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Direct and Indirect Impacts of Voluntary Pre-Kindergarten on Kindergarten Readiness and Achievement

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Abstract

Early Childhood Education (ECE) programs provide skills needed for successful kindergarten strides, especially for students from low socioeconomic backgrounds. While Florida's Voluntary Pre-Kindergarten (VPK) program currently serves most four-year-olds, some educators have questioned the program's quality. The purpose of this study was to investigate the direct and indirect effects of Florida's VPK program on kindergarten readiness and academic achievement for students attending the program in one county's VPK (CVPK) when compared to students who did not attend approved VPK programs in this county. The results suggest that, regardless of socioeconomic status, children who attended CVPK programs were just as prepared and performed equally as well in kindergarten as those who did not attend this program. Unfortunately, we cannot know how the CVPK program compared to specific pre-K alternatives without being able to distinguish program attendance across provider types (i.e., other ECE or no pre-K), which is something we recommend Florida begin tracking and make accessible.

Keywords Early childhood education · Voluntary pre-kindergarten · Universal pre-kindergarten · Kindergarten readiness · Kindergarten achievement · Program efficacy

Kindergarten is the bridge between preschool learning experiences and more formal education, despite being part of the K-12 structure of public education in the United States (US). It has traditionally been considered a special transition period between the primarily social-emotional domains of early childhood education (ECE), including prekindergarten (pre-K), and the more rigorous academics of elementary school, with most US states beginning compulsory attendance in first grade (National Center for Education Statistics, 2017). Researchers have explored both what children need to know and do to be considered ready for school, as well as the ways in which kindergarten success is strongly predictive of success in later grades; areas which are increasingly measured by assessment data points. The Obama administration pushed for more comprehensive pre-kindergarten through third grade (pre-K-3) programs to expand children's access to high-quality ECE. As a result, many states developed pre-K programs to better prepare children for kindergarten and compulsory education. As of 2020, only eight states enrolled 50% or more of their four-year-olds in a preschool program (Friedman-Krauss et al., 2021), and while as of 2018 only 17 states plus the District of Columbia require kindergarten attendance, and of those, only 13 require full-day kindergarten (Diffey, 2020), supporting pre-K is still an important endeavor. Inconsistencies, like these, across the nation for children in both access to high-quality pre-K-3 education as well as poverty-related risk factors contribute to equity issues and a predictable and persistent achievement gap among American students.

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Using extant data from one large Florida school district, this research explored the effects of Florida's Voluntary Pre-Kindergarten (VPK) program for four-year-olds on kindergarten readiness and academic achievement, as well as the extent to which poverty may moderate these effects. In the following sections, this paper addresses the effects of preschool on later grades and outlines the demands and challenges of modern kindergarten curriculum expectations, including assessments, to understand how pre-K affects children's school readiness and academic achievement.

Literature Review

Effects of Preschool on K-12 Education

The lack of kindergarten readiness is understood to have far-reaching consequences on student achievement, adult earning potential (Chetty et al., 2011), later academic success (Davoudzadeh et al., 2015), and other outcomes (e.g., Claessens & Engel, 2013; Curran & Kitchin, 2019). Additional research (e.g., Cates et al., 2016; Dietrichson et al., 2018; Gray-Lobe et al., 2021) makes a strong case that quality preschools mitigate the effects of risk factors children face. Today's kindergartens are experiencing changing demands and expectations due to the accountability shovedown (Hatch, 2002) of standards-driven instruction and assessment and the implementation of Common Core State Standards (CCSS; National Governors Association, 2010). To prepare young children for K-12 curriculum, educators must create a better partnership and balance between institutional ECE levels and developing socio-emotional and academic competencies (Hatch, 2002; NAEYC, 2005; 2009; West et al., 2000; West et al., 2001; Zill & West, 2001).

Impacts of Quality Preschool

Quality preschool interactions and environments can benefit all children when the adult/child relationships are supportive, when the curriculum is effective and developmentally appropriate, and when teachers and assistants are well-trained in child-development, responding to unique student needs and promoting children's development (NAEYC, 2005; Pianta et al., 2009; Yoshikawa et al., 2013). Academic and socio-emotional benefits are multiplied when preschool services extend into a second year and when carefully chosen and implemented across-the-board services, such as comprehensive screenings, vaccinations, medical and dental care opportunities, and parenting resources, are added to the preschool environment (Yoshikawa et al., 2013). Quality preschool contributes dramatically to improved language, literacy, and mathematics competencies as well as improved responses to learning in kindergarten and early elementary grades (Pianta et al., 2009; Yoshikawa et al., 2013). Even when the academic scores of children, who both have and have not attended preschool, ultimately begin to converge in later elementary school (also known as effect fadeout), other benefits of preschool attendance on children's cognitive and social development (e.g., increased educational attainment, higher earnings) persist even into adulthood (Pianta et al., 2009; Yoshikawa et al., 2013).

Measures of Quality Preschool

Many of the programs children are attending are subpar when it comes to quality (Barnett & Belfield, 2006; Friedman-Krauss et al, 2021; Yoshikawa et al., 2013), so the potential benefits from preschool attendance are diminished. Characteristics of quality preschools include small class sizes (or adult-to-child ratios), highly qualified and well-trained teachers, and developmentally appropriate curriculum and instruction (Barnett & Belfield, 2006; Friedman-Krauss et al, 2021; National Association for the Education of Young Children, 2005; Pianta et al., 2009; Yoshikawa et al., 2013). The goal of providing more high-quality preschool programs can be in opposition to the goal of providing universal or near-universal access to preschool (Bassok et al., 2014). In an effort to define high-quality programs, the National Institute for Early Education Research (NIEER) established benchmarks for a high-quality preschool program. The current benchmarks have been in place since 2016 and focus more on policies that directly align to how programs support continuous improvement of classroom quality. The NIEER Benchmarks for High-Quality Pre-K include: having early learning and development standards; teachers hold bachelor's degrees; teachers receive specialized training in pre-K; assistant teachers hold a child development associate credential or equivalent; staff receive professional development and/or coaching; class sizes are at or under 20 students; the adult-to-child ratio is 1:10 or better; students receive vision, hearing, and health screenings and referrals; there are curriculum supports; and there is a continuous quality improvement system in place (Friedman-Krauss et al., 2018, 2019, 2020, 2021).

Components of Quality Preschool Curricula

Much research has been done to determine the elements that comprise high-quality, evidence-based preschool/pre-K curricula. Authors from the Society of Research on Child Development and the Foundation for Child Development co-authored a policy brief advocating domain-specific, play-based approaches that provide children with "intensive exposure to a given content area" to better develop skills under a "more focused scope" (Yoshikawa et al., 2013, p. 7). Their work was grounded in prior research, particularly

the NAEYC (2009) edition of the DAP framework emphasizing that children learn in predictable sequences which should drive both instructional and assessment practices and developmental learning goals (Weiland et al., 2018). This framework has been referred to as the "strongest hope model" (e.g., Weiland et al., 2018; Yoshikawa et al., 2013), but Weiland and her colleagues report few preschool programs nationally use this DAP, discipline-focused theoretical framework to inform their work.

Instead, the most popular curricula claim to be whole-child focused yet tend to lack a deliberate scope and sequence or concentrated focus within specific domains (Jenkins & Duncan, 2017; Weiland et al., 2018). Readers are encouraged to read Weiland et al.'s comparative review for more detail but might be surprised to discover many pervasive and popular curricula do not score well (e.g., Creative Curriculum's math). Others, such as Boston Universal Pre-K program, score well for domain-specific content knowledge and skill development. The successes any programs have generated, however, are predicated on consistent, high-quality professional development to support teacher application, an area where Florida has consistently fallen short (Friedman-Krauss et al., 2018, 2019, 2020, 2021).

Florida's Voluntary Pre-Kindergarten.

While many states require students to meet established income thresholds for pre-K entry as research suggests that high-quality ECE mitigates the academic risks for children living in or near poverty, Florida has focused instead on universal access. The goal of universal enrollment comes at a cost with competing goals, demands, and challenges. Florida has prioritized VPK access to four-year-olds; VPK does not include three-year-olds, whereas, other state programs do. Florida is criticized for spending less than the national average per child, and is ranked 42nd in state spending and 43rd in all reported spending with consistent annual decreases in per pupil expenditures (Friedman-Krauss et al., 2021). The Florida Department of Education (FLDOE) Office of Early Learning (OEL; n.d.) was awarded an $8.52 M Preschool Development Grant Birth through Five (PDG B-5; Office of Child Care, 2019) award to "increase the quality, coordination, alignment and efficiency of the state's program and services to support families' needs and children's readiness and early grade success, particularly for vulnerable and underserved children" (Friedman-Krauss et al, 2019, p. 68).

Despite serving 72% of Florida's four-year-olds (4th for states serving the largest numbers of children in state-funded preschool) including more than half of Florida's children living in or near poverty, Florida's VPK program meets only two of ten NIEER Benchmark Standards, a performance rating which has been consistent over recent years (Friedman-Krauss et al., 2018, 2019, 2020, 2021). The VPK program has early learning and development standards, and class sizes are kept to 20 students or fewer, but standards addressing curriculum supports, teacher development and quality, teacher support, class size and ratios, and continuous quality improvement systems are not met. Beginning in 2016–17, changes in state policy allow parents to defer enrollment for children with birthdays between February 1 and September 2, so five-year-olds are now eligible (OEL, n.d.). In 2018–19, VPK served 173,633 children which is an increase of almost 4000 students from 2017–18 (Friedman-Krauss et al., 2020), but the COVID-19 pandemic has hit preschools hard across the country, and in 2019–2020, VPK served 166,726 children (Friedman-Krauss et al., 2021).

In spite of these criticisms, Florida's VPK in 2016 was found by the state to improve kindergarten readiness in several areas (OEL, 2016). In the 2015–16 school year (the academic year of this study's cohort), 131,906 children participated in the Florida VPK Assessment at both pre- and post-test administrations with a slight improvement in academic performance over the two previous years. Before the program, students' performances were typically below or just met expectations; after the program, students both met and exceeded expectations (OEL, 2016). While these results may be promising, the reported gains are ambiguous and do not provide sufficient, consistent evidence of kindergarten readiness.

The Demands and Expectations of Modern Kindergarten

As the first year of formal and comprehensive schooling for most US children, kindergarten is often a time of tremendous growth and change for children across multiple domains (West et al., 2001). In kindergarten, children have historically learned new academic content, which has been more the purview of formal, structured education, as well as socio-emotional behaviors through developmentally appropriate strategies, which has been more the purview of pre-K and other ECE experiences (NAEYC, 2005; 2009). Ideally, kindergarten must incorporate both the knowledge and skills children learn as part of their early education to form the foundation for later academic achievement (Rathbun & West, 2004). Our conception, however, of the knowledge and skills children must possess to be considered ready for formal schooling and successful completion of kindergarten has changed over the past thirty years. As recently as the 1990s, families and educators generally placed a high value on children's ability to communicate wants and needs as well as their ability to be curious (West et al., 1993). As we will discuss below, kindergarten teachers now report shifting priorities that are far more academic than socio-emotional (Bassok et al., 2016; Brown & Lan, 2015).

Kindergarten Readiness

Assessing a child's readiness for success in kindergarten comprises establishing a baseline of the knowledge and skills they bring to school upon kindergarten entry, including anything they may have learned in ECE settings. The resulting assessment data not only inform educators and policymakers regarding the effectiveness of children's experiences before kindergarten, but also should inform the kindergarten curriculum and instruction necessary both to meet children where they are and to help them meet specific standards of learning. Additionally, having baseline readiness data enables identification of learning or achievement gaps that may occur (Zill & West, 2001). However, identifying readiness can be difficult, both in the definition of the construct of readiness and in its evaluation with young children requiring one-on-one evaluation. Furthermore, best practice indicates young children be assessed not only on cognitive or academic domains but also on socio-emotional development, physical well-being, gross-motor development, language use, and approaches to learning and school (Friedman-Krauss et al, 2018, 2019, 2020, 2021; Zill & West, 2001).

Kindergarten is not immune to today's proliferation of assessment data points, both upon entry and throughout the kindergarten experience, intended to measure and predict student learning outcomes. Any assessment of academic readiness skills and knowledge must include representations of foundational literacy skills (National Early Literacy Panel, 2008) and numeracy and math skills (Zill & West, 2001). In order to acquire these skills, however, children must possess the essential foundational social-emotional and cognitive building blocks for readiness. Many children develop these skills in pre-K and other ECE programs, and research suggests that mastery of these foundational skills prior to kindergarten leads to increased chances that children will learn to read, write, and calculate sooner and more successfully (Zill & West, 2001).

Early school readiness is highly predictive of later school success, even when controlling for other variables such as parental education and family structure, and children in poverty often lack sufficient preschool ability (Davoudzadeh et al., 2015; Duncan et al., 1998; Gullo, 2017; Wolf et al., 2017). Being ready to learn upon entry to kindergarten is not solely an academic matter, such as having number sense, being able to count with one-to-one correspondence to 20, being able to name letters, and having some letter-sound awareness (Blair & Raver, 2015; Engle & Black, 2008; Huang & Invernizzi, 2012). Instead, a mix of academic readiness with social-emotional and self-regulatory readiness is essential.

Kindergarten Academic Achievement

Teachers now report significant increased academic expectations of children at kindergarten entry than they did thirty years ago. Children are expected to be able to read by the end of kindergarten, less time is spent on music and art lessons, children have fewer opportunities for discovery or play, and students increasingly use math and reading workbooks daily (Bassok et al., 2016). Attending kindergarten is especially important given how foundational literacy and mathematics skill-building and social-emotional competencies are critical for later school success, and the impact of kindergarten is amplified when children experience a high-quality preschool environment prior to kindergarten entry.

Kindergarten achievement serves as a predictor for elementary education outcomes and beyond (Claessens & Engel, 2013; Curran & Kitchin, 2019; Rathbun & West, 2004; Sharkins et al., 2016; West et al., 2001; Zill & West, 2001). School districts use a variety of measures to determine kindergarten students' academic outcomes based on predetermined benchmarks of success, but no consensus across states, agencies, or policymakers exists on what these assessments should include or how they should be administered. Presuming the assessments are aligned to state and local standards, an analysis of these standards can illuminate what kindergarten children should know and be able to do by the end of this first school year. Commonly, however, assessments of kindergarten achievement include measures of the following skills: foundational literacy, early math, and often science and social studies concepts and social-emotional skills (National Governors Association, 2010; NGSS Lead States, 2013). Assessments range from observational and performance-based to standardized and computer-administered, increasingly administered regularly throughout the school year mirroring the assessment schedules of other elementary grades.

Purpose

Although VPK is available to all four- and five-year-old children in Florida who have not entered kindergarten, the existing literature suggests VPK is especially critical for children in poverty. Poverty can negatively impact children's ability to learn, social and emotional development, and physical and emotional health (National Center for Children in Poverty Child Poverty, 2017; Raver et al., 2012). Children living in poverty frequently enter kindergarten lacking critical cognitive, academic, and social-emotional skills, and this gap predictably widens throughout K-12. While other publicly-funded preschool programs that serve economically disadvantaged children exist, such as Head Start, many low-income and children living in poverty attend VPK.

The 2015–2019 American Community Survey data (National Center for Children in Poverty, 2022) tells us that 10% of Florida's 1.3 million children under 6 years old live in deep poverty (< 50% of the federal poverty threshold or FPT), 22% live in poverty (< 100% FPT), and 48% live in low-income families (< 200% FPT). The numbers of Florida children under 5 years of age experiencing poverty households have declined since 2015, the year the children in this study were eligible to attend VPK, from 337,000 (26%) to 260,000 (20%), but this still comprises a sizable portion of the birth to five population in Florida (KIDS COUNT, 2020). Florida does not report VPK student demographic data, but the Florida Early Learning Coalition runs the School Readiness Program meant to support children birth to 6 years old from low-income families to help them be ready for school (Division of Early Learning, 2021). The number of Florida children enrolled in School Readiness in 2015–16 was 123,661 (22%), and the number of children enrolled in the county highlighted in this study was 1732 (21%). This is the closest estimate of the percentage of the total 169,025 4-year-olds enrolled in VPK in 2015–16 living in low-income households that we were able to generate. This educated guess (~20%), however, closely mirrors the state statistics.

Given that a presumably large number of low-income children attend Florida's VPK, examining the impacts of VPK are important to discern whether this program benefits *all* students, both before and after kindergarten. While a reasonable presumption is that any instruction focusing on developmental skills will, in fact, improve children's lives, it is not always clear *how* effective these interventions are. Unfortunately, many of the VPK programs that enroll Florida's children are ranked subpar when it comes to quality (Friedman-Krauss et al, 2018, 2019, 2020, 2021), so potential benefits from preschool attendance are likely diminished. For example, three providers had their school readiness program revoked for various violations in the county studied during the 2015–2016 academic year, when our participants were attending VPK.

Like any preschool educational program, Florida's VPK program is intended to ensure that children will be prepared for kindergarten. That is, children will have the necessary cognitive, social, emotional, and technical skills to comprehend and process what they will be taught in kindergarten. Despite criticism for being poorly funded and regulated, (Bassok et al, 2014; Friedman-Krauss et al., 2018, 2019, 2020, 2021), VPK is purported to improve kindergarten readiness (Office of Early Learning, 2016), and currently serves 72% of eligible students (Friedman-Krauss et al, 2021). It is not clear how well these Florida-reported VPK assessment results may generalize to other measures of kindergarten readiness (e.g., the national Healthy and Ready to Learn outcomes (Child Trends, 2020) or state-based assessments like the Florida Kindergarten Readiness Screener (Florida Department of Education, 2014), Georgia Kindergarten Inventory of Developing Skills (Georgia Department of Education, 2021), or Maryland's Ready for Kindergarten (Maryland Department of Education, 2021), or if these effects are consistent across socioeconomic status.

The ability to substantiate the claim that VPK improves kindergarten readiness, however, is dubious at best and warrants further scrutiny. Families can choose to send students to VPK at one of over 6,000 public, private, or charter school locations throughout the state. During 2015–2016, students could attend VPK with one of over 200 approved providers in the focus county alone. Statewide disaggregated VPK data on student demographic characteristics, student VPK location selection, and kindergarten readiness are not available to analyze the types of students enrolled in the program, student performance by location, whether children changed locations, or any potentially differential effects of the program for different groups of students. In an effort to approximate this level of understanding, we therefore sampled students from one Florida county-based school district to explore possible impacts and challenges present with VPK. This study addressed the following research questions:

1. After controlling for self-selection into the program, are students who attend a VPK program more prepared to attend kindergarten than those who do not?
2. Is there an indirect effect of Florida's VPK program for students on kindergarten achievement in English language arts (ELA) and mathematics when mediated by kindergarten readiness?
3. Does socioeconomic status moderate the effects that VPK has on either kindergarten readiness or kindergarten achievement in English language arts (ELA) and mathematics?

Methods

Participants

According to the state, Florida's VPK curriculum aligns to both the *Florida Early Learning and Developmental Standards: 4 Years Old to Kindergarten* and expectations for kindergarten readiness (Division of Early Learning, Florida Department of Education, 2022), but the reader is encouraged to visit the state's crosswalk to kindergarten for more detailed information (Division of Early

Learning, Florida Department of Education, 2017). During the 2015–2016 academic year, participating students residing in the focus county attended VPK at licensed private centers ($n = 118$), license-exempt centers ($n = 5$), private schools ($n = 3$), and public schools ($n = 38$).[1] Although the evidence of state-approved VPK curriculum options for 2015–2016 were not available, the current curricular options can be found at Florida's Division of Early Learning (2022); however, many do not align with the previously described "strongest hope model."

The available participants for this study included 4955 students who attended kindergarten during the 2016–2017 academic year in a single county-based school district in Central Florida. Of these, only 4345 had no missing data for the covariates or kindergarten readiness. Students ($N = 1138$) who attended a state-funded, county-based VPK program (CVPK) with an approved provider during the 2015–2016 academic year comprised the treatment group. Students who did not attend any approved VPK program made up the comparison group. VPK participation status was informed by parent report at kindergarten registration, so it is conceivable some students in the comparison group did attend an approved VPK program, but the parents did not report it. The data does include, however, students from a mix of district public school-based programs, charter school-based providers, and private providers.

Since VPK is voluntary and parents choose what ECE type their children receive, be it VPK or otherwise, children attending CVPK may be characteristically different from those who opt out of this program. Therefore, propensity score matching (Rosenbaum & Rubin, 1983) was used to balance several demographic characteristics of the scores between the two educational conditions. While this improved the validity of our results, it reduced the sample size to 1984.

Data Source

All data for this study were provided by the school district where the students attended kindergarten during the 2016–2017 academic year. The propensity scores were estimated from demographic data, which included socioeconomic status (SES), measured by whether or not a student is eligible for a free or reduced-price lunch, race, ethnicity, gender, age at kindergarten entry, exceptional student education status, and English Language Learner status.

[1] The information in this and the subsequent paragraph comes from documentation from the Early Learning Coalition for the district. To maintain confidentiality, they will not be cited here, but the references are available upon reasonable request.

Kindergarten readiness was measured using the Florida Kindergarten Readiness Screener Work Sampling System (FLKRS-WSS), which consists of 47 performance indicators that measure five domains found to be indicators of school readiness (Pearson & Florida Department of Education [FLDOE], 2014). The test is a behavioral checklist administered within the first 30 days of kindergarten attendance by teachers who observe students' behavior in either group or individual activities. The performance indicators include "whether students can recognize and describe the attributes of shapes, use senses and simple tools to explore solutions to problems, and show beginning control of writing tools" (FLDOE, 2014, p. 15). The domains include *Personal and Social Development*; *Language and Literacy*; *Mathematical Thinking*; *Scientific Thinking*; and *Physical Development, Health, and Safety*. The domains and performance indicators in the FLKRS-WSS were created based on the indicators for school readiness outlined in *Findings from the National School Readiness Indicators Initiative – A 17 State Partnership* (Pearson Florida Department of Education, 2014) and "align with Florida's Early Learning and Developmental Standards for Four-Year-Olds" (Florida Department of Education, 2014, p. 41). While not specific to the FLKRS-WSS, Meisels et al., (1995, 2001) found that their Work Sampling System, which Pearson customizes to align with state standards, demonstrated good concurrent and predictive validity when compared to the *Woodcock-Johnson Psychoeducational Battery-Revised* (Woodcock & Johnson, 1990) and *Child Behavior Rating Scale* (Bronson et al., 1990). While test scores are given for each domain, we only used the total score as a measure of kindergarten readiness in this study. For students who were assessed on all 47 performance indicators, their total score could range from 47 to 141 (47–81 Not Yet, 82–128 In Process, and 129–141 Proficient; Pearson & FLDOE, 2014). However, some students' WSS score may be based on fewer indicators.

The Iowa Assessments Form E Level 5/6 (IA-5/6) standardized scores were used to measure academic achievement in English Language Arts (ELA) and mathematics during the year that students attended kindergarten. To administer the test, teachers read questions aloud to individual students who marked answers in machine-scoreable booklets. The Complete Battery of the IA-5/6 consists of 187 items that measure six subtests of academic performance for five-year-old children who are in kindergarten or the first six months of first grade (University of Iowa, 2015). The ELA assessment was a composite of the subtests that measured *Vocabulary, Language,* and *Reading (Parts 1 and 2)*; and the mathematics assessment was based on the *Mathematics* subtest. The University of Iowa (2015) found the IA-5/6 subtests to be reliable and valid. Reliability coefficients from the Kuder-Richardson 20 indicated that both the ELA ($KR20 = 0.882$) and Mathematics ($KR20 = 0.804$) assessments had strong

Table 1 Means, Standard Deviations, and Correlations of Kindergarten Readiness and Academic Achievement

	M	*SD*	1	2
Full Sample				
1. FLKRS-WSS	121.680	20.640		
2. IA-5/6 ELA	138.030	10.542	.286	
3. IA-5/6 Mathematics	138.390	9.655	.324	.629
Matched Sample				
1. FLKRS-WSS	120.850	20.991		
2. IA-5/6 ELA	135.720	10.118	.030	
3. IA-5/6 Mathematics	136.060	9.463	.042	.634

FLKRS-WSS Florida Kindergarten Readiness Screener Work Sampling System, IA-5/6 Iowa Assessments Form E Level 5/6, ELA English Language Arts

internal consistency. Correlations between assessments over time suggested that the *Reading* ($r = 0.860$), *Language* ($r = 0.680$), and *Mathematics* ($r = 0.660$) subtests had strong test–retest reliability. Content validity was determined by creating test items that closely aligned with individual state standards, which were reviewed both internally and externally by educators. The ELA ($r = 0.600$) and Mathematics ($r = 0.560$) tests demonstrated good concurrent validity when compared to the *Cognitive Abilities Test* (Lohman, 2011). Table 1 provides the descriptive statistics for our original and matched samples.

Design and Analyses

Propensity score matching was used to reduce selection bias that may have occurred when parents elected to enroll their children in the CVPK program as opposed to other ECE options. Propensity scores were modeled using logistic regression to predict the probability that students would attend the CVPK program from the demographic characteristics. Matching on the propensity scores was conducted with R's MatchIT through SPSS (Thoemmes, 2012). Students attending a CVPK program were matched to those who did not attend the CVPK using paired (one treatment case to one control case), nearest neighbor matching within a caliper of 0.25*SD* without replacement (Bai & Clark, 2018). Of the original sample, 992 (96%) in the CVPK group were matched to 992 (30%) students in the comparison group. Overall, matching on propensity scores reduced covariate imbalance. Absolute standardized mean differences close to zero indicate small differences between the CVPK and comparison students. All covariates and two-way interactions of covariates had absolute standardized mean differences below 0.25, suggesting relatively good balance in the model. Only the matched cases were used to estimate the treatment effects of the CVPK on students' kindergarten readiness and academic achievement. Table 2 compares group differences in the covariates before and after matching.

Conditional process analyses (models that include both mediators and moderators; Hayes, 2018) were used to examine (a) how the CVPK attendance directly impacted kindergarten readiness, (b) how the CVPK attendance indirectly impacted academic achievement, and (c) if SES moderated these relationships. A set of models were tested for each measure of kindergarten achievement (ELA and mathematics) using the PROCESS macro (Hayes, 2018). In the full models, kindergarten readiness was included as a mediator, and SES was included as a moderator for the effect of CVPK attendance on kindergarten readiness and for the effect of kindergarten readiness on academic achievement (see Fig. 1). Simpler models were tested only if the moderator and/or mediator were not statistically significant.

Table 2 Group differences on covariates before and after matching

	Full Sample			Matched Sample		
	Treatment $n = 1{,}139$	Comparison $n = 3{,}816$	*d*	Treatment $n = 992$	Comparison $n = 992$	*d*
FR Lunch	60.4%	49.4%	0.49	60.3%	58.8%	0.04
Black	24.7%	19.9%	0.11	24.7%	22.7%	0.05
White	73.5%	77.6%	− 0.09	73.5%	76.2%	− 0.06
Hispanic	27.6%	25.6%	0.05	26.9%	29.4%	− 0.06
ESOL	6.5%	5.%6	0.04	6.5%	6.8%	− 0.01
English Native	82.1%	88.9%	− .178	83.3%	82.9%	0.01
English Home	82.3%	86.0%	− 0.10	82.8%	82.3%	0.01
Learning Disability	23.1%	6.2%	0.40	20.3%	19.8%	0.01
Gifted	0.7%	1.5%	− 0.10	0.7%	0.7%	0.00
Pre-K Age	53.93	53.90	0.09	53.61	53.62	0.07

FR Lunch is the percent of students who were eligible to receive a free or reduced-price lunch. ESOL = English for Speakers of Other Languages. English Native is a child who speaks English as their single or primary language. English Home indicates English is the single or primary language spoken in the child's home. Pre-K Age is the age (in months) of the child when he or she began pre-kindergarten

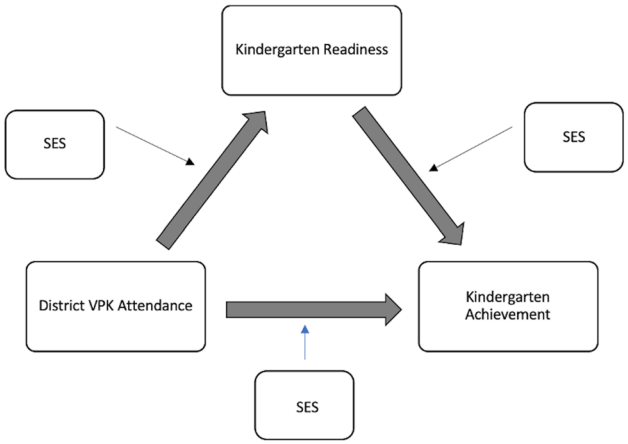

Fig. 1 Mediational model used to test the direct and indirect effects of VPK on kindergarten achievement

Additionally, a bootstrapping approach was used with the mediational analyses, as this tends to provide more robust estimates than the normal theory approach (Preacher & Hayes, 2008).

Results

SES as a Moderator for VPK on Kindergarten Readiness and Achievement

The first conditional process model indicated that there was not a significant interaction either between CVPK and SES on kindergarten readiness ($b = 0.023$; $SE = 0.024$; 95% $CI = -0.024, 0.071$) or between kindergarten readiness and SES on kindergarten achievement in ELA ($b = 0.255$; $SE = 0.752$; 95% $CI = -1.219, 1.730$). The second model indicated that there was not a significant interaction either between CVPK and SES on kindergarten readiness ($b = -0.004$; $SE = 0.023$; 95% $CI = -0.049, 0.040$) or between kindergarten readiness and SES on kindergarten achievement in mathematics ($b = 0.501$; $SE = 0.701$; 95% $CI = -0.874, 1.876$). Therefore, children from low SES backgrounds received the same benefits from the CVPK program and kindergarten readiness as their more affluent peers. While economically disadvantaged students were not necessarily helped more than their more advantaged peers, neither were they more academically compromised after attending CVPK.

Effect of the CVPK on Kindergarten Readiness

Since neither the moderators nor mediators were statistically significant in previous models, our final model looked at the relationships between the CVPK attendance and kindergarten readiness. A simple regression indicated that this CVPK had no impact on kindergarten readiness ($b = 0.794$; $SE = 0.943$; 95% $CI = -1.064, 2.642$). Therefore, these results suggest that children who attended this CVPK program were no more prepared for kindergarten than those who did not. This finding aligns with NIEER's evaluations of Florida's VPK as having had consistently subpar performance relative to meeting the established benchmarks (Friedman-Krauss et al., 2018, 2019, 2020, 2021).

Effects of the CVPK on Kindergarten Achievement

Since SES did not moderate either the effects of this CVPK on kindergarten readiness or the effects of kindergarten readiness on kindergarten achievement, it was removed as a moderator from subsequent models used to test the indirect effect of the CVPK attendance on kindergarten achievement when mediated by kindergarten readiness. These models indicated that kindergarten readiness did not mediate the relationship between the CVPK attendance and kindergarten achievement in either ELA ($ab = 0.007$; $SE = 0.019$; 95% $CI = -0.029, 0.049$) or mathematics ($ab = 0.007$; $SE = 0.022$; 95% $CI = -0.036, 0.055$). Even without including readiness as a mediator, there was not an effect of the CVPK on kindergarten achievement on ELA ($b = 0.206$; $SE = 0.477$; 95% $CI = -0.730, 1.142$) or mathematics ($b = -0.007$; $SE = 0.445$; 95% $CI = -0.879, 0.866$). Therefore, no direct or indirect benefit in attending this CVPK program was found with respect to kindergarten achievement. Once again, this finding seems to align with NIEER reports on the state of Florida's VPK program (Friedman-Krauss et al., 2018, 2019, 2020, 2021).

Discussion

After controlling for self-selection into the program, students who attended VPK were no more prepared to attend kindergarten than those who opted out of this pre-K program. Furthermore, there was not an indirect effect the VPK program on kindergarten achievement in either ELA or mathematics when mediated by kindergarten readiness. Finally, socioeconomic status did not moderate the relationship between being in a VPK program and either kindergarten readiness or kindergarten achievement. These findings contradict those from both the FLDOE OEL's own reporting on the success of VPK as well as previous studies suggesting ECE is a critical mechanism for reducing economically-related student disparities.

Prior literature is rich with claims that quality pre-K and other ECE programs can help children "overcome the constraints of poverty" (Schweinhart et al., 1985, p. 548) and are

critical for academic achievement, future health, and social mobility (Atinc & Gustafsson-Wright, 2018; Hirsh-Pasek et al., 2018; Wise, 2016). Previous research also suggests children from poverty or low-income backgrounds are going to be differentially affected by a pre-K program than their more affluent peers (Duncan & Magnuson, 2013; Ferguson et al., 2007; Lamy, 2016). These findings may also be explained by NIEER's assessments of Florida's VPK program (Friedman-Krauss, et al., 2021). While Florida may be commended for providing four-year olds with universal access to preschool, the program offerings are limited to four-year-olds and regularly fail to meet NIEER quality standards. The determination of VPK's poor quality (Friedman-Krauss et al., 2018, 2019, 2020, 2021) may mitigate any benefits children from financially insecure homes otherwise might have experienced.

Limitations

Perhaps the most obvious limitation in this study was that the control group consisted of any kindergarten student who did not attend a VPK program. This may have included students who could have received another mode of ECE preparation, such as homeschooling, other preschool programs unaffiliated with VPK, or childcare without any formal educational curriculum. The parent-informed data provided by the school district did not make these distinctions. The fact that the district and the state cannot, or do not, provide data tracking individual students from VPK through kindergarten is problematic, making it impossible to verify or disprove the state's claim that VPK prepares children for kindergarten. Without being able to delineate which children attended which programs in comparison to kindergarten readiness and outcomes remains a conundrum.

With these other preschool options confounding the data, comparisons between how VPK compares to attending alternative ECE or attending no educational programs was hampered. When attempting to make substantial claims about the effects of Florida's VPK program as a whole, data on other preschool options are essential. However, discovering this absence of data reveals an important finding for states and school districts charged with researching the effects of VPK on readiness and academic achievement. Given the inconsistencies with data collection and reporting at the district and state levels, government funding seems to assume that students would perform better in a state or private VPK program than without any formal preparation, yet the results from this study add more ambiguity than clarity to the discourse on the value of VPK, and while the data we analyzed is from 2016–2017, data transparency has not improved in Florida since. Based on the existing literature, children who have attended preschool education, be it VPK or some other program, would have greater advantages for kindergarten readiness and achievement than children who did not attend a preschool program, but without the county or state collecting the appropriate data, the differential effects of VPK cannot be determined.

Our sample limits the generalizability of our results based on three other characteristics. First, Florida's VPK program only serves four-year-olds, while other available ECE programs in Florida may accept three-years-olds. This poses two limitations: (a) possible confounding of the types and length of the programs compared in this study, and (b) lack of generalizability to other states' programs. For example, if some students in the either the comparison or treatment groups of this study received instruction for additional years while other students' instruction was limited to one year, the length of the intervention may also have affected the mediator or outcomes. VPK is state-funded for a portion of the day, so it is reasonable to expect many families with limited income would choose VPK over other ECE providers. Unfortunately, without being able to identify the other types of programs or how long students attended these programs, one cannot be sure if the quality or length of a program affects the outcomes. This lack of clarity also impacts the generalizability of our findings to other state programs. While Florida's VPK program only serves four-year olds, other states' preschool programs, such as the California State Preschool Program and Preschool for All in Illinois, provide preschool for three- and four-year olds. Quite possibly, preschool experiences and inherit looping may affect three-year-olds differently than four-year-olds.

Additionally, only students from a single Florida school district were included; therefore, these results may not be generalized to the other 66 Florida districts or other states. While students in this district typically outperform other districts (OEL, 2016), ascertaining if the VPK program effects were different when compared to other ECE options within the county or various ECE options throughout the state were difficult. A disadvantage of propensity score matching is that the results may not generalize to the population because the matched sample is intended to be homogenous on covariates. Since we are matching students on similarity, if the students are biased before matching, they will be dropped from the matched samples. That is, students in the VPK group with very high (or very low) propensity scores will be excluded if those in the comparison group does not have the same range of scores.

Exploring the benefits, or lack thereof, of Florida's VPK is worthwhile, but to do so requires appropriate comparison groups and a control group of children who did not experience any preschool programming. Therefore, even though the current study examined a relatively large sample, future research should focus on sampling from other districts using data that differentiated preschool experiences for students would allow stronger conclusions about Florida's

VPK program. This, however, is predicated on the ability to access accurate and transparent data from the state or counties/districts; until such time, research into this topic is limited. While Florida is not the only state with universal preschool, each state determines its own curricula and standards; therefore, these results may or may not be material. Verifiably, other states' programs meet a higher quality of NIEER quality standards, likely providing a greater advantage over alternative ECE or early homeschooling than this one county's data allowed.

Future Research

Although the current study was unable to uncover clear findings in regard to the value of public VPK in one Florida county, the findings are valuable to impact future research. Our methodology attempted to reduce selection bias caused by parents' choices to enroll their children in a VPK program. The demographic data collected by the school district did not allow a full accounting of the length, location, or quality of educational preparation for preschoolers. Therefore, the number of variables included in the propensity score analysis was somewhat limited. Future studies should consider accounting for other factors that affect VPK attendance, such as distance from school, childcare availability, number of siblings, parent education level, age of parents, and family structure. We should also examine the variety of VPK and preschool programs, including the time children spent enrolled and the types of curricula for associated educational outcomes. In conjunction, researchers should also examine whether the age in which students attend preschool affects educational outcomes.

Finally, further investigations should work to develop causal explanations for the results in this study. While this study was able to test how poverty and preschool affect kindergarten readiness and achievement, the lack of significant relationships might lead to the inclusion of additional research-based covariates or mediators in similar quantitative studies. For example, we should seek richer understandings of these programs by conducting qualitative interviews of parents to inquire about their perceptions of the program and their children's experiences in both VPK and kindergarten. With a growing focus on children in poverty and its negative impacts on important developmental milestones, our current study sought to examine the role of SES to investigate how best to serve this sizable population in order to mitigate the academic gaps that persist across all levels of schooling. SES was not found to moderate the effect of VPK on any of our dependent variables, and while this may be as a result of fewer educational disparities related to income, we are more inclined to believe it a result of not being afforded sufficiently nuanced data for analysis. SES was, however, significantly related to kindergarten readiness which was not one of our research questions and thus not reported. Collectively these findings warrant further investigation.

Conclusion

Previous research found that children attending Florida's VPK improved academically (Ansari et al., 2016; Conger et al., 2019; Drummond, 2013; OEL, 2016), but we were unable to replicate similar findings with the district data provided. While the current study results did not reveal any significant benefits for children attending a VPK program to improve kindergarten readiness on academic achievement, regardless of SES, the study does offer some important insights. While Drummond (2013) has found that public school-based pre-Ks in major cities are of higher quality than VPK in childcare centers, we would need Florida's VPK data across districts and comparison groups to replicate those findings.

Still, these timely findings have the potential to inform future work, especially since Florida was recently awarded a 2018 $8.52 million-dollar federal PDG B-5 grant (after this study's timeline) to improve opportunities for and the quality of early learning programs (Friedman-Krauss et al., 2021; Office of Child Care, 2019). These PDG B-5 grants are to be used for a comprehensive needs assessment and a strategic plan to increase the number of provider types and settings (Office of Child Care, 2019), and Florida intended to use the award to implement strategic plan development with the $9.89 million dollar program budget increase (Friedman-Krauss et al., 2021). While the COVID-19 pandemic-related school closures certainly affected Florida's VPK operations, performance, and enrollment, the program continues to meet only two of the ten NIEER quality benchmarks (Friedman-Krauss et al., 2021), despite the infusion of grant funding. Therefore, in order to make data-informed decisions in Florida, we make a strong recommendation that Florida VPK data across all districts be centralized and unified as a critical and necessary first step for effective analyses moving forward.

Given that Florida is one of the top investors in universal pre-K in the US (Barnett et al., 2017; Bassok et al., 2014; Friedman-Krauss et al., 2021), we support continued research to differentiate the effects of ECE programs, including VPK, by provider. Further long-term research focused on outcomes such as high school graduation, attending or completing higher education, and future potential earnings are worth investigating. Knowing that high-quality ECE experiences, including pre-K, are associated with immediate and long-term positive outcomes for children and have the potential to contribute to breaking the cycle of poverty (Chetty et al., 2011; Dodge et al., 2015; Duncan & Magnuson, 2013; Hirsh-Pasek et al., 2018; Pianta et al., 2009;

Yoshikawa et al., 2013), we must continue to collect and track data to capture the direct and indirect impacts.

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