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The relationship between kindergarten child care and child well-being: A comparison of regression and propensity score matching methods

**Amy Claessens
Northwestern University
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Abstract

Although a large body of literature documents the connection between pre-school child care and child well-being, little is known about the relationship between school-age child care experiences and child well-being. In addition, an important limitation of most child care studies is that the data are observational, making it difficult to isolate a causal connection between child care and child outcomes. Under certain assumptions, propensity score matching methods are one way to approximate a randomized experiment with non-experimental data. Through a comparison of matched groups of children with similar propensities for particular child care arrangements, this method estimates the effect of child care. Using a nationally representative sample of kindergartners, this study implements both longitudinal regression and propensity score matching methods to estimate the effect of center child care on a range of child achievement and socioemotional outcomes. Results indicate that center child care during the kindergarten year leads to increases in children's externalizing behavior, and this relationship is robust to a variety of regression and propensity score estimation techniques.

Although a large body of literature documents the connection between child care and child achievement and socioemotional well-being, this research focuses primarily on child care experiences prior to school entry. Thus, little is known about the relationship between school-age child care experiences and child well-being. While not typically considered the first year of formal school, 97% of American children attend kindergarten, making kindergarten an almost universal experience for American children (National Center for Education Statistics, 2000). As children enter kindergarten, many parents still need high quality, affordable child care for their children. Like all working parents, parents with school-age children choose from a wide-range of child care settings that best fit their needs, their children's needs, and their budgets. Because almost half of all kindergartners are in non-parental care, understanding the relationship between child care and child well-being for these children is important for both policy and practice.¹

An important concern in studying the effects of child care, regardless of child age, is the inability to make causal connections between child care and child outcomes. A key limitation of most child care studies is that the data are observational—children are not randomly assigned to child care. Because they rely on observational data, the results of many studies do not adequately address concerns about selection and omitted variable bias. While randomization, when correctly implemented, can eliminate most threats to external validity and causal estimates (Shadish, Cook, and Campbell, 2001), without such randomization, it is difficult to isolate the causal relationship between child care and child well-being.

Because randomization is often not feasible, researchers use a range of methodological techniques to address the problems that arise with observational data. Longitudinal regression and propensity score matching are two methodological techniques that can address some of the concerns about selection and bias more adequately than typical, cross sectional regression

¹ Author's calculation using the ECLS-K.

methods. Longitudinal regression methods—residualized change models and including as many observable characteristics of both the child and family as possible—address some of the problems through controlling for characteristics that might relate to child care selection and be correlated with the outcomes of interest. However, these regression techniques rely on assumptions that if not met, can produce biased estimates. Also relying on specific assumption, propensity score matching methods (Rosenbaum & Rubin, 1983) provide a way to approximate a randomized experiment with non-experimental data. Through a comparison of matched groups of children with similar propensities for particular child care arrangements, this method estimates of the effect of child care on the outcomes of interest (Heckman, Ichimura, & Todd, 1997, 1998; Dehejia & Wahba, 1999, 2002).

This study addresses two main gaps in the existing child care and child well-being literature. Unlike much of the extant literature, this study examines school-age child care experiences rather than formal after-school programs or child care prior to school entry. In addition, longitudinal regression and propensity score matching methods are implemented to address the methodological concerns that arise when using observational data. The present analysis examines the effect of center child care during the kindergarten year on child socioemotional and achievement outcomes, comparing estimates from propensity score methods to regression estimates.

Background

Child care and child well-being

Throughout childhood, children participate in a range of contexts including home, school, and child care. Children interact with these contexts, and the environments present children with both different opportunities and expectations. Developmental theory, both transactional and

ecological, suggests that child development is the product of the interaction of the child with these contexts (Bronfenbrenner & Ceci, 1994; Sameroff, 1994). Through participation in different contexts, children's characteristics and predispositions affect how their parents, caregivers, teachers, and peers respond and relate to them. Likewise, the characteristics of parents, caregivers, teachers, and peers along with their own predispositions affect both the environment and the child. This complex interplay between children and their environments affects their developmental trajectories (Bronfenbrenner & Ceci, 1994; Bronfenbrenner & Morris, 1998).

While early child care is often considered an important developmental context, school-age child care is rarely examined. Given the large proportion of school-age children in child care, it is surprising that little is known about the relationship between typical school-age child care experiences and child well-being. While often referred to as after-school care, school-age child care is both formal after-school programs and a wide-range of non-parental care such as center care and home-based care. However, when researchers and policymakers focus on school-age child care, they primarily concentrate on formal after-school programs and activities, paying little attention to the more typical child care experiences of school-age children (Vandell & Shumow, 1999). In the present study, I draw on the child care and child development literature, which is almost exclusively focused on child care prior to kindergarten entry.

Many studies find that aspects of early child care such as extent and type of care relate to child socioemotional and cognitive well-being (Baydar & Brooks-Gunn, 1991; Burchinal, Peisner-Feinberg, Bryant, & Clifford, 2000; Caughy, DiPietro, & Strobino, 1994; Halle, Hair, Zaslow, Lavelle, Martin, & Scott, et. al., 2005; Loeb, Bridges, Bassok, Fuller, & Rumberger, 2005; National Institute of Child Health and Human Development [NICHD], 1998, 2000, 2001,

2003, 2004; Peisner-Feinberg, Burchinal, Clifford, Yazejian, Byler, & Rustici, et. al., 1999; Votruba-Drzal, Coley, & Chase-Lansdale, 2004). Similarly, model early childhood intervention programs like Perry Preschool or Abecedarian Program which targeted low-income children also find that early care experiences relate to children's socioemotional and cognitive well-being (Barnett, 1995; Campbell, Ramey, Pungello, Sparling, & Miller-Johnson, 2002). All of this evidence points to the importance of early child care experiences for subsequent child development, suggesting that early school-age child care might also be an important context for child development.

Evidence from studies of early child care experiences consistently finds a positive association between center care and achievement outcomes (Loeb et al., 2005; Magnuson, Meyers, Ruhm, & Waldfogel, 2004; NICHD, 2000, 2002, 2004; Votruba-Drzal et al., 2004). In contrast, center care is often negatively associated with socioemotional outcomes (NICHD, 1998, 2001, 2002, 2003). Prior to school entry, center care is typically related to increases in problem behaviors and decreases in positive behaviors; however, this evidence is less consistent for particular subgroups of children (Votruba-Drzal et al., 2004).

Focusing specifically on child care prior to school entry, three studies using the nationally representative Early Childhood Longitudinal Study—Kindergarten cohort (ECLS-K), the same dataset used here, find that type of pre-school child care relates to child socioemotional and cognitive outcomes measured at kindergarten entry. Children in center child care the year prior to kindergarten had lower teacher ratings of positive behaviors (Loeb et al., 2005), and children in any non-parental care prior to kindergarten entry had less optimal teacher reports of self control (Halle et al., 2005). In terms of cognitive outcomes, children who attended center child

care the year prior to school entry had higher achievement test scores in kindergarten (Halle et al., 2005; Loeb et al., 2005; Magnuson et al., 2004).

Similarly, a study of primarily middle- and high-SES children from ten U.S. locations, the NICHD (2001, 2002, 2003) finds that children in center child care prior to school entry had more externalizing problems. In contrast, in a sample of primarily low-income, children in three cities, Votruba-Drzal et al. (2004) find that more time in center-based pre-school child care is associated with decreases in behavior problems. These studies illustrate that the relationship between preschool child care and children's well-being is complex and can vary by child characteristics. In terms of socioemotional outcomes, child care might be beneficial (Votruba-Drzal et al., 2004) or neutral for low-income children (Halle et al., 2005; Loeb et al., 2005), while care might be associated with negative socioemotional outcomes for more diverse group of children (Halle et al., 2005; Loeb et al., 2005; NICHD, 2001, 2003).

School-age child care

Although research on school-age child care is limited, formal after-school programs appear to relate to better peer relationships, conduct, emotional adjustment, and achievement (Posner & Vandell, 1994, 1999; Riley, Steinberg, Todd, Junge, & McClain, 1994). Participation in structured after-school activities, including clubs, sports, and other programs, is linked to both positive behavior and achievement (Mahoney & Stattin, 2000; McHale, Crouter, & Tucker, 2001; Morris & Kalil, 2006; Ripke, Huston, & Casey, 2006).

In one of the only studies of kindergarten child care arrangements, I find that type of care and not extent of care relates to child socioemotional outcomes (Claessens, 2006). In this study, attending any center child care during the kindergarten year is associated with increases in

negative behaviors and decreases in positive behaviors. The present study builds on this finding focusing on the relationship between center child care and child well-being.

Limitations of child care research

Uncovering how child care affects child development is difficult, given that children are continually influenced by multiple contexts and environments and that parents make choices about their work and their children's schooling that are likely influenced by characteristics of both the child and family (Fuller, Holloway, & Liang, 1996; Singer, Fuller, Keiley, & Wolf, 1998). Despite the extensive controls and variety of models tested in many child care studies, because the data are longitudinal rather than experimental, concerns remain about the estimates of the effect of child care. There are likely unmeasured or unobserved characteristics that are correlated with the selection of child care and the child outcomes of interest. Because these characteristics are not included, most estimates of child care effects are subject to omitted variable bias. Longitudinal regression models can address some of the concerns surrounding omitted variable bias. A residualized change regression models includes a prior measure of the outcome of interest as a covariate in the model. Including this measure in the model, eliminates most concerns about unobserved characteristics that might be correlated with the outcome as these characteristics are also likely to be correlated with the prior measure of the outcome.

However, regression models rely on assumptions about both the functional form (typically a linear relationship) of the model and the distributions of the comparison groups on the covariates (common support). While the functional form assumption can be relaxed, if the assumption about the distributions of the covariates is not met, the estimated treatment effects can be distorted. Because the comparison group members might not have distributions with substantial overlap, estimates from regression models using these groups without overlap are

based on comparisons of cases that might be very dissimilar. This is especially concerning in the case of estimating child care effects where random assignment is often not feasible, and researchers rely primarily on regression models.

Propensity score matching methods

Propensity score matching is one way to address the problems in estimating treatment effects in observational data (Rosenbaum & Rubin, 1983). Recently, propensity score matching has been used in studies on a wide range of topics including college attendance, food stamps, food insecurity, grade retention, and child care (Gibson-Davis & Foster, 2006; Hill, Waldfogel, Brooks-Gunn, 2002; Hong & Raudenbush, 2005; Stephan & Rosenbaum, 2006). Through propensity score matching, comparison cases that are comparable on observable characteristics are matched and only differ in terms of treatment status—approximating a randomized experiment (Dehejia & Wahba, 1999, 2002; Heckman et al., 1997, 1998).

However, propensity matching techniques are not without limitations. Like regression models, propensity score matching is based only on the observable characteristics available in the data. Thus, propensity models rely on the assumption that all characteristics related to treatment selection are observed in the data and used in the estimation of the propensity scores. While the method provides a better estimate of the effect of child care because the estimates are based on comparisons of cases that are the most similar, it is still subject to concerns about omitted variables. In addition, in order to compare the most comparable cases, researchers implementing propensity scores often disregard cases that are poor matches. While this helps to obtain unbiased estimates, it reduces the external validity of the results.

Method

Data

Data used in this analysis come from the ECLS-K. Designed to focus on children's early school experiences, the ECLS-K follows a nationally representative sample of over 21,000 children who entered kindergarten in 1998-99. The study will collect data at the fall and spring of both kindergarten and first grade, and the spring of third, fifth, eighth, tenth, and twelfth grades. This analysis uses data collected in the fall and spring of kindergarten. Data come from multiple sources including direct assessments of children, interviews with parents, and surveys of teachers and school administrators.

Sample

Although baseline data collection included over 21,000 children, this analysis includes 12,873 kindergarteners, primarily due to missing data. Children are excluded from this analysis if they are missing fall or spring of kindergarten achievement test scores, teacher reports of socioemotional skills and behavior, or data on child care during the kindergarten year. In addition, cases missing data on preschool child care, race, gender, SES or any of the other covariates described below are excluded from the analysis.

Measures²

Center child care. An indicator for the treatment of interest—center child care—was constructed using fall of kindergarten parent reports. In the fall of kindergarten, parents were asked about their child's regular weekly child care arrangements. Parents were asked these questions about child care by type of care. A small proportion of the children attended both center- and home-based child care. However, given that the treatment of interest is center child care, a dichotomous variable for whether or not a child was exposed to any center care was created. The dataset also provides retrospective information about children's preschool child care

² The information on the measures comes from the ECLS-K User's Manual.

experiences that are used as covariates in this analysis. Approximately 50% of the children in the sample are in some type of non-parental care during the kindergarten year.

Child outcomes. The outcomes of interest are children's spring of kindergarten math and reading achievement test scores and teacher reports of socioemotional and behavioral skills. Children were given direct cognitive assessments in language and literacy (reading) and math in both the fall and spring of kindergarten using Item Response Theory (IRT). Children were asked to give verbal responses or point to answers. The language and literacy assessment ($\alpha=.95$) measured children's in basic skills, vocabulary, and comprehension. The test contained five proficiency levels including identifying letters, associating letters with sounds at the beginning and end of words, recognizing words by sight, and reading words in context. The math assessment ($\alpha=.94$) measured skills in conceptual and procedural knowledge and problem solving. The assessment consisted of five proficiency levels including identifying numerals, counting, recognizing patterns, ordinality, solving word problems, addition, subtraction, multiplication, and division.

Teachers assessed all sampled children in their classrooms in both the fall and spring of kindergarten using the Social Rating Scale (SRS) designed specifically for the ECLS-K.³ The SRS is a self-administered questionnaire on which teachers rated children in five domains: self control, interpersonal skills, approaches to learning, and externalizing and internalizing problem behaviors. Teachers rated each of the items within a domain on a four point scale 1= "never" and 4= "very often". The reported reliabilities of these five scales range from .79 to .90.

The four item self control scale indicates a child's ability to control behavior by respecting the property rights of others, controlling temper, accepting peer ideas for group

³ The dataset does not item-level information for these scales due to copyright restrictions.

activities and responding appropriately to pressure from peers. The five item interpersonal skill scale rates the child's ability to form and maintain friendships, get along with people who are different, comfort or help other children, express feelings, ideas and opinions in positive ways, and show sensitivity to the feelings of others. The approaches to learning scale includes six items that measure the child's attentiveness, task persistence, eagerness to learn, learning independence, flexibility, and organization. The five item externalizing problem behaviors scale rates the frequency with which a child argues, fights, gets angry, acts impulsively, and disturbs ongoing activities. The four item internalizing problem behavior scale rates the child's anxiety loneliness, low self-esteem, and sadness.

Covariates. Given that parent's selection of child care is related to both parental and child characteristics (Fuller et al., 1996; Singer et al., 1998), including a wide range of family and child demographic and background characteristics in the regression models and in the estimation of the propensity scores is important. Child background characteristics include age, sex, race/ethnicity, child health, and whether the child was part of a multiple birth. Home environment characteristics include mother's age at first birth and the child's birth, number of siblings, a standardized composite measure of socioeconomic status (SES), number of books in the home, whether the family received WIC, whether the mother worked between birth and kindergarten entry, if the family moved four or more times prior to kindergarten, and whether the child lives in a single parent household. In addition, primary type of preschool child care, type of kindergarten, and the fall of kindergarten measures of achievement and socioemotional skills are also included.

Table 1 shows the means and standard deviations for the fall and spring measures of the outcomes of interest and the child and family background characteristics of the analytic sample

(n=12,873). Table 2 shows the correlations between the fall and spring of kindergarten achievement and socioemotional measures. As shown in table 1, the sample is 50% female and is primarily white (64%). An additional 14% of the sample is Black and another 12% Hispanic. Approximately 44% of the children attend half-day kindergarten, and 21% attend center child care during the kindergarten year, and 44% of the children attend half-day kindergarten. The average number of siblings is 1.43, and 20% of the children live in a single parent household.

Analytic Strategy

This analysis aims to estimate the effect of center child care during the kindergarten year on child achievement and socioemotional outcomes using longitudinal regression and propensity score matching methods. In addition, this study examines the advantages and disadvantages of using these techniques through comparing different matching methods to propensity score weighted and unweighted regression methods. The analytic plan used here is similar to the methods used by Gibson-Davis and Foster (2006) in their analysis of the relationship between Food Stamps and food insecurity using the ECLS-K.

A typical regression approach to estimate the relationship between center child care during the kindergarten year and child achievement or socioemotional well-being using the ECLS-K might take the form:

$$(1) \quad \mathbf{Child\ Outcome}_{iSK} = \mathbf{a}_1 + \mathbf{\beta}_1 \mathbf{Centercare}_{iK} + \mathbf{\beta}_2 \mathbf{Child}_{iFK} + \mathbf{\beta}_3 \mathbf{Fam}_{iFK} + \mathbf{\varepsilon}_{iSK}$$

Where $\mathbf{Child\ Outcome}_{iSK}$ is the spring of kindergarten (SK) child outcome (achievement or socioemotional) of child i . $\mathbf{Centercare}_{iK}$ is a dichotomous variable for whether or not child i 's parent reported that the child was exposed to any center child care during the kindergarten year. This model also includes \mathbf{Child}_{iFK} and \mathbf{Fam}_{iFK} which are background characteristics of both the child and family measured in fall of kindergarten. If this model were estimated for the full

sample of children, children who are not in center child care during kindergarten would serve as the reference group. Estimating this model for only those children in kindergarten child care results in children in home-based child care serving as the reference group.

The coefficient of interest in equation (1) is β_1 —the “effect” of center child care on the child outcome. However, unmeasured characteristics related to both selection of center child care and the child outcome might exist and omitting these characteristics from equation (1) results in a biased estimate of the coefficient of interest, β_1 . In addition, estimates from this type of regression approach might also be distorted because they come from comparisons of very dissimilar children, assuming that children in center child care and those not have substantial distributional overlap on the included covariates. Therefore, this analysis uses both residualized change regression models and propensity scores as alternative methods for estimating the effect of center child care.

Because the dataset used here has measures of the outcomes of interest at kindergarten entry, these measures can be included as covariates in the regression model, resulting in a residualized change model. In addition, given that the dataset sampled multiple children per kindergarten classroom, I can control for kindergarten specific inputs by using classroom fixed effects. This residualized change fixed effect model takes the form:

$$(2) \quad \mathbf{Child Outcome}_{ijSK} = \mathbf{a}_1 + \beta_1 \mathbf{Centercare}_{iK} + \beta_3 \mathbf{Child Outcome}_{ijFK} + \beta_4 \mathbf{Child}_{iFK} + \beta_5 \mathbf{Fam}_{iFK} + \delta_{jK} + \varepsilon_{ijSK}$$

Where $\mathbf{Child Outcome}_{ijSK}$ is child i 's spring of kindergarten (SK) achievement or behavior in classroom j . $\mathbf{Centercare}_{iK}$ as in equation (1) is a dichotomous variable for center child care.

$\mathbf{Child Outcome}_{ijFK}$ is a vector of fall of kindergarten (FK) measures of achievement and behavior for child i in classroom j . This model also includes \mathbf{Child}_{iFK} and \mathbf{Fam}_{iFK} which are background

and demographic characteristics of both the child and the family as in equation (1). This specification includes δ_{jk} a classroom, fixed effect.

Calculating and matching propensity scores. The first step in the propensity score estimation process is identifying the appropriate comparison groups. In this analysis, the treatment of interest is center child care during the kindergarten year. However, this treatment group will be compared to three overlapping comparison groups: kindergartners not in center care, in home-based child care, and with only parental care.

Table 1 shows descriptive statistics for the full sample and the treatment and three comparison groups. The treatment group includes the 2,704 children who attend center care, and the first comparison group is comprised of the remaining 10,169 kindergartners who either attended only home-based care or only parental care. The second comparison group is the 3,653 children who were in home-based care, and the third comparison group is the 6,616 children with only parental care. Although there appear to be a few small differences between the children in the treatment group and the children in the comparison groups, none of these differences is statistically significant, except with regard to type of kindergarten child care. This difference is expected given that the groups are defined according to type of kindergarten child care.

After identifying these three comparison groups, I use the standard propensity score methods for a dichotomous treatment (Harding, 2003; Morgan, 2001; Rubin, 1997) to first estimate propensity scores and then to estimate the effect of center child care on the child outcomes of interest. To obtain the propensity scores, I estimate a logistic regression model for the three comparison groups predicting the treatment—center child care—including the fall of kindergarten measures of the outcomes of interest and the covariates related to child care choice and child well-being (shown in table 1). These models provide conditional probabilities,

conditioned on the covariates included in the model, for being exposed the treatment (center child care). From these logistic regression models, each observation receives a predicted probability which is the propensity score.

After estimating the logistic regression models, the cases are divided into strata based on their propensity scores to check for balance on the covariates (Dehejia & Wahba, 1999, 2002). Each stratum achieves balance when there are no significant differences between treatment and control groups on any of the covariates within a given stratum. Achieving balance can be difficult if a large number of covariates are included in the propensity score estimation model. If a stratum is not balanced, exponential and interaction terms are added to the prediction equation until balance is achieved (Rosenbaum & Rubin, 1983). The addition of these terms is atheoretical, and there is some consensus building in the literature that indicates that having fewer statistically significant differences than would be expected by chance or having no substantive differences might be an appropriate alternative to achieving balance (Imai, King, & Stuart, 2006; Luellen, Shadish, & Clark, 2005).

After achieving balance, cases are matched on their propensity scores to estimate the effect of center child care on a given outcome. This analysis uses several different matching techniques to examine the sensitivity of propensity score estimates to the matching procedure. Like the analysis by Gibson-Davis and Foster (2006), I use nearest neighbor caliper with replacement, kernel, and stratification matching.

Nearest neighbor caliper matching with replacement matches treatment cases to the nearest control cases allowing control cases to be matched with more than one treatment group member (Dehejia & Wahba, 2002). Because this matching method compares only the cases that are most similar, it produces less biased estimates (Dehejia & Wahba, 2002), but can increase the

variance because of the small number of matched cases used in the estimation process (Smith & Todd, 2005). Reducing the variance, but increasing the bias, kernel and stratification matching use all of the available cases, rather than the most similar as in nearest neighbor, which leads to a larger number of matches, but these matches are not all very good (Smith & Todd, 2005). Kernel and stratification matching match treatment cases with multiple comparison cases through a weighting process. In this analysis, a Gaussian kernel with a .6 bandwidth is used. All three matching methods likely produce less biased estimates of the effect of center child care than standard regression techniques; however, nearest neighbor caliper matching should be the least biased but also have the largest variance. After the observations are matched, I compare the means of the matched treatment and control groups on the outcomes of interest for each type of matching model and compare these results to typical regression estimates for the same outcomes.

I also investigate the robustness of these results through additional sensitivity analyses. I re-estimate the three propensity score matching models using only those cases with propensity scores between .33 and .67. Black and Smith (2004) show that observations with propensity scores in this range are less likely to be biased. Then, I examine the sensitivity of the results to the specification of the propensity score prediction equation. I re-estimate the logistic regression models to obtain propensity scores and include additional covariates. After obtaining these propensity scores, I re-estimate all the matching estimators for both the full and restricted range of propensity scores.

Finally, I implement a doubly robust analysis as suggested by Imbens (2004) and implemented by Gibson-Davis and Foster (2006). I create weights using the inverse of the predicted probabilities—the propensity scores—and use these in a regression model shown in equation (2) (Foster, 2003; Gibson-Davis & Foster, 2006; Hirano & Imbens, 2001; Imbens,

2004). This method is similar to using matching estimators since including the propensity scores as weights results in the treatment, being uncorrelated with the other covariates in the regression model (Gibson-Davis & Foster, 2006; Hirano & Imbens, 2001; Imbens, 2004).

Results

Calculating propensity scores

Table 3 presents the results of the logistic regression models predicting treatment status for the three comparison groups. The first model for each comparison group includes a small set of background characteristics, and the second model (shown in columns 2, 4, and 6) adds additional child and family background characteristics to the first model. Including a large number of covariates in the estimation process reduces concerns about omitted variable bias; however, a large number of covariates might also make it difficult to achieve balance and reduce the number of good matches. While the models shown in table 3 represent the initial propensity score specification, the final propensity score prediction models included both interaction and higher order terms in order to achieve balance.⁴

As shown in table 3, across all three comparison groups, children in half-day kindergarten are more likely to attend center child care during the kindergarten year. In addition, higher teacher rated externalizing behavior in the fall of kindergarten predicts center child care in the three comparison groups. These propensity score models indicate that several child and family background characteristics do predict the treatment, including maternal work between birth and kindergarten and pre-school child care arrangements.

Table 4 presents the mean propensity scores by treatment and control status for both propensity score estimation models for the comparison groups. Table 4 also shows the

⁴ The addition of interaction and higher order terms to the prediction equation is atheoretical and is used only to achieve balance.

distribution of the treatment and control cases across the balancing strata by model and comparison group. The propensity scores come from the logistic regressions predicting center child care shown in table 3. For the first comparison, the mean propensity score for the treatment group is .31 in the first model and .30 in model 2. For the control group, the mean propensity score is .18 in both models. For the second comparison, the mean propensity score for the treatment group is .56 in model 1 and .57 in model 2, and the mean propensity score for the control group is .31 in both models.

In the third comparison, the mean propensity score for the treatment group is .42 in model 1 and .45 in model 2, and for the control group, the mean score is .24 in model 1 and .23 in model 2. For this comparison, balance was not achieved in one stratum for each model. Rather than exclude this stratum from the analysis, all cases were included. Although balance was not achieved, this one significant difference between the treatment and control groups is fewer differences than would be expected by chance and was not a substantive difference (Imai et al., 2006; Luellen et al., 2005).⁵

Estimating the effect of center child care

Using both longitudinal regression and propensity score matching, I estimate the effect of center child care on the seven spring of kindergarten child achievement and socioemotional outcomes. The estimates come from a residualized change fixed effect regression (shown in equation [2]), a propensity score weighted regression (equation [2]), and three propensity score matching techniques—nearest neighbor caliper, kernel and stratification matching.⁶ In addition, the results show estimates using both the full and restricted range (between .33 and .67) of

⁵ The pattern of results does not change when the unbalanced stratum is excluded from the estimation process.

⁶ The standard errors of the matched estimates are bootstrapped 500 times.

propensity scores. Because the results from models 1 and 2 were similar, the results shown here are from models using the model 2 propensity scores or covariates.

Comparison 1. Table 5 presents results from propensity score matched, propensity score weighted regression, and regression estimates for the spring of kindergarten achievement and socioemotional outcomes using the full range of propensity scores for the first comparison group. These estimates compare children in center child care during the kindergarten year to all other kindergartners.

The regression results show that center child care is negatively related to positive behaviors and positively related to negative behaviors compared to home-based care and no non-parental care during the kindergarten year. In these models, center child care is associated with a tenth of a standard deviation increase in externalizing behaviors, a tenth of a standard deviation decrease in self control, and .07 of a standard deviation decrease in both interpersonal skills and approaches to learning compared to other child care arrangements or no child care.

Turning to the propensity matched and propensity weighted regression estimates, table 5 shows that both kernel and stratification matched estimates and the weighted regression coefficients are generally similar in both size and significance. All three techniques indicate that center care is related to a decrease of between -.06 and -.11 of a standard deviation in self control for this comparison group. Similarly, center care is negatively related to approaches to learning—between -.05 and -.06 of a standard deviation. These estimates also show that center child care is related to an increase (.10 to .16 of a standard deviation) in externalizing behavior. Interestingly, both stratification and kernel matched estimates indicate that center child care increases internalizing behavior by about .05 of a standard deviation; however, none of the other techniques produce a statistically significant estimate for the internalizing behavior outcome.

As expected, the nearest neighbor matched estimates produce the largest standard errors. These estimates should be the least biased than other matched estimates given that they rely on better matches. The nearest neighbor estimates use only around 1,900 of the over 10,000 comparison group cases. In all but one instance, nearest neighbor matching produces statistically insignificant results, in large part due to the increased standard errors. However, the magnitude of the nearest neighbor estimates is often smaller than the other estimates. Nearest neighbor matching shows that center child care is related to an increase of .13 of a standard deviation in externalizing behavior in this comparison group.

The results in table 5 for the full range of propensity scores show consistently, across all estimation methods, that center child care during the kindergarten year is related to increases in externalizing behaviors compared to kindergartners. None of the estimates show a relationship between center child care and child achievement test scores. The results also show that for most outcomes the regression coefficient estimate is close in magnitude to the stratification and kernel matched and propensity weighted regression estimates. Across most of the estimation methods, center care is related to increases in negative behavior and decreases in positive behaviors. However, nearest neighbor matched estimates, which use better matches, show that center child is only statistically significantly related to increases in externalizing behaviors.

The results in table 6 come from the same estimation techniques and comparison group as used table 5, but use only those cases with propensity scores between .33 and .67. While the general pattern of the estimates is similar to those in table 5, using the restricted range of propensity scores produces few statistically significant estimates. This is due in part to much smaller sample given the restriction ($n=2,376$). However, these estimates should also be less biased since they rely on cases who are likely less sensitive to unobservables (Black & Smith,

2004). None of the regression estimates produce statistically significant coefficient estimates. While both the unweighted and propensity score weighted regression estimates are not statistically significant, all three matched estimates are, indicating that center care is related to an increase of between .12 and .16 of a standard deviation in externalizing behaviors.

Comparison 2. Table 7 shows the results from propensity score matched, propensity score weighted regression, and regression models for the second comparison group. These estimates compare center child care to home-based child care. The results from the regression estimates show that center child care is related to increases in externalizing behavior (.13 of a standard deviation) and decreases in self control, interpersonal skills, and approaches to learning compared to home-based child care. The regression estimates also show that center care is not related to child achievement or internalizing behavior.

Turning to the other estimates in table 7, none of the propensity score matched nor the propensity score weighted regression estimates show a relationship between center care and child achievement outcomes. This result is consistent with the results shown in the previous comparison in table 5. However, with a few exceptions, all three matched estimates and the propensity score weighted regression estimates show that center care is negatively related to positive behavior and positively related to externalizing behavior. In addition, these estimates are similar in magnitude to those from the regression model. Center care, compared to home-based care, is related to an increase of between .13 and .17 of a standard deviation in externalizing behavior and is related to decreases in self control, interpersonal skills, and approaches to learning.

Interestingly, all three matching techniques indicate that center care is related to increases in internalizing behaviors (.09 to .12 of a standard deviation) compared to home-based child

care; however, this result is not consistent in the regression models. As expected, the nearest neighbor matched estimates produce the largest standard errors, but these estimates should also be less biased than estimates from the other types of matching or regressions. Although only 3,904 of the 6,357 cases are included, many of the nearest neighbor estimates are statistically significant, and their point estimates are similar to the estimates from the other matching and regression techniques. This likely indicates that comparing center care to other types of child care arrangements results in both better matches (in the case of the matched estimates) and fewer distortions in the regression estimates.

Table 8 presents the regression, propensity score weighted regression, and propensity score matched estimates for the second comparison group using the restricted range of propensity scores. Using the restricted range of propensity scores reduces the sample size substantially from 6,357 to 2,022. While the general pattern of results remains—center care is negatively related to positive behaviors and positively related to negative behavior—there are few statistically significant relationships. Interestingly, as in table 7, all three matched estimates indicate that center care is related to increases in internalizing behavior of between .09 and .17 of a standard deviation compared to children in home-based care. Taken together, tables 7 and 8 show that center care is related to increases in externalizing behavior in the full range of scores and might be related to increases in internalizing behavior, although this result is not generalizable because it comes from a restricted sample.

Comparison 3. Table 9 presents the propensity score matched, propensity score weighted, and regression estimates for the third comparison group using the full range of propensity scores. These estimates compare center child care to only parental care. This group was the most difficult to balance in the propensity score estimation process, indicating that the two groups are

quite dissimilar. Consistent with the results from the previous two comparisons, the regression estimates in table 9 show that center care is not related to reading achievement, although the regression estimates do show that center care is related to an increase in math achievement of .04 of a standard deviation. Similarly, center care during the kindergarten year is related to increases in externalizing behavior (.09 of a standard deviation), and decreases in self control (-.09 of a standard deviation), interpersonal skills (-.08 of a standard deviation), and approaches to learning (-.08 of a standard deviation).

Few of the propensity score matched or propensity score weighted regression estimates produce statistically significant results. Consistent with the other comparison group estimates, nearest neighbor matched estimates produce the largest standard errors and few statistically significant results. However, for externalizing behavior, nearest neighbor matched estimates show that center care is related to increases in externalizing behaviors of .08 of a standard deviation compared to only parental care. The other two matching techniques—stratification and kernel—also show that center care is related to an increase in externalizing behavior. The results in table 9 suggest that center care is related to increases in externalizing behavior compared to only parental care, but that center care is not consistently related to the other six outcomes.

Table 10 presents the results for this comparison group using only cases with propensity scores between .33 and .67. As in the other comparison groups, restricting the range of propensity scores reduces the sample size substantially from 9,320 to 3,129. While the results in table 10 show few statistically significant relationships, the regression, propensity score weighted regression, and kernel matched estimates show that center care is related to an increase in externalizing behavior of between .11 and .13 of a standard deviation compared to only parental care. However, for the externalizing outcome using the restricted range of propensity

scores, the nearest neighbor matched estimates do not produce a statistically significant estimate. Taken together the results in tables 9 and 10 suggest that center child care is related to an increase in externalizing behavior.

Discussion

Although nearly half of all kindergartners are in non-parental care, little is known about the relationship between these child care arrangements and child well-being. While many studies of early child care experiences show that center child care is related to child behavior, these studies typically rely on observational data, making the estimates subject to concerns about omitted variable bias. While limited to exploring only the effects of center child care, the present study addresses two gaps in the existing child care literature through its focus on early school-age child care experiences and through implementing longitudinal regression and propensity score matching methods to address some of the limitations of relying on observational data. While longitudinal regression and propensity score methods are not without their own limitations, the most reliable models used here indicate that center child care during the kindergarten year is related to an increase in externalizing behaviors.

Although propensity scores under several assumptions can approximate a randomized experiment (Heckman et al., 1997, 1998; Dehejia & Wahba, 1999, 2002), propensity score matching has several limitations. Although they can approximate a randomized experiment, propensity score methods are still subject to omitted variable bias concerns since they rely on observables to match cases. In this study, if there are unobserved variables related to both selection of kindergarten child care type, the propensity score estimation equation is misspecified. However, in this analysis, two different prediction equations were used to examine the sensitivity of the results to the propensity score estimation equation, and the results were

consistent across both models. While this might lessen some concerns about omitted variable bias in the propensity matched estimates, it can not erase all concerns as other variables related to child care selection might not be observed in this dataset.

Although the dataset provides a nationally representative sample of kindergarteners, using propensity score matching methods and the restricted range of propensity scores leads to concerns about the generalizability of the findings. While cases were not excluded from the propensity matched estimates, nearest neighbor matching—by design—uses only the best matches and eliminates the poor matches. Thus, while producing the least biased estimates, nearest neighbor matched results rely on a sample that might be very different from the original nationally representative sample. Similarly, although the analysis using the restricted range of propensity score should produce less biased estimates, this analysis also restricts the sample, leading to concerns about the external validity of these results.

Even though propensity score matching has several limitations, the matched estimates provide a better understanding of the relationship between child care and child well-being when using observational data. In this study, the propensity matched estimates consistently show that center child care during the kindergarten year is related to an increase in externalizing behavior across multiple comparison groups and specifications. In addition, for this outcome, the propensity score estimates were similar to the coefficients from the longitudinal regression models, indicating that longitudinal regression adjustments might be sufficient when using a dataset that allows for a residualized change specification and contains a rich set of child and family background characteristics, such as the ECLS-K. However, for many of the other outcomes, the coefficients from the longitudinal regression estimates showed a statistically significant relationship between center care the child outcome, but the propensity score matched

estimates did not. This lends some support to the need to use propensity score matching to make comparisons between cases that are most similar in order to avoid drawing false conclusions from regression results.

Across a range of estimation techniques, this study overwhelmingly finds that center child care during the kindergarten year is related to increases in behavior problems. Short of random assignment, this study provides the best evidence to date of the relationship between center care and child well-being. Although the finding is robust to a variety of specifications and models, caution should be used in interpreting this result. This analysis cannot address the reasons why center child leads to increased externalizing behavior. Further research is needed to uncover the processes through which center care affects child behavior.

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Table 1. Descriptive Statistics for Outcomes and Control Variables

Variable	Full Sample	Treatment Group	Comparison Group 1	Comparison Group 2	Comparison Group 3
	Mean (Std. Dev.)	Mean (Std. Dev.)	Mean (Std. Dev.)	Mean (Std. Dev.)	Mean (Std. Dev.)
Spring of Kindergarten					
<i>Child Outcomes</i>					
Reading Test	33.15 (10.43)	34.20 (10.18)	32.87 (10.48)	31.80 (9.77)	33.46 (10.81)
Math Test	28.83 (8.70)	29.83 (8.49)	28.57 (8.73)	27.56 (8.21)	29.11 (8.97)
Teacher Report:					
Self Control	3.21 (0.62)	3.08 (0.64)	3.24 (0.60)	3.21 (0.61)	3.25 (0.60)
Interpersonal Skills	3.16 (0.63)	3.07 (0.65)	3.18 (0.62)	3.16 (0.62)	3.20 (0.63)
Approaches to Learning	3.16 (0.67)	3.11 (0.66)	3.17 (0.67)	3.14 (0.67)	3.19 (0.67)
Externalizing Problem Behaviors	1.65 (0.63)	1.83 (0.69)	1.60 (0.61)	1.63 (0.62)	1.59 (0.60)
Internalizing Problem Behaviors	1.55 (0.51)	1.58 (0.51)	1.55 (0.51)	1.54 (0.50)	1.55 (0.51)
Fall of Kindergarten					
Reading Test	23.08 (8.78)	24.34 (8.69)	22.74 (8.77)	21.74 (7.89)	23.28 (9.15)
Math Test	20.47 (7.39)	21.46 (7.25)	20.21 (7.40)	19.46 (6.90)	20.60 (7.64)
General Knowledge Test	23.08 (7.37)	23.57 (7.14)	22.95 (7.42)	22.31 (7.09)	23.29 (7.57)
Teacher Report:					
Self Control	3.11 (0.60)	3.00 (0.63)	3.14 (0.59)	3.10 (0.60)	3.17 (0.58)
Interpersonal Skills	3.01 (0.62)	2.95 (0.64)	3.03 (0.62)	3.00 (0.62)	3.05 (0.62)
Approaches to Learning	3.04 (0.66)	3.00 (0.65)	3.04 (0.66)	3.01 (0.67)	3.06 (0.66)
Externalizing Problem Behaviors	1.61 (0.63)	1.78 (0.69)	1.57 (0.60)	1.60 (0.61)	1.55 (0.59)
Internalizing Problem Behaviors	1.52 (0.51)	1.53 (0.50)	1.52 (0.51)	1.51 (0.51)	1.52 (0.52)
Kindergarten child care					
Proportion in child care:					
Center child care	0.21 (0.41)	1.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Home-based child care	0.33 (0.46)	0.19 (0.39)	0.36 (0.48)	1.00 (0.00)	0.00 (0.00)
Half-day kindergarten	0.44 (0.50)	0.45 (0.50)	0.44 (0.50)	0.46 (0.50)	0.42 (0.49)
Child care arrangements (pre-K)					
Relative pre-school care	0.13 (0.34)	0.06 (0.24)	0.15 (0.36)	0.32 (0.47)	0.05 (0.23)
Center pre-school care	0.46 (0.50)	0.69 (0.46)	0.40 (0.49)	0.24 (0.43)	0.49 (0.50)
Non-relative pre-school care	0.11 (0.31)	0.09 (0.29)	0.11 (0.32)	0.23 (0.42)	0.05 (0.21)
Head Start	0.08 (0.27)	0.04 (0.19)	0.09 (0.29)	0.07 (0.26)	0.10 (0.30)

Table 1. (continued)

Variable	Full Sample	Treatment Group	Comparison Group 1	Comparison Group 2	Comparison Group 3
	Mean (Std. Dev.)	Mean (Std. Dev.)	Mean (Std. Dev.)	Mean (Std. Dev.)	Mean (Std. Dev.)
Baseline Child Characteristics					
Age (in months)	68.54 (4.30)	68.22 (4.25)	68.62 (4.31)	68.40 (4.31)	68.74 (4.30)
Race					
Black	0.14 (0.34)	0.15 (0.36)	0.13 (0.34)	0.17 (0.38)	0.11 (0.31)
Hispanic	0.12 (0.33)	0.11 (0.31)	0.13 (0.34)	0.14 (0.35)	0.12 (0.33)
White	0.64 (0.48)	0.66 (0.47)	0.64 (0.48)	0.58 (0.49)	0.67 (0.47)
Asian	0.04 (0.20)	0.04 (0.20)	0.04 (0.20)	0.04 (0.20)	0.04 (0.20)
Other	0.05 (0.22)	0.04 (0.21)	0.06 (0.23)	0.06 (0.24)	0.05 (0.22)
Female	0.50 (0.50)	0.48 (0.50)	0.50 (0.50)	0.51 (0.50)	0.49 (0.50)
Child's health	1.63 (0.79)	1.62 (0.76)	1.63 (0.80)	1.67 (0.80)	1.61 (0.79)
Child part of multiple birth	0.02 (0.16)	0.02 (0.15)	0.03 (0.16)	0.02 (0.15)	0.03 (0.16)
Home Environment					
Number of siblings	1.43 (1.09)	1.08 (0.89)	1.52 (1.12)	1.31 (1.02)	1.63 (1.15)
Single Parent Household	0.20 (0.40)	0.26 (0.44)	0.19 (0.39)	0.30 (0.46)	0.13 (0.33)
SES	0.12 (0.77)	0.32 (0.72)	0.07 (0.77)	0.03 (0.72)	0.10 (0.80)
Mother's age at child's birth	27.33 (5.84)	27.94 (5.83)	27.16 (5.83)	26.46 (5.98)	27.54 (5.71)
Mother's age at first birth	24.16 (5.45)	25.36 (5.66)	23.84 (5.34)	23.43 (5.38)	24.07 (5.31)
Received WIC	0.41 (0.49)	0.33 (0.47)	0.43 (0.50)	0.48 (0.50)	0.40 (0.49)
Mom worked between birth and kindergarten	0.77 (0.42)	0.92 (0.27)	0.73 (0.44)	0.90 (0.31)	0.64 (0.48)
Number of books in the home	81.09 (59.85)	83.20 (56.78)	80.53 (60.63)	73.85 (57.71)	84.32 (61.92)
Four or more moves pre-school	0.12 (0.32)	0.14 (0.35)	0.11 (0.32)	0.12 (0.33)	0.11 (0.31)

Note. Full sample n=12,873; treatment group n=2,704; control group 1 n=10,169; control group 2 n=3,653; control group 3 n=6,616

Table 2. Correlations Between Fall and Spring of Kindergarten Measures of Achievement and Socioemotional Skills

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Spring of Kindergarten														
1. Reading Test	1.00													
2. Math Test	0.71	1.00												
3. Self Control	0.21	0.21	1.00											
4. Interpersonal Skills	0.23	0.24	0.81	1.00										
5. Approaches to Learning	0.42	0.44	0.65	0.68	1.00									
6. Externalizing Problem Behaviors	-0.17	-0.17	-0.73	-0.62	-0.53	1.00								
7. Internalizing Problem Behaviors	-0.18	-0.21	-0.33	-0.39	-0.42	0.32	1.00							
Fall of Kindergarten														
8. Reading Test	0.81	0.65	0.17	0.20	0.37	-0.14	-0.17	1.00						
9. Math Test	0.69	0.81	0.19	0.22	0.42	-0.15	-0.21	0.74	1.00					
10. Self Control	0.20	0.21	0.63	0.57	0.49	-0.57	-0.24	0.18	0.20	1.00				
11. Interpersonal Skills	0.23	0.24	0.55	0.62	0.50	-0.46	-0.27	0.22	0.24	0.79	1.00			
12. Approaches to Learning	0.37	0.41	0.50	0.51	0.71	-0.43	-0.31	0.36	0.41	0.67	0.70	1.00		
13. Externalizing Problem Behaviors	-0.15	-0.16	-0.59	-0.51	-0.44	0.73	0.23	-0.13	-0.15	-0.70	-0.57	-0.51	1.00	
14. Internalizing Problem Behaviors	-0.15	-0.17	-0.23	-0.27	-0.30	0.20	0.56	-0.14	-0.17	-0.28	-0.35	-0.36	0.27	1.00

Note. N=12,873

Table 3. Logistic regression predicted likelihood of attending center child care during the kindergarten year

	Comparison 1		Comparison 2		Comparison 3	
	Model 1 (1)	Model 2 (2)	Model 1 (3)	Model 2 (4)	Model 1 (5)	Model 2 (6)
Fall of Kindergarten						
Math Test	0.107** (0.036)	0.115** (0.038)	0.088 (0.047)	0.084 (0.049)	0.117** (0.038)	0.137** (0.042)
Reading Test	-0.020 (0.032)	-0.025 (0.034)	0.112** (0.043)	0.092* (0.045)	-0.073* (0.034)	-0.076* (0.037)
General Knowledge Test	-0.139** (0.031)	-0.137** (0.033)	-0.098* (0.040)	-0.125** (0.042)	-0.159** (0.033)	-0.150** (0.037)
Self Control	-0.143** (0.043)	-0.101* (0.046)	-0.058 (0.054)	-0.021 (0.057)	-0.180** (0.047)	-0.147** (0.051)
Interpersonal Skills	0.051 (0.040)	0.032 (0.042)	0.035 (0.050)	0.022 (0.053)	0.069 (0.043)	0.039 (0.046)
Approaches to Learning	0.104** (0.036)	0.070 (0.038)	0.051 (0.046)	0.048 (0.048)	0.140** (0.039)	0.098* (0.042)
Externalizing Behaviors	0.258** (0.031)	0.255** (0.033)	0.203** (0.040)	0.222** (0.042)	0.289** (0.034)	0.268** (0.037)
Internalizing Behaviors	-0.013 (0.025)	-0.018 (0.027)	0.018 (0.032)	0.014 (0.033)	-0.022 (0.027)	-0.035 (0.029)
Half-day Kindergarten	0.243** (0.045)	0.263** (0.048)	0.169** (0.058)	0.159** (0.060)	0.317** (0.049)	0.363** (0.053)
Child care arrangements (pre-K)						
Relative	-0.338** (0.095)	-0.514** (0.101)	-1.441** (0.103)	-1.462** (0.109)	0.931** (0.110)	0.731** (0.117)
Center Care	1.074** (0.065)	1.031** (0.069)	0.982** (0.080)	0.983** (0.084)	1.120** (0.068)	1.065** (0.073)
Nonrelative Care	0.388** (0.090)	0.136 (0.094)	-0.871** (0.100)	-0.933** (0.105)	1.533** (0.105)	1.230** (0.110)
Head Start	-0.290* (0.116)	-0.221 (0.125)	-0.338** (0.131)	-0.283* (0.140)	-0.307* (0.121)	-0.224 (0.133)
Baseline child characteristics						
Child Age	-0.015** (0.005)	-0.016** (0.006)	-0.011 (0.007)	-0.012 (0.007)	-0.017** (0.006)	-0.018** (0.007)
Race						
Black	0.237** (0.070)	0.244** (0.078)	-0.038 (0.085)	0.059 (0.093)	0.378** (0.078)	0.373** (0.088)
Hispanic	0.006 (0.072)	0.071 (0.077)	-0.119 (0.088)	-0.048 (0.094)	0.058 (0.079)	0.106 (0.086)
Asian	-0.281* (0.113)	-0.165 (0.123)	-0.426** (0.144)	-0.424** (0.153)	-0.222 (0.122)	-0.044 (0.136)
Female	-0.023 (0.046)	-0.024 (0.049)	-0.121* (0.058)	-0.130* (0.061)	0.002 (0.050)	0.005 (0.054)
SES	0.314** (0.027)	0.247** (0.032)	0.306** (0.036)	0.200** (0.042)	0.347** (0.030)	0.295** (0.035)
Number of siblings	-0.392** (0.025)	-0.348** (0.029)	-0.177** (0.030)	-0.169** (0.035)	-0.481** (0.027)	-0.445** (0.032)
Single Parent	0.580** (0.057)	0.608** (0.063)	0.003 (0.066)	0.091 (0.073)	1.034** (0.066)	1.048** (0.074)
Mother's age at first birth		0.002 (0.007)		0.012 (0.009)		-0.004 (0.008)
Mother's age at child's birth		0.014* (0.006)		0.008 (0.008)		0.017* (0.007)
WIC		-0.291** (0.063)		-0.330** (0.076)		-0.275** (0.070)
Number of books in the home		-0.001 (0.000)		0.000 (0.001)		-0.001 (0.000)
Mom work		1.345** (0.077)		0.315** (0.100)		1.589** (0.079)
Child's health		0.054 (0.030)		0.036 (0.038)		0.074* (0.034)
Child part of multiple birth		0.305* (0.153)		0.455* (0.195)		0.330* (0.168)
Four or more moves pre-school		0.236** (0.071)		0.304** (0.088)		0.188* (0.080)

Standard errors in parentheses

* significant at 5%; ** significant at 1%

Table 4. Mean Propensity Scores and Strata Distribution by Treatment Status, Comparison, and Model Type

	Model 1		Model 2		Model 1		Model 2		Model 1		Model 2	
	T	C	T	C	T	C	T	C	T	C	T	C
Mean propensity score	0.31	0.18	0.30	0.18	0.56	0.31	0.57	0.31	0.42	0.24	0.45	0.23
Std. Dev.	0.15	0.13	0.14	0.12	0.21	0.22	0.21	0.22	0.19	0.17	0.20	0.18
Strata	T	C	T	C	T	C	T	C	T	C	T	C
1	56	1,222	52	1,412	44	523	40	519	35	691	19	684
2	90	1,194	157	1,842	82	584	177	972	80	956	36	521
3	121	1,104	200	1,489	119	494	269	694	123	879	59	936
4	229	1,768	287	1,354	257	745	191	403	143	740	96	753
5	284	1,396	150	648	228	448	162	228	434	1,415	121	640
6	340	1,286	178	601	75	115	347	249	288	607	312	972
7	175	554	396	1,022	93	92	600	331	334	449	444	821
8	201	445	356	735	355	271	664	208	263	355	282	400
9	639	1,194	309	475	707	402	254	49	244	249	261	265
10	436	472	405	436	728	220	-	-	422	345	226	195
11	221	156	168	128	207	46	-	-	429	210	215	137
12	103	69	46	27	-	-	-	-	100	24	310	165
13	-	-	-	-	-	-	-	-	-	-	197	83
14	-	-	-	-	-	-	-	-	-	-	126	44
Total	2,895	10,860	2,704	10,169	2,895	3,940	2,704	3,653	2,895	6,920	2,704	6,616

Notes. Model 1 controls for fall of kindergarten reading, math, and general knowledge tests, teacher reports of socioemotional and behavioral skills, pre-kindergarten child care, half-day kindergarten, child race, age, gender, SES, single parent household, and number of siblings. Model 2 adds mother's age at first birth, mother's age at child's birth, ever received WIC, mother worked between birth and kindergarten, number of books in the home, child health, child part of multiple birth, and four or more moves prior to kindergarten entry to model 1 variables.

Table 5. Regression and Matching Estimators for Comparison 1: Center Child Care Versus Home-Based and No Child Care Using Full Range of Propensity Scores

Outcome	Nearest Neighbor			Kernel			Stratification			Weighted Regression		
	Estimate	SE	CI	Estimate	SE	CI	Estimate	SE	CI	Estimate	SE	CI
Reading Test	-0.018	(0.036)		-0.015	(0.023)		-0.042	(0.025)		0.018	(0.020)	
Math Test	0.046	(0.028)		0.03	(0.023)		0.013	(0.024)		0.036	(0.020)	
Self Control	-0.059	(0.035)		-0.100***	(0.023)		-0.060*	(0.024)		-0.106***	(0.024)	
Interpersonal Skills	-0.020	(0.034)		-0.070**	(0.022)		-0.038	(0.023)		-0.087***	(0.024)	
Approaches to Learning	-0.042	(0.032)		-0.063**	(0.021)		-0.050*	(0.023)		-0.059**	(0.022)	
Externalizing Problem Behaviors	0.133***	(0.033)		0.161***	(0.023)		0.117***	(0.023)		0.108***	(0.022)	
Internalizing Problem Behaviors	0.027	(0.037)		0.057*	(0.023)		0.048*	(0.023)		0.019	(0.028)	

Note. Standard errors in parentheses. Treatment group n=2,704 for all the estimates. Comparison group n=10,169 for all estimates except nearest neighbor. Nearest neighbor comparison group n=1,907-1,982. Model includes fall of kindergarten reading, math, and general knowledge tests, teacher reports of socioemotional and behavioral skills, pre-kindergarten child care, half-day kindergarten, child race, age, gender, SES, single parent household, number of siblings, mother's age at first birth, mother's age at child's birth, ever received WIC, mother worked between birth and kindergarten, number of books in the home, child health, child part of multiple birth, child ever attended center care, and four or more moves prior to kindergarten entry. Standard errors for the matching estimates are bootstrapped 500 times. Regression and weighted regression t-scores are estimated with a z-score. Regression and weighted regression coefficients come from classroom fixed effects models. Outcomes are standardized to the full weighted sample.

* p<.05, ** p<.01, *** p<.001

Table 6. Regression and Matching Estimators for Comparison 1: Center Child Care Versus Home-based and No Child Care Using Restricted Range of Propensity Scores

Outcome	Nearest Neighbor	Kernel	Stratification	Weighted Regression	Regression
Reading Test	-0.092 (0.070)	-0.081 (0.048)	-0.095* (0.046)	-0.055 (0.046)	-0.057 (0.038)
Math Test	0.025 (0.056)	0.020 (0.044)	0.009 (0.042)	0.028 (0.046)	0.025 (0.037)
Self Control	-0.054 (0.050)	-0.070 (0.042)	-0.025 (0.042)	-0.082 (0.061)	-0.085 (0.047)
Interpersonal Skills	-0.054 (0.052)	-0.070 (0.042)	-0.025 (0.043)	-0.078 (0.059)	-0.073 (0.048)
Approaches to Learning	-0.088 (0.053)	-0.060 (0.039)	-0.040 (0.037)	0.021 (0.051)	0.020 (0.042)
Externalizing Problem Behaviors	0.140* (0.055)	0.159*** (0.045)	0.117** (0.044)	0.072 (0.055)	0.073 (0.048)
Internalizing Problem Behaviors	0.055 (0.075)	0.050 (0.042)	0.031 (0.043)	-0.006 (0.060)	-0.005 (0.051)

Note. Sample includes only cases with propensity scores between .33 and .67. Standard errors in parentheses. Treatment group n=1,059 for all the estimates. Comparison group n=1,317 for all estimates except nearest neighbor. Nearest neighbor comparison group n=612-641. Model includes fall of kindergarten reading, math, and general knowledge tests, teacher reports of socioemotional and behavioral skills, pre-kindergarten child care, half-day kindergarten, child race, age, gender, SES, single parent household, number of siblings, mother's age at first birth, mother's age at child's birth, ever received WIC, mother worked between birth and kindergarten, number of books in the home, child health, child part of multiple birth, child ever attended center care, and four or more moves prior to kindergarten entry. Standard errors for the matching estimates are bootstrapped 500 times. Regression and weighted regression t-scores are estimated with a z-score. Regression and weighted regression coefficients come from classroom fixed effects models. Outcomes are standardized to the full weighted sample.

* p<.05, ** p<.01, *** p<.001

Table 7. Regression and Matching Estimators for Comparison 2: Center Child Care Versus Home-based Care Using Full Range of Propensity Scores

Outcome	Kernel			Stratification			Weighted		
	Nearest Neighbor	Kernel	Regression	Nearest Neighbor	Kernel	Regression	Nearest Neighbor	Kernel	Regression
Reading Test	-0.048 (0.041)	0.002 (0.031)	-0.044 (0.034)	-0.013 (0.025)					-0.015 (0.024)
Math Test	0.010 (0.047)	0.046 (0.029)	0.017 (0.031)	0.035 (0.026)					0.037 (0.025)
Self Control	-0.112** (0.037)	-0.110*** (0.033)	-0.097** (0.034)	-0.101** (0.033)					-0.095** (0.032)
Interpersonal Skills	-0.079 (0.042)	-0.099** (0.032)	-0.087** (0.032)	-0.078* (0.034)					-0.066* (0.032)
Approaches to Learning	-0.072 (0.043)	-0.066* (0.030)	-0.066* (0.032)	-0.062* (0.031)					-0.057* (0.029)
Externalizing Problem Behaviors	0.152** (0.048)	0.172*** (0.034)	0.153*** (0.034)	0.134*** (0.032)					0.134*** (0.031)
Internalizing Problem Behaviors	0.119** (0.046)	0.091** (0.031)	0.085* (0.033)	0.026 (0.036)					0.034 (0.036)

Note. Standard errors in parentheses. Treatment group n=2,704 for all the estimates. Comparison group n=3,653 for all estimates except nearest neighbor. Nearest neighbor comparison group n=1,212-1,260. Model includes fall of kindergarten reading, math, and general knowledge tests, teacher reports of socioemotional and behavioral skills, pre-kindergarten child care, half-day kindergarten, child race, age, gender, SES, single parent household, number of siblings, mother's age at first birth, mother's age at child's birth, ever received WIC, mother worked between birth and kindergarten, number of books in the home, child health, child part of multiple birth, child ever attended center care, and four or more moves prior to kindergarten entry. Standard errors for the matching estimates are bootstrapped 500 times. Regression and weighted regression t-scores are estimated with a z-score. Regression and weighted regression coefficients come from classroom fixed effects models. Outcomes are standardized to the full weighted sample.

* p<.05, ** p<.01, *** p<.001

Table 8. Regression and Matching Estimators for Comparison 2: Center Child Care Versus Home-based Care Using Restricted Range of Propensity Scores

Outcome	Nearest Neighbor		Kernel	Stratification	Weighted Regression	
	Nearest Neighbor	Kernel			Stratification	Regression
Reading Test	-0.028 (0.054)	0.003 (0.045)	-0.007 (0.046)	0.023 (0.059)	0.041 (0.046)	
Math Test	0.027 (0.051)	0.064 (0.043)	0.055 (0.044)	0.067 (0.057)	0.049 (0.045)	
Self Control	-0.107* (0.053)	-0.034 (0.044)	-0.030 (0.044)	-0.110 (0.079)	-0.105 (0.057)	
Interpersonal Skills	-0.059 (0.052)	-0.021 (0.046)	-0.024 (0.047)	-0.022 (0.079)	-0.015 (0.057)	
Approaches to Learning	-0.086 (0.059)	-0.009 (0.045)	-0.008 (0.045)	-0.028 (0.067)	-0.030 (0.051)	
Externalizing Problem Behavior	0.104 (0.065)	0.061 (0.044)	0.063 (0.045)	0.029 (0.081)	0.012 (0.056)	
Internalizing Problem Behavior:	0.170** (0.056)	0.091** (0.031)	0.117* (0.048)	0.031 (0.086)	0.022 (0.068)	

Note. Sample includes only cases with propensity scores between .33 and .67. Standard errors in parentheses. Treatment group n=1,044 for all the estimates. Comparison group n=978 for all estimates except nearest neighbor. Nearest neighbor comparison group n=520=539. Model includes fall of kindergarten reading, math, and general knowledge tests, teacher reports of socioemotional and behavioral skills, pre-kindergarten child care, half-day kindergarten, child race, age, gender, SES, single parent household, number of siblings, mother's age at first birth, mother's age at child's birth, ever received WIC, mother worked between birth and kindergarten, number of books in the home, child health, child part of multiple birth, child ever attended center care, and four or more moves prior to kindergarten entry. Standard errors for the matching estimates are bootstrapped 500 times. Regression and weighted regression t-scores are estimated with a z-score. Regression and weighted regression coefficients come from classroom fixed effects models. Outcomes are standardized to the full weighted sample.

* p<.05, ** p<.01, *** p<.001

Table 9. Regression and Matching Estimators for Comparison 3: Center Child Care Versus No Child Care Using Full Range of Propensity Scores

Outcome	Nearest Neighbor	Kernel	Stratification	Weighted	
				Regression	Regression
Reading Test	0.001 (0.039)	-0.026 (0.027)	-0.037 (0.030)	0.021 (0.029)	0.007 (0.021)
Math Test	0.027 (0.040)	-0.002 (0.027)	-0.002 (0.027)	0.047 (0.027)	0.044* (0.021)
Self Control	-0.019 (0.037)	-0.045 (0.028)	-0.026 (0.029)	-0.065 (0.036)	-0.086*** (0.029)
Interpersonal Skills	-0.002 (0.035)	-0.040 (0.029)	-0.013 (0.029)	-0.051 (0.033)	-0.083** (0.027)
Approaches to Learning	-0.005 (0.037)	-0.037 (0.027)	-0.033 (0.026)	-0.040 (0.031)	-0.083** (0.027)
Externalizing Problem Behaviors	0.077* (0.034)	0.094*** (0.028)	0.097** (0.030)	0.053 (0.029)	0.086*** (0.025)
Internalizing Problem Behaviors	0.018 (0.029)	0.057* (0.029)	0.015 (0.029)	-0.031 (0.043)	0.002 (0.032)

Note. Standard errors in parentheses. Treatment group n=2,704 for all the estimates. Comparison group n=6,386 for all estimates except nearest neighbor. Nearest neighbor comparison group n=1,484-1,537. Model includes fall of kindergarten reading, math, and general knowledge tests, teacher reports of socioemotional and behavioral skills, pre-kindergarten child care, half-day kindergarten, child race, age, gender, SES, single parent household, number of siblings, mother's age at first birth, mother's age at child's birth, ever received WIC, mother worked between birth and kindergarten, number of books in the home, child health, child part of multiple birth, child ever attended center care, and four or more moves prior to kindergarten entry. Standard errors for the matching estimates are bootstrapped 500 times. Regression and weighted regression t-scores are estimated with a z-score. Regression and weighted regression coefficients come from classroom fixed effects models. Outcomes are standardized to the full weighted sample.

* p<.05, ** p<.01, *** p<.001

Table 10. Regression and Matching Estimators for Comparison 3: Center Child Care Versus No Child Care Using Restricted Range of Propensity Scores

Outcome	Nearest Neighbor	Kernel	Stratification	Weighted	
				Regression	Regression
Reading Test	0.006 (0.049)	-0.035 (0.037)	-0.043 (0.039)	-0.013 (0.046)	-0.010 (0.038)
Math Test	0.047 (0.051)	-0.002 (0.035)	-0.001 (0.037)	0.041 (0.049)	0.043 (0.040)
Self Control	-0.059 (0.049)	-0.063 (0.036)	-0.036 (0.038)	-0.010 (0.056)	-0.098* (0.048)
Interpersonal Skills	-0.013 (0.054)	-0.060 (0.038)	-0.042 (0.039)	-0.098 (0.061)	-0.098* (0.047)
Approaches to Learning	-0.006 (0.055)	-0.064 (0.034)	-0.049 (0.035)	-0.020 (0.053)	-0.025 (0.043)
Externalizing Problem Behaviors	0.093 (0.049)	0.131*** (0.038)	0.105** (0.039)	0.121* (0.051)	0.124** (0.045)
Internalizing Problem Behaviors	0.033 (0.048)	0.022 (0.038)	0.012 (0.039)	0.026 (0.062)	0.029 (0.053)

Note. Sample includes only cases with propensity scores between .33 and .67. Standard errors in parentheses. Treatment group n=2,704 for all the estimates. Comparison group n=1,606 for all estimates except nearest neighbor. Nearest neighbor comparison group n=776-806. Model includes fall of kindergarten reading, math, and general knowledge tests, teacher reports of socioemotional and behavioral skills, pre-kindergarten child care, half-day kindergarten, child race, age, gender, SES, single parent household, number of siblings, mother's age at first birth, mother's age at child's birth, ever received WIC, mother worked between birth and kindergarten, number of books in the home, child health, child part of multiple birth, child ever attended center care, and four or more moves prior to kindergarten entry. Standard errors for the matching estimates are bootstrapped 500 times. Regression and weighted regression t-scores are estimated with a z-score. Regression and weighted regression coefficients come from classroom fixed effects models. Outcomes are standardized to the full weighted sample.

* p<.05, ** p<.01, *** p<.001