-imm	Imm	Non-imm	Imm	Non-imm	Imm	Non-imm
Tenure	0.188	0.034	0.005	0.001	0.033	0.029	0.007	0.017
	(0.256)	(0.040)	(0.130)	(0.027)	(0.140)	(0.032)	(0.100)	(0.030)
Tenure squared	-0.034	-0.005	-0.001	-0.001	-0.004	-0.004	-0.004	-0.001
	(0.036)	(0.004)	(0.014)	(0.003)	(0.016)	(0.003)	(0.010)	(0.003)
Pre-teacher ed	-1.406	-0.009	-1.053	-0.064	-0.535	-0.185	-0.322	-0.048
	(2.004)	(0.345)	(1.173)	(0.191)	(0.884)	(0.273)	(0.821)	(0.244)
Male	0.373	0.448	0.804	0.320	0.307	0.487	-0.070	-0.045
	(2.448)	(0.269)*	(1.272)	(0.155)**	(1.432)	(0.241)**	(0.969)	(0.213)
Imm. backgr	-0.913	-0.016	-0.263	0.048	-0.234	0.007	0.068	0.107
	(1.850)	(0.238)	(0.787)	(0.135)	(0.844)	(0.171)	(0.613)	(0.159)
Sick leave days	-1.054	-0.003	-0.580	0.150	-1.030	-0.123	-1.642	-0.162
	(2.415)	(0.515)	(1.630)	(0.284)	(1.814)	(0.363)	(1.566)	(0.371)
Log(children)	0.045	0.044	0.129	0.080	0.198	-0.003	-0.053	-0.060
	(0.466)	(0.071)	(0.244)	(0.041)*	(0.256)	(0.058)	(0.148)	(0.055)
N	540	1621	540	1621	540	1621	540	1621

Note: N = 2161. The models are estimated by ordinary least square. All specifications control for the variables described in Section 4.1, as well as the risk set described in Section 5. Standard errors are clustered at the child care center level . */**/*** denotes statistical significance at the 10/5/1 percent level.

Table 17: Subsample analysis: Stratifying on immigrant background - Mathematics

	Percent of SD		>=25th		>=50th		>=75th	
	Imm	Non-imm	Imm	Non-imm	Imm	Non-imm	Imm	Non-imm
Tenure	-0.026	0.042	-0.004	0.018	-0.028	0.024	-0.082	0.018
	(0.224)	(0.045)	(0.125)	(0.029)	(0.141)	(0.030)	(0.068)	(0.028)
Tenure squared	-0.007	-0.004	-0.003	-0.002	0.002	-0.000	0.008	-0.002
	(0.027)	(0.005)	(0.014)	(0.003)	(0.016)	(0.003)	(0.007)	(0.003)
Pre-teacher ed	-0.253	0.093	-0.745	0.261	-0.358	-0.244	0.421	-0.372
	(1.657)	(0.374)	(1.026)	(0.205)	(0.913)	(0.260)	(1.130)	(0.244)
Male	-0.603	0.321	-0.318	0.175	0.346	0.201	0.080	-0.026
	(1.655)	(0.314)	(1.058)	(0.183)	(1.191)	(0.224)	(1.064)	(0.233)
Imm. backgr	-0.175	0.141	-0.207	0.041	0.017	0.088	-0.022	-0.130
	(1.552)	(0.256)	(1.049)	(0.161)	(0.826)	(0.157)	(0.641)	(0.166)
Sick leave days	-2.377	0.198	-2.341	0.211	-1.376	0.400	-0.859	0.168
	(2.640)	(0.523)	(1.442)	(0.298)	(1.808)	(0.366)	(1.111)	(0.315)
Log(children)	-0.046	0.018	0.062	0.036	-0.036	0.031	0.001	-0.030
	(0.390)	(0.078)	(0.244)	(0.042)	(0.221)	(0.051)	(0.153)	(0.053)
N	540	1621	540	1621	540	1621	540	1621

Note: The models are estimated by ordinary least square. All specifications control for the variables described in Section 4.1, as well as the risk set described in Section 5. Standard errors are clustered at the child care center level . */**/*** denotes statistical significance at the 10/5/1 percent level.

Table 18: Mechanisms: Including peers

	Language			Math		
	(1)	(2)	(3)	(1)	(2)	(3)
Pre-school char						
Tenure	0.029	0.013	0.019	0.023	0.032	0.026
	(0.021)	(0.031)	(0.037)	(0.021)	(0.038)	(0.043)
Tenure squared	-0.006	-0.005	-0.006	-0.004	-0.005	-0.005
	(0.003)**	(0.004)	(0.004)	(0.002)*	(0.005)	(0.005)
Pre-teacher ed	-0.066	-0.013	-0.135	0.117	0.188	0.122
	(0.184)	(0.228)	(0.301)	(0.187)	(0.207)	(0.292)
Male	0.394	0.529	0.749	0.267	0.418	0.497
	(0.166)**	(0.215)**	(0.242)***	(0.177)	(0.213)**	(0.261)*
Immigrant backgr	0.048	0.027	-0.069	0.160	0.145	0.123
	(0.120)	(0.156)	(0.197)	(0.114)	(0.160)	(0.199)
Sick leave days	-0.431	-0.572	-0.677	-0.309	-0.457	-0.606
	(0.309)	(0.382)	(0.467)	(0.312)	(0.402)	(0.497)
Log(nr. of children)	-0.042	-0.057	-0.019	-0.075	-0.070	-0.023
	(0.034)	(0.045)	(0.061)	(0.032)**	(0.049)	(0.056)
Peer char						
Share college edu parents	0.272	0.008	-0.007	0.237	0.116	0.011
	(0.167)	(0.254)	(0.332)	(0.174)	(0.241)	(0.289)
Share immigrant backgr	0.125	0.069	0.111	0.208	0.108	0.186
	(0.161)	(0.227)	(0.290)	(0.170)	(0.225)	(0.268)
Choice set (pooled)	No	Yes	No	No	Yes	No
Choice set (1, and 2-7)	No	No	Yes	No	No	Yes
R squared	0.201	0.427	0.570	0.195	0.465	0.593

Note: N = 2161. The models are estimated by ordinary least square. All specifications control for the variables described in Section 4.1, as well as the risk set described in Section 5. Standard errors are clustered at the child care center level . */**/*** denotes statistical significance at the 10/5/1 percent level.

Statistics Norway

Postal address:
PO Box 8131 Dept
NO-0033 Oslo

Office address:
Akersveien 26, Oslo
Oterveien 23, Kongsvinger

E-mail: ssb@ssb.no
Internet: www.ssb.no
Telephone: + 47 62 88 50 00

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Statistisk sentralbyrå
Statistics Norway

Design: Siri Boquist