DISCUSSION PAPER

Vital Signs for Pediatric Health: School Readiness

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June 26, 2023

This paper is part of a series on pediatric vital signs. The other selected measurements in this series include infant mortality, chronic absenteeism, and high school graduation. These papers can be found at https://doi.org/10.31478/202306a, https://doi.org/10.31478/202306c, and https://doi.org/10.31478/202306d.

Introduction

In 2015, the Institute of Medicine (now the National Academy of Medicine) released the report *Vital Signs: Core Metrics for Health and Health Care Progress* as a "basic, minimum slate of core metrics for use as sentinel indices of performance at various levels with respect to the key elements of health and health care progress" (IOM, 2015). Although indicators of pediatric health were included in that report as key elements of healthy behaviors, healthy communities, and preventive services, the core measures in the report emphasized indicators of adult health. This series of papers, "Vital Signs for Pediatric Health", describes four metrics across the pediatric life course, each measuring how well the health care system is building the physical, cognitive, and socio-emotional health of the pediatric population, thereby laying the foundation for life-long health and well-being. The metrics—infant mortality, school readiness, chronic absenteeism, and high school graduation—were selected to focus on four different developmental stages of growth. A standardized set of core metrics to assess pediatric health could provide data to support health systems in identifying important areas for attention among their pediatric population and enable them to respond in a timely way. This rapid response is especially important in pediatric health systems as children undergo rapid development within a short time span.

This paper discusses one of those four measures—school readiness—as a developmental target for early childhood (ages 0 to 5). School readiness could serve as a comprehensive lens for the early development of children across various domains: physical, socio-emotional, language, knowledge, cognition (including early literacy and math), and approaches to learning. Systemic measurement of young children's school readiness plays a critical role at multiple levels of health and educational systems. At the individual level, comprehensive assessment in early childhood facilitates the early identification of children who would benefit from preventive and intervention services to support their growth and development. At the district level, aggregate indicators can identify where to target resources and interventions within local health and educational systems. At the systems level, understanding current trends in school readiness data can facilitate the development of effective state and federal performance indicators. Ultimately, longitudinal tracking of school readiness could monitor strengths, risks, and the effects of practice and policy changes on meeting the needs of young children over time across districts, states, and the country (Williams et al., 2019). Together, the role of school readiness in the broader picture of child health and development, as well as the identified roles for communities and systems to track school readiness data and intervene with programs and polices when indicated, support the utilization of school readiness as a pediatric vital sign.

This paper outlines the authors' definition of school readiness and describes why it is a promising pediatric vital sign. The paper also outlines the importance of school readiness and its impacts on individual health, as well as how a lack of school readiness can lead to health disparities. Finally, the paper lays out the challenges in linking data across health and educational systems to further the capability of communities in improving the health and well-being of their populations.

Defining School Readiness

Most current definitions of school readiness at the state and federal levels go beyond literacy and numeracy, espousing a comprehensive developmental approach to school readiness (Slutzky and DeBruin-Parecki, 2019). In this paper, the term *school readiness* is utilized to describe the full scope of knowledge, skills, attitudes, and behaviors children need to be successful in school. This term and its scope include five domains:

1. physical well-being and sensory motor development, including health status and growth;
2. social and emotional development, including self-regulation, attention, impulse control, capacity to limit aggressive and disruptive behaviors, turn-taking, cooperation, empathy, and the ability to communicate one's own emotions;
3. approaches to learning, including enthusiasm, curiosity, temperament, culture, and values;
4. language development, including listening, speaking, and vocabulary and literacy skills including print awareness, story sense, and writing and drawing processes; and
5. general knowledge and cognition, including early literacy and math skills (Williams et al., 2019).

The concept of school readiness began to enter the national parlance in 1991, when the National Education Goals Panel convened by then-President George H. W. Bush adopted the goal of ensuring that all children would enter school ready to learn by the year 2000 (Williams et al., 2019). School readiness was also included in the later No Child Left Behind Act of 2001, the Every Student Succeeds Act of 2015, and Healthy People 2030, indicating that school readiness is both understandable and deemed a valuable outcome for young children in the United States (Public Law 107-110; Public Law 114-95; ODPHP, 2021).

Selecting School Readiness as a Pediatric Vital Sign

The authors of this paper chose school readiness as the potential indicator for early childhood well-being because it reflects the degree to which the development of young children is supported, protected, and promoted. It reflects children's early experiences, exposures, and school and home environments. This measure was also chosen because there are a range of proven methods that families, communities, and systems can use to promote the school readiness of children, as evidenced in *Table 1*. By extension, the methods listed in *Table 1* point to potential interventions or policy levers that can support families and young children in ensuring school readiness. For example, the presented methods suggest that communities monitor the percent of young children living in poverty, the percent of infants and toddlers enrolled in early education programs, or the percent of elevated blood lead levels—all factors associated with school readiness—and adjust policies and procedures accordingly to promote children's school readiness (McLaine et al., 2013; Magnuson et al., 2004). Similarly, states and communities can attend to factors that contribute to the educational level of mothers and the age at which they first become pregnant, as well as child maltreatment and stability of foster care placements to promote children's school readiness on a population level.

School readiness can serve as a reflection of the success (or lack thereof) of pediatric health and educational systems in building young children's overall school readiness. Examining school readiness for all young children across the U.S., in and across catchment areas, would offer greater potential for systemic optimization of early childhood health and development.

Two data sources have produced national estimates of school readiness:

1. The National Survey of Children's Health (NSCH), an annual nationally representative parent-report survey beginning in 2016 directed by the Health Resources and Services Administration's Maternal and Child Health Bureau and administered by the U.S. Census Bureau; and
2. The Early Childhood Longitudinal Study (ECLS), composed of nationally representative samples of kindergarteners through fifth graders (cohorts titled ECLS-K from 1999, 2011, and 2023) and a sample of birth through kindergarten entry (cohorts titled ECLS-B starting in 2001), all sponsored by the National Center for Education Statistics (NCES, n.d.).

Given these two robust data sources, the multi-faceted nature of school readiness, and its potential as an indicator for early intervention, school readiness is a critical vital sign for childhood and community health. However, challenges exist in the availability of local-level data on school readiness for use by health systems. Interagency agreements could be developed to allow for data sharing across education and health sectors to support data-driven decision-making (Bernard et al., 2021). An example is the relationship between the Chicago Department of Public Health and Chicago Public Schools (DASH, 2018). Such agreements could assist with data sharing and support decision-making across sectors, while ensuring educational data sharing adheres to the Family Educational Rights and Privacy Act (DOE, 2021). Furthermore, research suggests providing school nurses with appropriate access to the full medical electronic health records of the students they serve can support student health and academic outcomes (Baker and Gance-Cleveland, 2020). Tools are emerging to assist health departments to use available data such as school readiness to assess children's well-being at the population level (PHII, 2022).

TABLE 1 | Core Indicators from the National School Readiness Indicators Initiative: A 17-State Partnership

Ready Families
• **Mother's Education Level:** Percent of births to mothers with less than a 12th grade education. • **Births to Teens:** Number of births to teens age 15 to 17, per 1,000 girls. • **Child Abuse and Neglect:** Rate of substantiated child abuse and neglect among children birth to age six. • **Children in Foster Care:** Percent of children birth to age six in out-of-home placement (foster care) who have no more than two placements in a 24-month period.
Ready Communities
• **Young Children in Poverty:** Percent of children under age six living in families with income below the federal poverty threshold. • **Supports for Families with Infants and Toddlers:** Percent of infants and toddlers living in poverty who are enrolled in Early Head Start. • **Lead Poisoning:** Percent of children under age six with blood lead levels at or above 10 micrograms per deciliter.
Ready Services - Health
• **Health Insurance:** Percent of children under age six without health insurance. • **Low Birthweight Infants:** Percent of infants born weighing under 2,500 grams (5.5 pounds). • **Access to Prenatal Care:** Percent of births to women who receive late or no prenatal care. • **Immunizations:** Percent of children ages 19 to 35 months who have been fully immunized.
Ready Services - Early Care and Education
• **Children Enrolled in an Early Education Program:** Percent of three- and four-year-olds enrolled in a center-based early childhood care and education program (including child care centers, nursery schools, preschool programs, Head Start programs, and pre-kindergarten programs). • **Early Education Teacher Credentials:** Percent of early childhood teachers with a bachelor's degree and specialized training in early childhood. • **Accredited Child Care Centers:** Percent of child care centers accredited by the National Association for the Education of Young Children. • **Accredited Family Child Care Homes:** Percent of family child care homes accredited by the National Association for Family Child Care. • **Access to Child Care Subsidies:** Percent of eligible children under age six receiving child care subsidies.
Ready Schools
• **Class Size Average:** Teacher/child ratio in K-1 classrooms. • **Fourth Grade Reading Scores:** Percent of children with reading proficiency in fourth grade as measured by the state's proficiency tests.

SOURCE: Rhode Island Kids Count. 2005. *Getting ready: Findings from the National School Readiness Indicators Initiative, a 17 state partnership.* Available at: https://www.rikidscount.org/Portals/0/Uploads/Documents/Early%20Learning/Getting%20Ready/Getting%20Ready%20-%20Full%20Report.pdf (accessed May 23, 2023).

Recent Data and Trends in School Readiness

NSCH includes indicators of school readiness as a pilot Healthy and Ready to Learn (HRL) summary measure, with the goal of developing a Title V National Outcome Measure (Ghandour et al., 2019). The four domains assessed by the HRL parent-report are early learning skills, social-emotional development, self-regulation, and physical well-being. Initial analyses identified that only 42.4% of children aged 3 to 5 years in the U.S. are considered HRL across all four domains, suggesting that most children are at risk and in need of additional supports (Ghandour et al., 2021). Moreover, there is variation in school readiness across the country, as depicted in *Figure 1*. The HRL metric continues

to undergo validation and refinement in each subsequent year of the NSCH, and thus national and state trends over time will not be available for several years. Cultural, linguistic, and psychometric properties within and across diverse communities are important considerations in the development of the HRL metric. Further, efforts are underway to use small-area estimation techniques and state oversamples to provide more local estimates of granular school readiness.

In the ECLS cohort studies, school readiness has been evaluated using direct child assessment along with reports from parents and teachers. Analyses of the 1999 cohort found that only 16% of the national sample scored above the mean on all four dimensions of school readiness, a profile labeled as "comprehensive positive development" (Hair et al., 2006). Even when lower developmental standards were used, only 30% of the cohort was classified as having comprehensive positive development. As such, only about one-third to one-fifth of America's young children were developing fully across all four dimensions at the time of analysis.

Results across cohorts of the ECLS (1998–1999 and 2010–2011) have also been examined (Baumgartner, 2017). One analysis found school readiness scores in the cognitive domains—math and verbal readiness—were significantly higher in the later cohort, suggesting a general increase in school readiness across the country over time. However, the non-cognitive school readiness component—approaches to learning—appeared to decrease slightly over time.

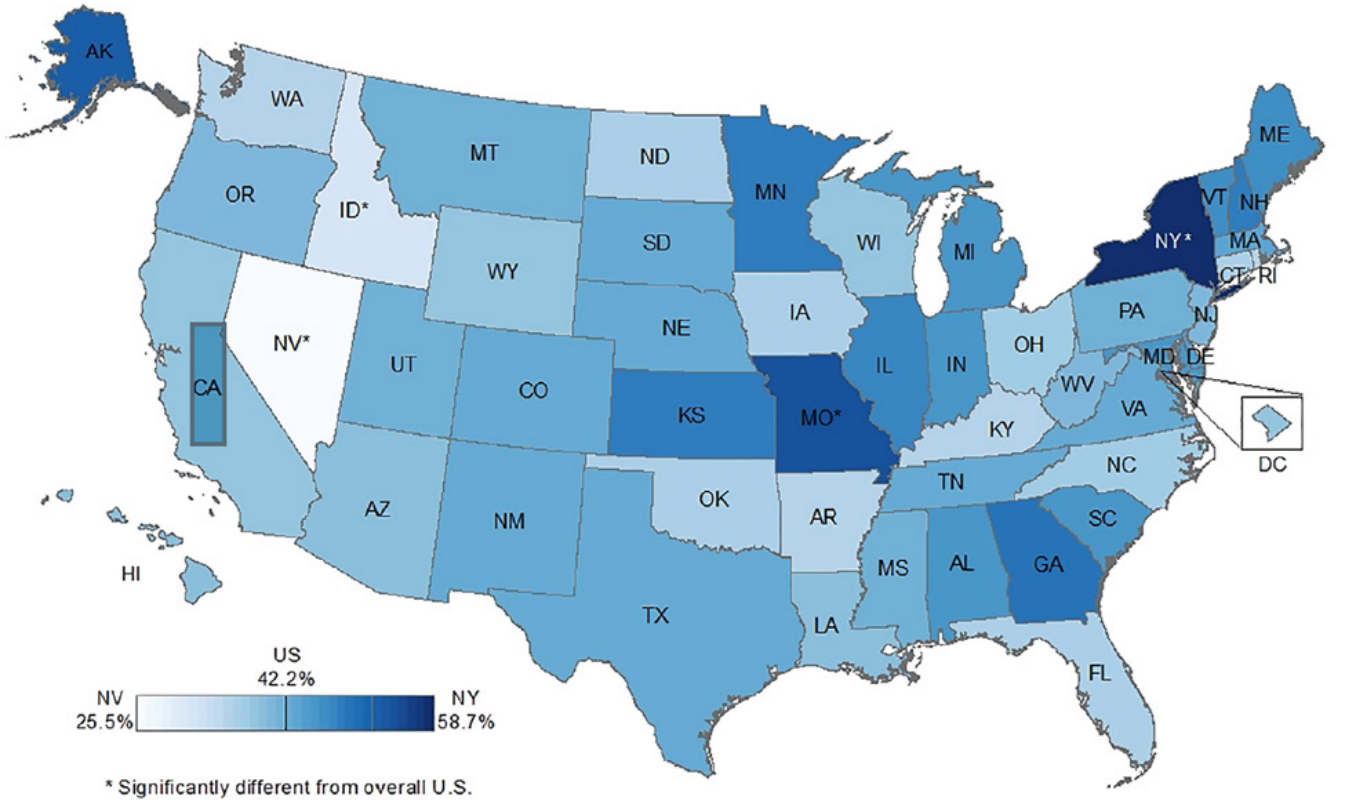
Disparities

Results from both national studies have generally shown disparities in school readiness associated with five factors:

1. household and parent education,
2. income,
3. household and family structure,
4. gender, and
5. race and ethnicity.

However, when accounting for compounding factors in advanced analyses with NSCH data, fewer disparities related to sociodemographic factors are evidenced, although some do still exist (Ghandour et al., 2021). Namely, increased child age, higher household education, absence of health care needs, posi-

FIGURE 1 | Prevalence of U.S. Children Ages 3 to 5 Years Rated "On-track" for "Healthy and Ready to Learn" Pilot Measure, National Survey Children's Health, 2016



SOURCE: Ghandour, R. M., A. H. Hirai, K. A. Moore, L. R. Robinson, J. W. Kaminski, K. Murphy, M. C. Lu, and M. D. Kogan. 2021. Healthy and ready to learn among US preschool children: prevalence and correlates of a pilot measure to assess school readiness. *Academic Pediatrics* 21(5): 818–829. https://doi.org/10.1016/j.acap.2021.02.019.

Published June 26, 2023

tive parent mental health status, lack of adverse childhood experiences, and access to neighborhood amenities such as parks and libraries are all positively associated with school readiness across the country (Ghandour et al., 2021). Moreover, actionable items such as decreased screen time and increased oral engagement—reading, singing, storytelling—are positively associated with school readiness (Ghandour et al., 2021).

When using longitudinal studies to examine school readiness, various factors—including low birthweight, having a teenage parent, and sociodemographic factors such as living in poverty—continue to be associated with repeating kindergarten or first grade, thus widening disparities that exist at school entry (Hair et al., 2006). Furthermore, disparities in school readiness present in the ECLS 1999 cohort associated with family structure (such as single parents), less maternal education, low household income, gender, and race and ethnicity persisted in the 2011 cohort (Baumgartner, 2017). Additionally, children living in poverty tend to hear fewer words in their first few years of life, which is associated with disparities in language development once the children reach school age (Hart and Risley, 2003). However, a narrowing of gaps in school readiness between Black, Hispanic, and White children was found in math and verbal readiness and approaches to learning (Baumgartner, 2017).

Within the 2011 ECLS-K cohort, disparities were apparent in children from different levels of socioeconomic status and of differing races and ethnicities (García and Weiss, 2015). As depicted in *Figure 2*, reading skills at kindergarten entry vary by a full standard deviation between young children at the highest and lowest socioeconomic levels. Similar levels of disparities were also reported in mathematics. While disparities among different socioeconomic groups were less present in skills within non-cognitive domains—including approaches to learning, self-control, and social skills—performance of these skills was consistently weakest for the poorest children in the U.S. (García and Weiss, 2015). Hispanic English language learners scored the lowest on mathematics at kindergarten entry. However, these learners were relatively stronger than other groups in the non-cognitive domain of persistence based on teacher report, although not from parent reporting. As was found when adjustments were applied to the NSCH study, many racial and ethnic disparities lessen when accounting for socioeconomic status and parenting factors, although some of those disparities still persist (García and Weiss, 2015).

Many of these findings point toward an existing opportunity gap for children living in poverty (NASEM, 2021). The unequal distribution of resources on the basis of factors including socioeconomics contributes to disparities in both health and academic outcomes in children (NASEM, 2021; Acevedo-Garcia et al., 2019).

The data described above highlight the value of comprehensive data analysis and understanding larger contextual factors in conceptualizing school readiness. Otherwise, focusing solely on "the skills of a child places an undue burden of proof of readiness on that child and is particularly unfair because of economic, experiential, and cultural inequities in our society" (Williams et al., 2019).

The COVID-19 pandemic has further underscored the disparities described in this section. Given the numerous disruptions to all aspects of life, the cascading and reverberating effects of COVID-19 on the development of young children, their readiness for school, and the impact on their communities remains to be an important area to be studied and addressed.

Challenges in Measuring School Readiness

State and local measurement of school readiness varies widely, and thus currently available data are not easily compared. In 2016, the U.S. Department of Education's Institute for Education Sciences conducted a scan of kindergarten entry assessments (KEAs). KEAs are typically administered prior to or immediately after kindergarten entry and are completed via a direct assessment of the child's skills, observation, and/or other measurement approaches, such as family surveys or portfolios. The scan found a lack of consistency in KEA implementation across states. Only half of states had legislation requiring KEAs, and only two-thirds of states were in the process of piloting or implementing KEAs (IESRELP, 2016).

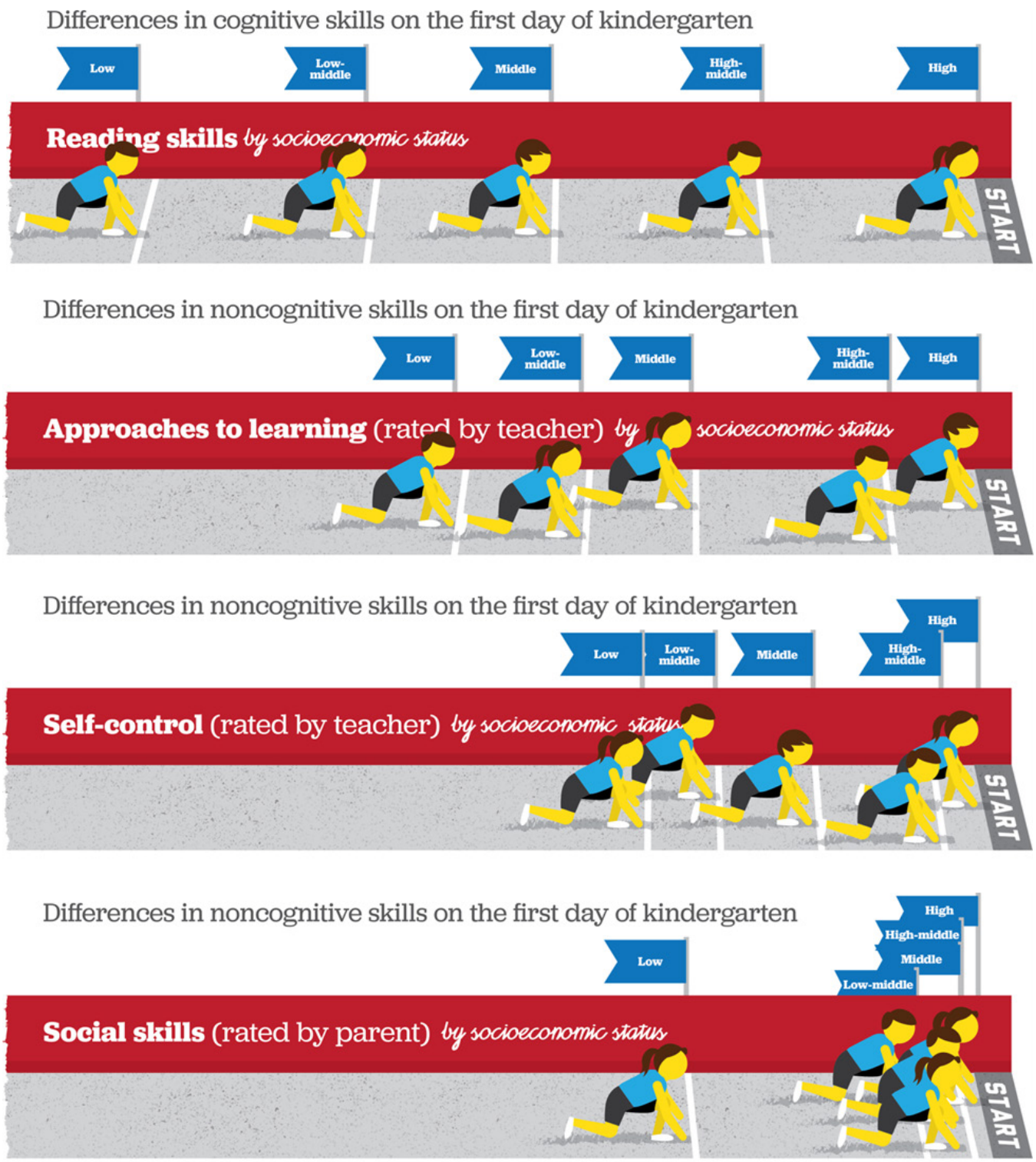
In addition to variation in implementation, there is inconsistency in the domains assessed to determine school readiness. The scan identified that only seven states included all five domains of school readiness in their definition stipulated at the beginning of this paper—physical health and well-being, social competence, emotional maturity, language and cognitive development, and communication skills and general knowledge.

Specific measurement tools are also varied, with only one-fifth of states using the same instrument or an adapted version (IESRELP, 2016). Furthermore, school readiness measures vary in their assessment approach, including direct child assessment, parent report, teacher report, or a combination of sources. The state-by-state differences in measurement currently limit nationwide ability to examine children's growth and development at a broader systemic level. Moving forward, standardization of measurement would allow for the use of KEAs as a vital sign.

School readiness assessments further vary in their depth and purpose. Shorter-form measures facilitate community-wide screening and population tracking, but can be less precise than longer-form measures that are administered for diagnostic and programmatic purposes. The HRL measure previously described is an example of a broad-based measure that was piloted in the NSCH.

A promising population-based measure developed in Canada and gaining traction across the U.S. and internationally is the Early Development Instrument (EDI) (Janus and Offord, 2007).

FIGURE 2 | Standard Deviation Differences by Socioeconomic Status in ECLS-K 2011 Study



SOURCE: García, E., and E. Weiss. 2015. *Early education gaps by social class and race start U.S. children out on unequal footing: A summary of the major findings in inequalities at the starting gate.* Economic Policy Institute. Available at: https://www.epi.org/publication/early-education-gaps-by-social-class-and-race-start-u-s-children-out-on-unequal-footing-a-summary-of-the-major-findings-in-inequalities-at-the-starting-gate/ (accessed February 13, 2023).

Completed by teachers in the second half of kindergarten, the EDI is comprised of 103 items grouped into five domains:

1. physical health and well-being;
2. social competence;
3. emotional maturity;
4. language and cognitive development; and
5. communication skills and general knowledge.

Numerous cross-sectional and longitudinal studies have documented aspects of reliability and validity of the EDI (Brinkman et al., 2013; Hymel et al., 2011; Guhn et al., 2007; Janus and Offord, 2007). Once collected, data from the EDI are made available at the school and neighborhood levels to monitor population-level developmental outcomes. In its current use, the EDI is generally collected every three years. It is important to note that this measure was not developed for diagnostic and programmatic purposes, which may be a limitation for some instances of use.

A critical component in school readiness measurement is ensuring technical integrity for the overall population, including diverse communities. Analyzing for technical integrity could include using advanced measurement and analytic approaches to examine and ensure cultural, linguistic, and psychometric validity. School readiness measures developed within states likely vary in their technical approaches and precision, as well as in their incorporation of cultural and linguistic factors. Although some commercially available measures have strong empirical evidence for use with culturally and linguistically diverse young children, others have no published empirical evidence (Barrueco et al., 2012).

Importance of Measuring School Readiness to Understand Children's Health

Linkages to Health Outcomes Later in Life

Both school readiness and its accurate measurement are important for all children and communities. Children with stronger school readiness skills at school entry experience long-term benefits over their life courses (Heckman, 2006). Evidence from the Quebec Longitudinal Study of Child Development suggests that school readiness indicators predict later positive physical health behaviors. For example, children with higher receptive vocabulary in kindergarten ate more dairy, fruits, and vegetables in fourth grade along with fewer snacks than children with lower receptive vocabulary (Pagani and Fitzpatrick, 2014). Furthermore, kindergarteners with high math skills engaged in significantly more physical activities as fourth graders than kindergarteners with low math skills. A meta-analysis of six longitudinal studies also underscored the long-term academic benefits associated with school readiness. Pre-academic and behavioral skills at school entry significantly predicted reading and math achievement scores assessed at ages 8 to 14 years (Duncan et al., 2007).

Potential Health Systems Benefits

Evaluations of early childhood interventions designed to increase school readiness and decrease poverty-associated disparities related to school entry provide evidence that changes in school readiness are associated with positive outcomes in later education, occupation, social factors, and health. Two randomized trials of high-quality early childhood education interventions for children in low-income families have followed child participants into adulthood. One of these trials, the Carolina Abecedarian Project, provided 57 high-risk infants with six to eight hours of quality childcare, five days a week, for five years. Compared to the control group, the children who received childcare had higher cognitive and academic test scores through age 21, obtained significantly more years of education, were more likely to be consistently employed at age 30, and had significantly lower prevalence of risk factors for cardiovascular and metabolic diseases in their mid-30s (Campbell et al., 2014; Campbell et al., 2012; Campbell et al., 2001).

A second randomized trial, the Perry Preschool Project, provided high-quality preschool education to three- and four-year old African American children living in poverty and at high risk for school failure. Children randomly assigned to participate in the program were more likely to graduate high school, had fewer teenage pregnancies, had higher incomes, and had committed fewer crimes by age 40 (Schweinhart et al., 2005).

On a broader scale, long-term outcomes of participation in the federal Head Start program to improve school readiness include better educational outcomes through high school and beyond. Participation in this program was associated with, in adulthood, better measures of social, emotional, and behavioral development, as seen in indicators such as self-control, self-esteem, and positive parenting with their own children. These adulthood indicators were especially pronounced for Black participants. The Nurse-Family Partnership, a prenatal to age two years home visiting program, has documented similar long-term cognitive outcomes at age 18 for children of high-risk mothers with low psychological resources (Kitzman et al., 2019).

Conclusion

Even though school readiness measurement at kindergarten entry is not yet implemented on a national scale, local- or state-level opportunities exist where comprehensive measurement is already conducted. Thus, advancements could be made at regional levels. To strengthen the usability of school readiness as a pediatric vital sign, next steps could include addressing the measurement challenges described in this paper and mobilizing stakeholder investment and implementation supports that could provide the foundation for adoption of a national vital signs metric for young children that is sensitive to varied contexts, cultures, and languages.

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DOI

https://doi.org/10.31478/202306b

Suggested Citation

Kaminski, J., S. Barrueco, K. J. Kelleher, K. Hoagwood, A. Edwards, and E. G. Fox. 2023. Vital Signs for Pediatric Health: School Readiness. *NAM Perspectives*. Discussion Paper, National Academy of Medicine, Washington, DC. https://doi.org/10.31478/202306b.

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Acknowledgments

This manuscript was supported in part by funding (Task Order 200-2011-38807/0070) from the Centers for Disease Control and Prevention.

This paper benefited from the thoughtful input of **Alyna Chien, MD, MS,** Boston Children's Hospital; and **Ashley Darcy-Mahoney Ph.D., NNP, FAAN,** The George Washington University.

Conflict-of-Interest Disclosures

Erin Fox discloses employment by the National Academies of Sciences, Engineering, and Medicine while this paper series was being drafted.

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