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Universal Screening of Hunger, Tiredness, and Sickness:

Implications for Kindergarten Readiness and Racial/Ethnic Disparities

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Abstract

This study investigated associations of three teacher-reported health indicators—hunger, tiredness, and sickness—with kindergarten readiness skills in San Francisco Unified School District (N = 12,423; female = 48%; M_{age} = 5.47, SD_{age} = 0.30, $range_{age}$ = 4.67–7.00; Asian American = 26%, Black = 5%, Latinx = 20%, Multiracial/Other = 23%, White = 18%). *Research Findings:* Accounting for demographic characteristics, each teacher-reported health indicator was negatively associated with measures of students' academic and social-emotional readiness. These relations did not differ by student race/ethnicity despite a disproportionately high prevalence of health concerns among Black and Latinx students relative to White students. Moreover, teacher-reported hunger, tiredness, and sickness partially explained racial/ethnic disparities in kindergarten readiness skills, especially among Black students compared to their White, Latinx, and Asian American peers. *Practice or Policy:* Results demonstrate the feasibility and utility of universal teacher-administered basic health screening and underscore the importance of early childhood health for efforts to redress educational inequality.

Keywords: Kindergarten readiness; Child health; Race/ethnicity; Inequality; Disparities

Universal Screening of Hunger, Tiredness, and Sickness: Implications for Kindergarten Readiness and Racial/Ethnic Disparities

Kindergarten teachers know that a hungry student may have trouble listening to a story, a sleepy student may struggle to count blocks, and a student with a cold may have difficulty showing empathy toward peers. Indeed, in nationally representative surveys, kindergarten teachers have long identified being "physically healthy, rested, and well-nourished" as the most important qualities for their incoming students' readiness to learn (National Center for Education Statistics, 1993). Previous studies have demonstrated the effects of prenatal and maternal health conditions and chronic diseases on early educational outcomes (Currie, 2005; Peterson et al., 2018). However, less is known about how common, often overlooked health indicators like being hungry, tired, and sick during the school day relate to kindergarten readiness skills in representative samples of children attending public schools. Given the significance of students' kindergarten readiness for their future educational and behavioral outcomes (e.g., Duncan et al., 2007; Jones et al., 2015), there is a need to better understand how such health indicators relate to academic and social-emotional development at elementary school entry.

Systemic racial/ethnic inequalities in income, wealth, housing, parental stress and employment, and access to health care and educational opportunities contribute to persistent racial/ethnic disparities in both early childhood health (Mehta et al., 2013) and kindergarten readiness (Brooks-Gunn et al., 2007; Reardon & Portilla, 2016). The current study aimed to advance our understanding of the relative prevalence and education-related implications of health problems for students from diverse racial/ethnic backgrounds. Leveraging teachers' reports of three health indicators—hunger, tiredness, and sickness—on an annual district-wide kindergarten readiness screener, we investigated: (1) the unique links of each teacher-reported

health indicator with students' literacy, cognitive/motor, and social-emotional readiness skills; (2) racial/ethnic inequities in health indicator prevalence among Asian American, Black, Latinx, and White students; (3) whether the associations of health indicators with kindergarten readiness skills were invariant across these four racial/ethnic groups; and (4) the extent to which the health indicators explained racial/ethnic disparities in kindergarten readiness skills.

Health, Kindergarten Readiness, and Racial/Ethnic Disparities

In a recent review, Peterson and colleagues (2018) highlight health as an understudied driver of kindergarten readiness, synthesizing extant research on the impacts of child health conditions including under-nutrition, poor sleep hygiene, and chronic illness on early language, cognitive, and social-emotional development. The authors call for a more cohesive, equitable early childhood system that attends to children's intersecting health- and education-related needs. The framework offered by Heissel and colleagues (2017) further elucidates associations between health and academic outcomes, identifying biological factors such as fatigue and stress arousal through which health concerns contribute to disparities in learning and achievement. They posit that we cannot understand disparities in educational opportunity without attending to health-related stressors that undermine everyday learning as well as performance on achievement tests. Nevertheless, the early childhood field lacks evidence regarding how young children's everyday health concerns at school relate to their kindergarten readiness. Further, Slopen and Heard-Garris's (2021) model provides a broader socioecological perspective, articulating the ways in which structural racism gives rise to racial/ethnic child health disparities through pathways within children's social and physical environments. For example, systemic factors including explicit racial discrimination in homeownership in part drive racial/ethnic inequalities in intergenerational wealth. In turn, wealth inequality contributes to racial /ethnic disparities in

access to high-quality housing and food security, which affect children's neurodevelopment, programming of stress and immune systems, and ultimately, physical and mental health.

Collectively, these frameworks speak to the importance of understanding how health concerns contribute to children's development and, more specifically, how racial/ethnic disparities in early childhood health relate to racial/ethnic disparities in kindergarten readiness, as reflected in Figure 1. Given that racism, not race/ethnicity, produces disparities in health and educational outcomes (Gillborn et al., 2018), in Figure 1 and throughout this study we conceptualize associations of race/ethnicity with children's health and kindergarten readiness as reflections of the structural barriers in access to health- and education-related opportunities that children of marginalized racial/ethnic identities encounter.

Physical Health and Kindergarten Readiness Skills

Young children's physical health is a fundamental prerequisite for school engagement, and compromised health may limit children's cognitive, social, and emotional learning. Acute and chronic health conditions, such as low birth weight, asthma, lead poisoning, and dental caries, have been shown to pose profound challenges to the successful transition to kindergarten in the U.S. (Currie, 2005; Peterson et al., 2018). Far less research has investigated the early educational consequences of experiencing hunger, tiredness, and sickness in the classroom—experiences that may not be identified by health care professionals or reflected in children's medical or school records but may nevertheless impact the development and expression of kindergarten readiness skills.

Hunger. Hunger can impact children's learning through both nutritional pathways (e.g., decreased energy) and non-nutritional pathways (e.g., parental stress) (Cook, 2013). According to nationally representative caregiver surveys of household food insecurity (HFI), approximately

one in seven U.S. households with children under six were food insecure in 2019 (Coleman-Jensen et al., 2020). Caregiver-reported HFI is negatively related to children's academic, behavioral, and emotional outcomes from infancy through adolescence (Shankar et al., 2017), including their academic and social-emotional readiness at kindergarten entry (e.g., Johnson & Markowitz, 2017; Nelson et al., 2016).

Comparatively little work has investigated links between child hunger and educational outcomes. The distinction between HFI and child hunger is an important one: Children living in food-insecure households may not themselves experience hunger due to caregivers' efforts to shield them from HFI's direct effects (Hanson & Connor, 2014). The few studies that specifically examine the effects of child hunger suggest that among children raised in food-insecure households, those experiencing hunger have lower academic and behavioral outcomes relative to those not experiencing hunger (Murphy et al., 1998; Weinreb et al., 2002; Winicki & Jemison, 2003), though not consistently (Weinreb et al., 2002). Notably, these studies—as well as the larger literature on child food insecurity to date—measure child hunger at the household level, rather than the child level, obscuring the experiences of individual children, who may be receiving food from other sources, including their schools (Cook, 2013). More research is needed to understand the prevalence and educational implications of experiencing hunger at school, especially in early childhood, when nutrition can impact foundational cognitive development (Center on Hunger, Poverty, and Nutrition Policy, 1994).

Tiredness. By affecting young children's ability to engage with and learn from the classroom environment, tiredness may impede kindergarten readiness (Fallone et al., 2002). Neurobiologically, tiredness impairs the activation of prefrontal brain areas that support higher-level cognitive skill development (Thomas et al., 2000) as well as healthy impulse and emotion

regulation (Palmer & Alfano, 2017). To date, most investigations of the impacts of tiredness on early academic and social-emotional development have relied on caregiver reports of children's sleep problems or sleepiness, with few studies specifically examining tiredness in the classroom. Studies of caregiver-reported sleep have revealed that as many as 25% of children regularly encounter sleep disruptions (Mindell et al., 1999) and that 20–50% of children experience daytime sleepiness (Dewald et al., 2010).

Caregiver-reported sleep problems and daytime sleepiness in elementary and middle school students have each been associated with lower academic, behavioral, and social-emotional outcomes (e.g., Calhoun et al., 2012; Dewald et al., 2010). Though less common, some research has reported similar patterns in early childhood. Among a large, nationally representative sample of Head Start preschoolers, caregiver-reported sleep disruptions were related to lower concurrent performance in math, language, literacy, and behavior (Schlieber & Han, 2018). Additionally, a few studies have linked shorter caregiver-reported sleep duration with reduced social-emotional and cognitive outcomes and greater hyperactivity at kindergarten entry (Touchette et al., 2007; Tso et al., 2016). To our knowledge, a recent study by Ursache and colleagues (2021) offers the only evidence to date on links between teacher-reported tiredness and schooling outcomes among elementary aged students. In a sample of predominately Black first graders, they found that teacher-reported sleepiness, but not parent-reported sleepiness, was associated with higher concurrent behavioral and emotional challenges and lower longitudinal academic achievement (Ursache et al., 2021). Given the relative scarcity of research concerning the educational effects of tiredness in early childhood, as well as evidence that children's daytime sleepiness is more strongly associated with school performance than sleep duration or quality (Dewald et al., 2010), there is a need to further examine the implications of teacher-

reported tiredness during the school day for kindergarten readiness.

Sickness. Childhood sickness can influence young children's academic experiences both directly, via physiological mechanisms, and indirectly, through factors including increased school absenteeism (Peterson et al., 2018). Researchers have frequently examined the impacts of discrete medical concerns such as asthma, tooth decay, allergies, ear infections, and lead poisoning on students' school performance (e.g., Halterman et al., 2001; McLaine et al., 2013). A smaller body of work has examined the effects of children's general poor health status—typically reported by caregivers—on educational outcomes. In a recent study using a nationally representative sample, caregivers reported that 29% of children experienced poor physical health between birth and age five (Kull & Coley, 2015).

Caregiver reports of children's poor physical health have been concurrently and longitudinally linked to lower cognitive and psychosocial adjustment at kindergarten entry (Kull & Coley, 2015; Spernak et al., 2006). Nevertheless, caregiver reports may underestimate poor child health by emphasizing only salient health-related events (e.g., doctors' diagnoses, hospitalizations) or by invoking overly positive responses (i.e., social desirability bias; Kull & Coley, 2015; Spernak et al., 2006). To our knowledge, no existing study has probed the education-related consequences of regularly being sick as identified by one's kindergarten teacher.

Universal Screening of Health Risks by Kindergarten Teachers

Existing research establishing the relevance of hunger, tiredness, and sickness for kindergarten readiness has come primarily from siloed studies of distinct health indicators based on reports from caregivers or medical professionals focusing on vulnerable pediatric populations. Such studies provide limited insights into the everyday experiences of young students. To start,

caregivers and medical professionals do not regularly observe children's health-related experiences in the classroom, which may differ from those in their home environments. Moreover, it is impractical and cost-prohibitive to employ caregivers' or medical professionals' reports to routinely assess the prevalence and learning-related consequences of common health indicators across entire school districts. Due in part to the burdens of collecting health data from caregivers and medical professionals, much of the extant literature on early health and education is based on relatively small, non-representative samples drawn from restricted socioeconomic or racial/ethnic populations, therein limiting the generalizability of the findings.

Universal screening of hunger, tiredness, and sickness by kindergarten teachers offers a unique opportunity to understand the implications of these health indicators as observed within a classroom context. Although past scholarship involving teachers' assessments of student health has established the validity and reliability of similar measures (e.g., Davies et al., 2016), it has rarely examined concurrent associations with students' early academic or social-emotional development (c.f., Ursache et al., 2021). Since common health concerns frequently co-occur in young children, teachers' reports of hunger, tiredness, and sickness can also extend prior work—which has typically focused on a single domain of health—by examining the unique and joint contributions of multiple health indicators. Finally, the scalability of teacher-reported health indicators via widespread universal kindergarten readiness screeners can facilitate investigations of the disparities and educational implications of health-related experiences in larger, more representative samples of racially/ethnically diverse students.

Racial/Ethnic Disparities in Child Health

The persistence of striking racial/ethnic disparities in health reflects larger patterns of social stratification and oppression in the United States (Williams et al., 2016). Due in part to

institutional and interpersonal racism and related material and psychosocial stressors, racial/ethnic inequities in health exist at all levels of socioeconomic status (Braveman et al., 2010; Williams et al., 2010; 2016). Racial/ethnic health disparities are readily apparent in early childhood (Braveman & Barclay, 2009; Peterson et al., 2018) and extend to the common health concerns examined in this study. Although health disparities affect children of numerous racial/ethnic identities, most research to date focuses on differences that Asian American, Black, and Latinx children experience in relation to White children—collectively, the four largest racial/ethnic child populations in the U.S. (*America's Children: Key National Indicators of Well-Being, 2021 - Demographic Background*, 2021).

With respect to hunger, Black and Latinx households with children consistently face elevated risk of HFI relative to their White counterparts (Coleman-Jensen et al., 2020). While Asian Americans may experience a lower aggregate burden of HFI than White, Black, and Latinx households (Furness et al., 2004), there is substantial heterogeneity in HFI among Asian American subgroups (Becerra et al., 2018). Regarding tiredness, studies show that Black and Latinx children experience shorter nighttime sleep duration and lower sleep quality than their White peers (Guglielmo et al., 2018; Peña et al., 2016; Smith et al., 2019), with some evidence that Asian American children may face more sleep problems than White children as well (Peña et al., 2016). Finally, Black and Latinx children experience worse general physical health than White children, while Asian American children experience the best relative physical health (Braveman et al., 2010; Mehta et al., 2013). As with other health conditions, racial/ethnic disparities in food insecurity, sleep problems, and sickness persist after accounting for socioeconomic status (Guglielmo et al., 2018; Kaiser et al., 2007; Mehta et al., 2013).

Despite documented racial/ethnic inequities in the prevalence of child health concerns, it

remains unclear whether the strength of associations between health concerns and kindergarten readiness vary across race/ethnicity. From a health disparity perspective (National Institutes of Health, 2002), health problems may disproportionately harm the academic and social-emotional development of children from historically marginalized racial/ethnic backgrounds, who experience greater cumulative stress and reduced access to high-quality health care and early learning opportunities relative to their White peers (Brooks-Gunn et al., 2007; Weinick & Krauss, 2000). To date, a few studies with small samples have found that relations between health concerns such as sleep disruptions and academic outcomes differ by student race/ethnicity (e.g., Philbrook et al., 2017). Meanwhile, one study with a large, representative sample suggested that associations between young children's health and kindergarten readiness are consistent across race/ethnicity (Kull & Coley, 2015). Given these mixed findings and a general dearth of relevant literature, it is important to further examine whether the academic implications of common health concerns are similar for students of diverse racial/ethnic identities.

Further, we need to better understand the extent to which racial/ethnic health disparities account for racial/ethnic disparities in kindergarten readiness. Institutional and interpersonal racism limits access to resources for optimal health and high-quality educational opportunity for children of marginalized racial/ethnic identities (Reardon et al., 2019; Sanders-Phillips et al., 2009), and for Black children in particular (Dumas, 2016). Given established links between racism and food insecurity (e.g., Odoms-Young, 2018), sleep problems (e.g., Yip et al., 2020), and poor general child health (e.g., Priest et al., 2013), as well as between such health concerns and early educational outcomes, it is plausible that racial/ethnic disparities in child health partially explain racial/ethnic disparities in early educational outcomes (Currie, 2005). Empirical evaluations of the contributions of early child health disparities to kindergarten readiness

disparities can inform the design of holistic early childhood education systems.

The Present Investigation

This study addresses important research gaps by investigating the implications of three common teacher-reported health indicators—hunger, tiredness, and sickness—for kindergarten readiness in three kindergarten cohorts in San Francisco Unified School District (SFUSD). We leverage teachers' reports of students' health and early academic and social-emotional skills on an annual district-wide kindergarten readiness screener administered at the beginning of the school year. Specifically, we examine the following research questions:

1. Accounting for demographic characteristics, are the three teacher-reported health indicators uniquely related to students' kindergarten readiness skills?
2. How does the prevalence of teacher-reported hunger, tiredness, and sickness differ by student race/ethnicity?
3. Do the three teacher-reported health indicators relate to kindergarten readiness skills similarly among Asian American, Black, Latinx, and White students?
4. To what extent are racial/ethnic disparities in kindergarten readiness skills explained by racial/ethnic disparities in teacher-reported hunger, tiredness, and sickness?

In accordance with evidence of distinct mechanisms through which hunger, tiredness, and sickness affect child development and learning (e.g., Fallone et al., 2002; Peterson et al., 2018), we anticipate that each teacher-reported health indicator will uniquely relate to kindergarten readiness in literacy, cognitive/motor, and social-emotional domains. Further, given documented racial/ethnic health disparities, we expect that Black and Latinx kindergarteners will be more likely to experience teacher-reported health concerns than their White peers. We do not present hypotheses for our third and fourth research questions, which are exploratory in nature.

This study employs a dual reference group approach regarding student race/ethnicity. First, we use White students as the reference group to reflect that access to health and educational opportunity are racially stratified in a society dominated by whiteness, and to be consistent with cited prior research. We additionally report analyses using Black students as the reference group in light of anti-Black racism in access to health- and education-related resources and in alignment with the framework put forth by Johfre and Freese (2021).

Method

Participants

The sample consisted of the entire population of 12,423 kindergarten students in general education classrooms in 72 schools with kindergarten readiness data collected in 2017–18 (n = 4,171), 2018–19 (n = 4,153), and 2019–20 (n = 4,099) in SFUSD. We received child-level data from the district as part of a multi-year research practice partnership. On average, 52% of kindergarteners at each school were eligible for free-or -reduced-price meals (FRPM; SD = 22%, min = 13%, max = 96%). Mean age at kindergarten entry was 5.47 years (SD = 0.30). About half (48%) of the students were girls, and 10% were classified as special education students. Based on a home language survey or a language proficiency exam taken at kindergarten entry, a plurality (47%) was designated as English proficient, 38% as English learners, and 15% were missing English proficiency data.

Students were racially/ethnically diverse: 26% Asian American, 5% Black, 20% Latinx, 23% Multiracial/Other, and 18% White, with 8% missing race/ethnicity data. The Asian American group included children identified by their caregivers as having Chinese, Japanese, Korean, Cambodian, Vietnamese, Asian Indian, Hmong, Laotian, or Other Asian ancestry. Latinx ethnicity was ascertained by asking whether the child had Hispanic or Latino

ancestry. Multiracial/Other included children identified as having Hawaiian Native, Samoan, Guamanian, Other Pacific Islander, Filipino, Arabic/Middle Eastern, American Indian, or Alaska Native ethnicity and those who reported "Other" (5% of the total sample) as well as those identified as having multiple races or ethnicities (18% of the total sample). Due to sample size constraints, we did not examine heterogeneity among Asian American or Multiracial/Other subgroups. Analyses that focused specifically on race/ethnicity did not include the 8% of students whose caregivers declined to state their race/ethnicity ($N = 931$) or the 23% of students designated as Multiracial/Other ($N = 2{,}825$), because the variability of ethnic/racial experiences within the latter group made it challenging to draw appropriate and meaningful interpretations. As such, the sample size for our second, third, and fourth research questions was 8,667 students.

Procedure

The Kindergarten Readiness Inventory (KRI) was designed by our partner school district as a low-cost, feasible assessment tool to gather data on the entire population of incoming kindergarteners. Each year, kindergarten teachers used the KRI to assess all students during normal school hours in the first six weeks of the school year. Before the school year, kindergarten teachers received a detailed administration guide in addition to participating in mandatory training to practice assessing and calibrating scores. All children within a classroom were assessed by the lead teacher on the same day; on the assessment day, the district sent a substitute teacher to run the classroom while the lead teacher completed assessments. Average assessment time was 20-45 minutes per student.

Measures

Kindergarten Readiness Inventory (KRI). The KRI is intended to acquaint teachers with aspects of students' incoming literacy, mathematics, motor, and social-emotional skills. It is

comprised of questions from the Fountas & Pinnell Foundational Skills assessment, a common early literacy measure (Fountas & Pinnell, 2016), and the Kindergarten Observation Form (Applied Survey Research, 2001), which was used in the National Survey of Children's Health. Designed as a screener, the KRI enables annual assessment of the district's entire kindergarten population, but only captures a handful of skills that fall under the broader construct of kindergarten readiness.

Academic and social-emotional skills. The KRI features nine academic and social-emotional items administered to all students (see Table S1 in the online supplement for the questions and scoring information). Teachers directly assessed academic items with students individually or in small groups, whereas the social-emotional items were based on teacher observation during whole-classroom activities.

We began with an exploratory factor analysis on a randomly sampled half of our data to identify the factor structure. We used the Root Mean Square Error of Approximation (RMSEA), Comparative Fit Index (CFI), and Standardized Root Mean Square Residual (SRMR) to evaluate model adequacy (Hu & Bentler, 1999). The two-factor model demonstrated poor fit [$\chi^2(df = 19) = 1351.312$, $p < .001$, RMSEA = .105 (90% CI [.100, .110]), CFI = .916, SRMR = .040], and a four-factor model was not identified. The three-factor model fit significantly better than the two-factor model [$\chi^2(df = 7) = 1518.487$, $p < .001$] and demonstrated good fit [$\chi2(df = 12) = 35.145$, $p < .001$, RMSEA = .017 (90% CI [.011, .024]), CFI = .999, SRMR = .005]. Using these results and a conceptual understanding of the nine items, we identified a three-factor solution: literacy skills (letter recognition; letter sounds; and early literacy behaviors; $\alpha = .87$), cognitive/motor skills (counting to 20; pencil grip; and name-writing; $\alpha = .72$), and social-emotional skills (follows two-step directions; expresses empathy and caring for others; and demonstrates

curiosity and eagerness to learn; α = .75). Confirmatory factor analysis with clustered standard errors on the second half of our data confirmed that this three-factor model provided adequate fit to the data: $\chi^2(df = 23) = 844.137$, $p < .001$, RMSEA = .075 (90% CI [.071, .079]), CFI = .947, SRMR = .043. We averaged the scores for each factor to create three composites. The literacy items were scored on separate scales and were thus standardized prior to composite creation.

Health indicators. The KRI includes three health questions that capture how often a given "student indicated they were hungry in class," "appeared tired in class," and "was sick in class." Teachers reported each health indicator on a four-point scale: 1 = *rarely (never or at most once every few weeks);* 2 = *on some days (at most once per week);* 3 = *on most days (twice/three times per week);* and 4 = *just about every day (four/five times per week).* The health indicators were highly skewed. As such, in line with prior research (e.g., Currie et al., 2008), we dichotomized them to differentiate students who rarely experienced a health concern from students who experienced a health concern one or more times per week.

Covariates. Parents reported student-level demographic characteristics on an enrollment form. These data included students' date of birth, gender, and race/ethnicity. Special education classification was obtained from school records. School-level FRPM rates were obtained from publicly available administrative records reported by the district. English language proficiency was assessed using the California English Language Development Test in the 2017−18 kindergarten year and the English Language Proficiency Assessments for California in the 2018−19 and 2019−20 kindergarten years. Students whose scores placed them in a category other than Fluent or Proficient were classified as English learners.

Analytic Strategy

To evaluate unique relations between health indicators and kindergarten readiness skills,

we conducted a series of path analyses. First, we estimated a direct effects model to explore whether teacher-reported health indicators were uniquely linked to students' kindergarten readiness skills, controlling for all covariates. Second, we used multivariate logistic regression to compute adjusted odds ratios of experiencing hunger, tiredness, and sickness across student demographic characteristics, including race/ethnicity. Third, we tested whether associations between the three health indicators and kindergarten readiness domains differed across student race/ethnicity by equating pathways for Black, Latinx, Asian American, and White students and comparing model fit using chi-square difference tests. Finally, as shown in Figure 1, we estimated a mediation model to estimate how much the three health indicators explain associations between race/racism and kindergarten readiness skills. In light of our large sample size and consequent statistical power, we only interpret findings that are significant at the $p < .01$ level.

Analyses were conducted in Mplus 7.4 with standard errors clustered at the classroom level to account for the nesting of students within classrooms. There was little missingness in students' literacy (2.2%), cognitive/motor (1.6%), and social-emotional (0.7%) outcomes. All demographic covariates had less than 0.2% of missing data except for English language proficiency (15%) and race/ethnicity (8%). To make use of all available data, we employed full information maximum likelihood estimation (FIML). This approach is regarded as one of the best ways to handle missing data (Enders, 2010). This study received approval from the [XXX] University Institutional Review Board and from the participating school district. In accordance with the Family Educational Rights and Privacy Act (FERPA), we did not obtain parental consent to perform secondary data analysis of deidentified educational records.

Results

Health Indicators and Kindergarten Readiness

Table 1 provides descriptive statistics and bivariate correlations. Twenty-five percent of students experienced at least one teacher-reported health concern. Specifically, teachers reported that 13% of students experienced hunger, 17% experienced tiredness, and 6% experienced sickness. All three health indicators were moderately positively correlated (*rs* ranged from .21 to .41, *ps* < .001).

Direct associations between the health indicators and kindergarten readiness skills are presented in Table 2. The coefficients for health indicators are standardized on the dependent variable only, such that each coefficient represents the effect of regularly experiencing a given health concern, relative to not regularly experiencing that health concern, in *SD* units. As hypothesized, accounting for covariates, teacher-reported hunger, tiredness, and sickness were each independently negatively associated with each of the three kindergarten readiness domains. Of the three health indicators, tiredness demonstrated the strongest negative relation with each kindergarten readiness domain (βs ranged from -0.078 to -0.166, *ps* < .001), and its strongest negative relation was with social-emotional skills. Each of the three health indicators was most weakly associated with literacy (βs ranged from -0.078 to -0.024, *ps* < .001) relative to cognitive/motor and social-emotional skills. Over and above the included covariates, the three teacher-reported health indicators increased the R^2 by 1.0% (to 33.1%) for literacy skills, by 1.8% (to 18.6%) for cognitive/motor skills, and by 3.8% (to 18.0%) for social-emotional skills.

Racial/Ethnic Distribution of Health Indicators

Table 3 includes odds ratios of teacher-reported health indicators adjusted for student demographic characteristics. According to teachers, Black students were 3.07 times more likely than their White peers to experience hunger (95% CI: 2.31, 3.99); 2.17 times more likely to

experience tiredness (95% CI: 1.72, 2.72); and 2.48 times more likely to experience sickness (95% CI: 1.59, 3.86). Further, relative to White students, Latinx students were 1.8 times more likely to experience sickness (95% CI: 1.25, 2.67). Meanwhile, according to teachers, Asian American students were less likely to experience hunger (aOR: 0.48; 95% CI: 0.36, 0.63) or tiredness (aOR: 0.54; 95% CI: 0.44, 0.66) than their White classmates.

Compared to their Black peers, White students were less likely to experience hunger (aOR: 0.33; 95% CI: 0.25, 0.43), tiredness (aOR: 0.46; 95% CI: 0.37, 0.58), and sickness (aOR: 0.40; 95% CI: 0.26, 0.62). A similar pattern emerged for Asian American students, whose teachers reported a lower likelihood of hunger (aOR: 0.16; 95% CI: 0.11, 0.21), tiredness (aOR: 0.25; 95% CI: 0.19, 0.32), and sickness (aOR: 0.31; 95% CI: 0.20, 0.46) relative to Black students. Finally, Latinx students were less likely to experience both hunger (aOR: 0.38; 95% CI: 0.29, 0.51) and tiredness (aOR: 0.51; 95% CI: 0.40, 0.67) than their Black classmates.

Health Risks and Kindergarten Readiness by Student Race/Ethnicity

To explore whether the associations between teacher-reported health indicators and kindergarten readiness skills varied across Asian American, Black, Latinx, and White students, we estimated a multigroup model. We used a likelihood ratio test to evaluate whether a constrained model that equated the associations between the three health indicators and kindergarten readiness domains across student race/ethnicity resulted in significantly worse model fit compared to an unconstrained model that did not equate those associations. We found no statistically significant difference in model fit between these models ($\chi^2(df = 27, N = 8{,}667) = 32.351, p = .219$). Further, the constrained model demonstrated good fit: $\chi^2(\text{df} = 27) = 32.351$, $p = .219$, RMSEA = .010 (90% CI [.000, .020]), CFI = .999, SRMR = .009. Thus, results suggest that associations between teacher-reported health risks and kindergarten readiness skills were

consistent for Asian American, Black, Latinx, and White students in our sample.

Student Race/Ethnicity, Health Concerns and Kindergarten Readiness: Indirect Effects

Teachers' reports of students' hunger, tiredness, and sickness mediated associations between race/ethnicity and kindergarten readiness skills. Direct and indirect effects are shown in Table 4 and indirect effects are visualized in Figure 2. Disparities are expressed as the difference in group means, with the higher-scoring group reported first. The percent of the total effect explained by the indirect effect is computed by dividing the estimate of the indirect effect by the estimate of the total effect (Kenny, 2014). Standardized mediation results produce slightly different direct and indirect effect estimates depending on the reference group used. In instances of inconsistent mediation, in which the direct and indirect effects operate in opposite directions, the percent of the total effect that is indirect is not reported or interpreted (Preacher & Kelley, 2011).

Between White and Black students, the three teacher-reported health indicators collectively explained 16.8% of literacy, 20.8% of cognitive/motor, and 28.9% of social-emotional skill disparities. Between White and Latinx students, health indicators collectively explained 2.3% of literacy and 11.2% of cognitive/motor skill disparities. Between Asian American and White students, health indicators collectively explained 4.7% of literacy and 8.3% of cognitive/motor skill disparities. Between Latinx and Black students, health indicators collectively explained 27.0% of cognitive/motor and 20.4% of social-emotional skill disparities. Lastly, between Asian American and Black students, health indicators collectively explained 10.0% of literacy, 15.0% of cognitive/motor, and 43.8% of social-emotional skill disparities.

Discussion

Our study amplifies calls for more holistic understandings of kindergarten readiness that

include not only students' academic and social-emotional skills, but also the foundational physical wellness that supports young students' classroom engagement and learning. Using data from SFUSD's district-wide kindergarten readiness assessment, we found that teacher-reported hunger, tiredness, and sickness were each uniquely related to students' academic and social-emotional kindergarten readiness skills above and beyond established demographic predictors. Associations between health indicators and kindergarten readiness skills did not differ across racial/ethnic groups. Compared to White students, Black and Latinx students were more likely to experience teacher-reported health concerns; in contrast, Asian American students were less likely to experience teacher-reported health concerns than their White peers. Racial/ethnic disparities in hunger, tiredness, and sickness partially accounted for racial/ethnic disparities in kindergarten readiness skills, especially among Black students relative to their White, Latinx, and Asian American classmates.

Although prior research has documented the effects of acute health conditions and chronic diseases on children's early learning (e.g., Currie, 2005; Peterson et al., 2018), comparatively little work has explored relations of common health concerns that students experience at school with their kindergarten readiness skills. This is due in part to a lack of available data. Our study suggests that teacher reports of student health concerns collected as part of an existing district-wide assessment can be meaningful indicators of early academic and social-emotional risk and may be used to identify students for additional supports. Teachers have unique insight into young students' health—concerns that may otherwise go undetected by the medical system.

Physical Health is a Critical Aspect of Kindergarten Readiness

Our study extends prior literature documenting negative associations of caregiver-

reported hunger, tiredness, and sickness with early educational outcomes (Crosnoe, 2006; Johnson & Markowitz, 2017; Kull & Coley, 2015; Nelson et al., 2016; Schlieber & Han, 2018; Spernak et al., 2006; Touchette et al., 2007; Tso et al., 2016) by demonstrating similar associations using teacher reports of student health concerns. The standardized effect sizes of the links between each teacher-reported health indicator and kindergarten readiness domain in the current study were small, ranging from .02 to .17 standard deviation units. Such effects are similar in magnitude to those from past investigations leveraging caregiver reports among large, nationally representative samples (Crosnoe, 2006; Kull & Coley, 2015). Though modest in size, small individual effect sizes can translate to large population health impact (Matthay et al., 2021). Pragmatic, scalable kindergarten readiness screeners that include common health concerns and are administered annually to all students in a district can be used to monitor the impacts of population-level changes in early childhood practice and policy.

A life-course perspective highlights the importance of young children's health for both contemporary development and future wellbeing (Braveman & Barclay, 2009). Hunger and poor general health in early childhood have been linked to lower academic outcomes at the end of kindergarten, through elementary school, and into young adulthood (Currie et al., 2008; Spernak et al., 2006; Winicki & Jemison, 2003). At the same time, longitudinal relations between health and education are reciprocal, with ample evidence that early childhood educational outcomes predict greater later-life health (e.g., Reynolds et al., 2007). Our results suggest that efforts to address inequities in adult health- and education-related outcomes should go hand-in-hand and begin in early childhood.

These efforts may include reducing barriers to participation in existing school-based programs such as FRPM, especially in light of evidence that many eligible students do not

participate (e.g., Ribar & Haldeman, 2013). For example, providing universal access to free breakfast in elementary school classrooms has been highlighted as a promising strategy to enhance food access among vulnerable young students (Basch, 2011). Such efforts may also entail the creation of new initiatives, including the provision of more robust school-based health services ranging from dental screenings and asthma management to increased investment in school nurses. Further, student tiredness—the health indicator found to be most strongly associated with kindergarten readiness in our study—can be mitigated by increasing caregivers' access to information about and resources to support healthy sleep hygiene (Bonuck et al., 2016). On a larger scale, it is critical to address systemic causes of inadequate nighttime sleep, including stressful environmental conditions such as crowding, excessive noise, and lead exposure that interfere with children's sleep quality (Bagley et al., 2015; Evans, 2006).

Early Childhood Health Concerns Reflect and Explain Racial Inequalities

Corroborating prior scholarship (Kull & Coley, 2015), we found that associations between teacher-reported health indicators and kindergarten readiness skills did not differ across racial/ethnic groups. However, our analyses also revealed that racial/ethnic differences in kindergarten readiness skills can be partially explained by racial/ethnic differences in compromised physical health.

When using White students as a reference group to understand disparities in the context of the structural privileges of whiteness, we found that teacher-reported hunger, tiredness, and sickness account for 17-29% of the White-Black disparity in kindergarten readiness skills, 2-11% of the White-Latinx disparity, and 5-8% of the Asian American-White disparity. In analyses with Black students as a reference group, because anti-Black racism affects access to health- and education-related resources, we further found that teacher-reported health concerns explain 20-

27% of the Latinx-Black disparity and 10-44% of the Asian American-Black disparity in kindergarten readiness skills. Again, disparities in kindergarten readiness skills are expressed as the difference in group means and reported with the higher-scoring group first. Notably, our estimates of the contribution of early childhood health to the White-Black readiness disparities are in line with Currie's (2005) pooled estimates across several studies indicating that roughly 25% of White-Black disparities in kindergarten readiness skills can be explained by racial differences in child and maternal health conditions (e.g., asthma, iron deficiency, maternal depression).

The greater explanatory power of health concerns for kindergarten readiness disparities involving Black students relative to White-Latinx and Asian American-White disparities could be due to several reasons. First, of the four racial/ethnic groups in our sample, Black students experienced the highest rates of teacher-reported hunger, tiredness, and sickness. Specifically, we found that Black kindergarteners were more than two times as likely to be identified as tired or sick, and more than three times as likely to be identified as hungry, relative to their White peers, a finding that corroborates prior work documenting profound racial/ethnic disparities in caregiver-reported early childhood health (Braveman et al., 2010; Coleman-Jensen et al., 2020; Furness et al., 2004; Guglielmo et al., 2018; Mehta et al., 2013; Peña et al., 2016) resulting from structural racism and related inequalities (e.g., Odoms-Young, 2018; Priest et al., 2013; Yip et al., 2020). Further, Black families and children also experience disproportionate barriers and discrimination in access to health-related resources (e.g., Weinick & Krauss, 2000; Williams et al., 2010).

Additionally, that the three health concerns explain a greater proportion of the Latinx-Black and Asian American-Black kindergarten readiness disparities than the White-Latinx and

Asian American-White disparities suggests that the sets of structural inequalities driving differences in health and kindergarten readiness among Black and Latinx or Black and Asian American students overlap more than those driving differences among White and Latinx or White and Asian American students. This finding may reflect the specific San Francisco Bay Area context, where White residents remain highly segregated from Black, Latinx, and Asian American families and racial/ethnic inequities in wealth, income, employment, and housing persist (The San Francisco Foundation, 2017).

Limitations

This study is limited by shared-method variance, as teachers reported both child health indicators and kindergarten readiness skills. We note that this limitation may be less salient for the literacy and cognitive/motor items, which were directly assessed according to clear evaluation criteria, and the hunger item, which was based on students telling their teachers they were hungry. Although related investigations based on caregiver-reported data suffer from similar shared-method concerns (Shankar et al., 2017), additional work should corroborate our findings with data from more diverse sources (e.g., caregiver or nurses' reports of students' health, direct assessments of students' social-emotional skills). Relatedly, while our study demonstrates the predictive validity of teacher-reported health indicators for kindergarten readiness, future scholarship should interrogate the psychometric properties of teacher reports of child health and examine additional indicators of kindergarten readiness.

Further, past work has demonstrated that teachers' reports of student appearance and ability can be biased by students' race/ethnicity (e.g., Meissel et al., 2017). Racial bias may be most common when measures of student ability are more subjective, with less clearly defined evaluation criteria (Quinn, 2020). These findings suggest that racial bias in the current study may

be present for the social-emotional readiness items and tiredness and sickness health items, all of which were based on teachers' observations of students during classroom activities rather than direct assessments or students' verbal report to teachers. While our data did not permit an interrogation of potential racial biases, future studies should triangulate teachers' reports with data from other sources in order to do so. Related work can also extend existing scholarship on the role of teacher-student racial/ethnic match in teachers' evaluations of students' academic and social-emotional abilities (e.g., Downer et al., 2016; Wright et al., 2017) to examine the implications of teacher-student racial/ethnic match in teachers' reports of students' health concerns.

We partially addressed our inability to control for student-level socioeconomic status by including school-level FRPM rates, an approach that has been utilized in other studies of school readiness (Davies et al., 2016). However, future studies should examine associations of teacher-reported hunger, tiredness, and sickness with kindergarten readiness in the context of student-level socioeconomic status. Finally, we were unable to meaningfully interpret race/ethnicity-related findings for the more than 20% of students in our sample identified as Multiracial/Other. Novel work is needed to investigate the nuanced health- and kindergarten readiness-related experiences of multiracial students and students from racial/ethnic groups whose sample sizes are often too small for inclusion in statistical analyses. Such work should also explore the heterogeneity of experiences among students in commonly used racial/ethnic categories.

Future Directions & Conclusion

This study advances research at the intersection of early childhood health and education by reporting unique relations among teacher-reported hunger, tiredness, and sickness and reduced academic and social-emotional skills at kindergarten entry. By identifying the

contributions of common health concerns to racial/ethnic disparities in early learning outcomes, we further understandings of actionable mechanisms that may be responsive to intervention at the school and district level. Future scholarship should rigorously examine policies and programs to reduce kindergarteners' hunger, tiredness, and sickness in the classroom in order to reduce persistent racial/ethnic educational inequalities.

Such initiatives will require measuring young students' health at scale. Given the frequency with which teachers interact with students, they may be better poised to serve as early observers of students' health-related needs than pediatricians or other social service providers. A scalable three-item health survey linked to an existing kindergarten readiness assessment can provide important information to target resources to students who need them most.

In addition to considering the health of individual students, expanded definitions of kindergarten readiness should include the preparedness of schools and other child-serving systems to meet young students' health-related needs. A five-year-old student frequently telling her teacher that she is hungry, or a teacher observing that a student is often sick in class, offers evidence of structural failures in existing systems' abilities to meet those needs. The broader early childhood field would benefit from comprehensive conceptual frameworks that illustrate links between young children's health and learning and forefront systemic drivers of disparities in both domains. To shed light on promising areas for policy intervention, causal studies should explore upstream structural factors—including housing instability, lack of access to quality medical care, and the absence of paid parental sick leave—known to be systematically patterned by race/ethnicity that may drive young children's hunger, tiredness, and sickness in the kindergarten classroom.

Future investigations can build upon our cross-sectional analyses to explore longitudinal

relations between teacher-reported health indicators and students' social-emotional and academic outcomes. Such work can also examine the education-related implications of early childhood mental health in addition to physical health. Further, while our binary health indicators have practical relevance as a simple screener, future scholarship should explore more nuanced student health measures that capture greater variability.

Similar to health, kindergarten readiness is a complex construct encompassing many domains and skills. The design of kindergarten readiness assessments that can be routinely implemented at scale while also comprehensively evaluating all relevant aspects of students' readiness remains a challenge for the early education field. Going forward, research-practice partnerships can help both schools and scholars strike the right balance. Novel work is needed to explore how to implement richer measures of kindergarten readiness that capture a more inclusive set of young children's social-emotional, physical, and academic skills; provide actionable results; and remain practical for regular classroom- and district-wide use.

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