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International Journal of Educational Research 115 (2022) 102055

DOI or URL to published work (if available) https://doi.org/10.1016/j.ijer.2022.102055

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International Journal of Educational Research 115 (2022) 102055

Contents lists available at ScienceDirect

International Journal of Educational Research

journal homepage: www.elsevier.com/locate/ijedures

Remote learning engagement and learning outcomes during school closures in Ghana

Sharon Wolf [a,*], Elisabetta Aurino [b], Noelle M. Suntheimer [a], Esinam A. Avornyo [c], Edward Tsinigo [d], Jasmine Jordan [e], Solomon Samanhiya [d], J. Lawrence Aber [f], Jere R. Behrman [g]

[a] University of Pennsylvania, Graduate School of Education, 3700 Walnut St, Philadelphia, PA 19104, USA
[b] University of Barcelona, Spain
[c] University of Cape Coast, Ghana
[d] Innovations for Poverty Action, New Haven, CT, USA
[e] Georgia State University, GA, USA
[f] Global TIES for Children, New York University, USA
[g] University of Pennsylvania, Departments of Economics and Sociology, USA

ARTICLE INFO

Keywords:
COVID-19
School closure
Remote learning
Inequality
Ghana
Sub-Saharan Africa

ABSTRACT

Remote learning programs were rapidly implemented throughout the COVID-19 pandemic during school closures. We drew on an ongoing longitudinal study of a cohort of children in the Greater Accra Region of Ghana to survey children ($N = 1{,}844$), their caregivers, and teachers to examine learning experiences during the ten months of school closures in Ghana in 2020. We documented inequalities in remote learning opportunities offered by public and private schools, as well as who accessed remote learning and the quality of learning opportunities. In addition, controlling for pre-pandemic learning outcomes, we documented learning gaps, with food insecure, low socio-economic status, and public-school children performing significantly worse than their peers (0.2–0.3 SD gap). Results highlight pandemic-related inequalities in a cohort of Ghanaian primary schoolchildren.

1. Introduction

The COVID-19 pandemic led to school closures worldwide, leaving children across diverse contexts without formal education for nearly one year. At the peak of school closures, over 1.6 billion children did not attend school for extended periods, of which 26% lived on the African continent (United Nations, 2020). Countries around the world responded to the crisis by developing and implementing educational activities through remote learning. Yet in 2020, about one-third of children worldwide were unable to access remote learning opportunities, with inequalities in access documented by gender and socioeconomic status (UNICEF, 2021).

Groups historically at greater risk of poorer educational attainment, including girls and children from the poorest families, tend to be disproportionately affected by large-scale shocks and school closures, amplifying existing educational inequalities. In Ghana, Akyeampong et al. (2021) used data from school holiday closures in 2016–2017 and found that while schools were closed, literacy gaps widened, particularly for girls and boys who did not receive educational support at home or were taught in a non-preferred language.

* Corresponding author.
E-mail address: wolfs@upenn.edu (S. Wolf).

https://doi.org/10.1016/j.ijer.2022.102055
Received 8 June 2022; Received in revised form 19 August 2022; Accepted 22 August 2022
Available online 26 August 2022

In a study across five African countries examining learning loss due to school closures during the COVID-19 pandemic, Angrist, Djankov, Goldberg and Patrinos (2021) found larger learning loss for children who previously struggled most in reading. Additional studies have shown that the pandemic compounded pre-existing vulnerabilities to educational disadvantage by gender, poverty, and disability (Hevia, Vergara-Lope, Velásquez-Durán & Calderón, 2022; Jones et al., 2021).

With schools closed on such a wide scale, most high-income countries turned to synchronous online learning during the pandemic, whereas low- and middle-income countries (LMICs) tended to use one-way broadcasting of lessons through online, television and/or radio. In high-income countries, a mounting body of evidence shows large disparities in engagement in remote learning during the pandemic, with important implications for learning outcomes (Donnelly & Patrinos, 2021; Maldonado & De Witte, 2021). However, similar gaps have not been yet systematically documented in lower-income settings, particularly in sub-Saharan Africa (SSA). Offering remote learning does not necessarily lead to its take up or to learning; even in periods of stability technology's impact on learning is mixed (Ganimian, Vegas & Hess, 2020). In LMICs, where children had a very low learning base before the pandemic (Angrist et al., 2021), understanding the use and effectiveness of remote learning and its role in widening pre-existing learning inequalities is an area in need of additional research.

In this study, we contribute to addressing this gap with a sample of primary-school children in the Greater Accra Region of Ghana, one of the areas that were hardest hit by the pandemic in the country (Ghana Statistical Service, 2021). Children were enrolled in public and private schools before the pandemic; children, their caregivers, and teachers were surveyed during the period of school closures in 2020. We document the type and quality of support offered by schools and that utilized by children during school closures, as well as inequalities in both opportunities and learning outcomes. Our results have important implications for addressing educational equity as children have returned to school, as well as for future crises.

2. COVID-19 disrupted education and learning globally

The COVID-19 pandemic placed heavy burdens on children, families, and governmental systems. While school closures and safety protocols were implemented to reduce the spread of COVID-19 and protect families, these changes simultaneously jeopardized millions of children's education. While 90% of educational ministries across the world implemented some form of remote learning or broadcasting (Dreesen et al., 2020; UNESCO, UNICEF & World Bank, 2020), there was wide variation in how much these digital programs were able to mimic classroom environments. For example, radio-broadcasting lessons were pre-recorded, and thus limited teacher-child interactions and opportunities for children to respond to questions (UNICEF, 2021). Evidence from India shows that low-tech, one-way learning modalities had much lower usage than two-way synchronous lessons, with radio programming uptake extremely low at only 2% of adolescents using it for learning (van Cappelle, Chopra, Ackers & Gochyyev, 2021). Even so, children needed access to digital tools to be able to participate in remote learning, and children in West and Central Africa were the hardest to reach with digital and broadcast remote learning (an estimated 48% of children could not be reached; UNICEF, 2020).

Beyond interrupting educational activities directly, school closures led to halts to school feeding programs, which were a key poverty-alleviation strategy (in both high- and low- income countries) and an important source of nutrition for disadvantaged children that could promote learning (Aurino, Wolf & Tsinigo, 2020). The World Food Programme estimated that 369 million children missed school meals because of school closures at the peak of school closures in April 2020 (Borkowski et al., 2021).

Further, lockdowns due to the pandemic increased poverty rates and food insecurity (Egger et al., 2021). Household hardship posed further serious risks to children's educational engagement and learning and could have led to "a hardship chain reaction," where caregivers were less able to provide support to children (Gunnar, 2021). Decades of research have documented strong negative links between economic hardship and schooling outcomes in the United States (National Academies of Sciences Engineering & Medicine, 2019) as well as on the African continent (Evans & Mendez Acosta, 2021). Yet, few studies to date have reported associations between economic hardship during the pandemic and children's educational opportunities and learning outcomes in Africa. Recent studies have documented the link between economic hardship and parent mental health in Ghana (e.g., Atuoye & Luginaah, 2017), which may have negatively impacted parents' ability to support children's learning (Lee, Ward, Chang & Downing, 2021; Xu, Wu, Levkoff & Jedwab, 2020).

3. The educational context of Ghana before and after the pandemic

Ghana is a lower-middle-income country in West Africa with a population of 32.4 million people (World Bank, 2021). The adult literacy rate is 76.6%, nearly one quarter (23.4%) of the population lives below the national poverty line (World Bank, 2021). Despite significant progress in increasing universal primary school enrollment (UNESCO, 2014), educational quality and learning levels were already low by both national and international standards before the pandemic (Angrist et al., 2021). For example, the 2016 National Education Assessment in Ghana showed that only 22% of Primary 4 (P4; equivalent of fourth grade) students achieved proficiency in mathematics, and only 25% attained proficiency in Primary 6 (P6; equivalent of sixth grade). In English, 37% of P4 students and 36% of P6 students achieved proficiency (Ghana Ministry of Education, 2016).

As demand for schooling has grown, the private sector has expanded significantly and helped fill large gaps in communities where public schools have been slower to open or expand (Bidwell & Watine, 2014). Importantly, a large majority of private schools in Ghana charge low fees and cater to low-income families (known as low-fee private schools), and many schools struggle to cover their costs (Baum, Abdul-Hamid & Wesley, 2018). Yet, parents often perceive them to be of better quality than public schools (Dixon & Tooley, 2012; Zuilkowski, Piper, Ong'ele & Kiminza, 2018). Students in private schools outperform their public-school counterparts, and children in private schools tend to come from higher-income and better-educated families (Pesando, Wolf, Behrman & Tsinigo, 2020).

Very little evidence exists of the differential learning opportunities and outcomes of children in private versus public schools during school closures.

When the first case of COVID-19 was identified in Ghana, the government swiftly responded by closing schools for 10 months between March 2020 and mid January 2021 (UNESCO, 2021) .[1] Accra and Kumasi, the country's largest cities, also underwent a partial lockdown during three weeks in April 2020. The Ministry of Education designed and rapidly implemented educational TV and radio-broadcast programming for primary-school students. The Ghana Education Service (GES) created a special TV channel (Ghana Learning TV) to deliver free educational content; specific timetables were designed to cover pre-primary through secondary curricula at different points throughout each day. In contrast, radio broadcasting was developed with a broader scope, with the aim to bridge the digital access gap. Also, government-sponsored online platforms were available for pre-primary through secondary school grades to deliver learning content through different learning systems (i.e., iCampus content and Edmodo online learning tools) (Ghana Education Service, 2020).

However, overcrowded households, no access to electricity (especially in rural areas), lack of devices, and limited learning space as well as parental and teacher support, posed challenges to children accessing and benefitting from these resources (UNICEF, 2021). For example, across the nation in 2018, 16.1% of children did not have access to media services, and more than 4 million people did not have access to at least 3 G networks (Ghana Statistical Service, 2018).

Upon the re-opening of schools, GES has modified the curriculum to promote recovery learning by ensuring that learners could complete truncated courses from the previous school year. End-of-term examinations were replaced with class exercises and class tests to assess learning. Finally, GES has continued to deploy TV, radio, and online classes to augment face-to-face teaching and learning even though schooling were reopened as of January 2021. However, it is not known how many children continued to access remote learning programs in conjunction with in-person schooling.

In addition to governmental efforts, some individual schools and teachers offered remote learning opportunities for children, though the amount and types of these supports have not been systematically documented. Further, as in other LMICs, the pandemic led to very high rates of economic hardship and food insecurity across the country, including in rural and northern areas, where poverty is higher, but hardships were more widespread in big cities such as Accra and Kumasi (Ghana Statistical Service, 2021). For example, in a representative sample of households in Ghana, more than 40% of respondents say they had to limit portion sizes at mealtimes or reduce the number of meals in the past week (Egger et al., 2021). In addition, while 65% of respondents from the same survey reported working in February 2020, only 41% of households reported working in the past week in April 2020. Of those still working, 41% earned less and 29% worked fewer hours in the past week (Innovations for Poverty Action, 2020). The government aimed to increase cash support by leveraging and expanding existing cash transfers, reduce electric costs for households, etc., but evidence on whether these efforts have reached all eligible households is still limited (Ewuradjoa Dadzie & Raju, 2020).

4. The current study

In this study, we documented children's learning opportunities and outcomes during COVID-19 induced school closures in peri-urban Ghana, as well as the role of other stressors such as food insecurity and economic hardship on children's remote learning engagement and learning outcomes. We drew on an on-going study of children and parents from the Greater Accra region (Wolf et al., 2019a, 2019b; Wolf, 2019) to answer the following research questions:

- What activities did primary schools offer for remote learning in peri-urban Ghana across private and public schools, and at what rates did students engage with remote learning opportunities?
- What supports and barriers to remote learning engagement did students encounter?
- Controlling for previous test scores, were household economic shocks associated with less remote learning engagement and worse literacy and math test scores for students?
- Controlling for previous test scores, were there gaps in children's literacy and math test scores across public and private school students, between boys and girls, by household SES, and food security/insecurity?

5. Methods

5.1. Participants

Our sample was drawn from an ongoing longitudinal impact evaluation of a preschool-randomized trial conducted in the 2015–2016 school year in the Greater Accra Region of Ghana (Wolf et al., 2019a). Preschools were sampled from six districts in the summer of 2015. A listing of all preschools was based on the Ghana Education Service Educational Management Information System database. Preschools were then randomly sampled, stratified by district, and within district by public and private preschools, to obtain 240 schools total (Wolf, 2019). An average of 15 children were randomly selected within each preschool to participate in direct assessments. These children were 49.5% female and on average, 5.2 years-old ($SD = 1.8$) at baseline. Children were followed for three subsequent waves of data collection in-person, with the third follow-up conducted in May-June 2018.

[1] In mid-June, school closures were partially lifted for final-year senior-high-school and junior-high-school students to allow for exam preparation and completion.

We attempted to reach as many of the children and caregivers who participated in Year 1 (2015–2016) of the project ($N = 3867$) and were able to reach 48% of children ($N = 1844$). We discuss below differences in critical variables between this sub-sample and the original sample, derived using linear probability models to predict attrition status. Children who were present in the 2020 wave differed from the original sample in that they were more likely to be in the teacher training-treatment arm of the original RCT ($b_1 = 0.07$, $SE = 0.03$; representing a 7% increase in the probability of remaining in the sample), had higher baseline socioeconomic status ($b_2 = 0.002$, $SE = 0.001$; representing a 0.2% increase in the probability of remaining in the sample for each additional point on this 100-point scale), and more likely to attend private preschools at baseline ($b_3 = 0.06$, SE = 0.03; representing a 6% increase in the probability on remaining in the sample). In addition, they were less likely to be from the Ga South district ($b_4 = -0.10$, $SE = 0.04$; representing a 10% decrease in the probability of remaining in the sample). Variables on which there no significant differences between the two groups included parental education, cognitive stimulation, books in the home, literacy, math, social-emotional, executive function, approaches to learning, and the five other study districts.

5.2. Procedures

This study was reviewed and approved by the [Institution removed for peer review] Institutional Review Board (IRB) and was approved under an IRB reliance agreement by [Institution removed for peer review]. We conducted phone-based surveys with children and their primary caregiver in October 2020 to collect data specific to the COVID-19 pandemic. All data collectors had prior experience working with children, were trained in the study's research protocols and methodology, and spoke English and local languages (Dangme, Ga, Twi, Ewe, and Hausa). Following receipt of verbal assent, children were asked several modules related to their well-being and involvement in educational activities during the COVID-19 pandemic, in addition to the assessment of their literacy and math skills. We followed the best practices related to phone-based assessments with children available at the time of data collection (Angrist et al., 2020). Data collectors asked children to locate quiet and comfortable seats while engaging in the phone survey, as well as to obtain paper and pencils to solve the math problems. Further, caregivers were also asked to give children privacy while they were engaging in the survey. Prior to starting the assessment, data collectors informally spoke with the children to help them feel at ease, and then administered the survey in the language in which each child was most comfortable. Sampled children were all attending primary school pre-pandemic (56% private schools), on average, 10.1 years-old ($SD = 1.2$) and were 49% male.

Table 1
Sample Characteristics.

	M or%	*SD*
Children *(N = 1844)*		
Male	49.4%	–
Age (in years)	10.06	1.25
Grade level[a]		
Below Primary 3	10.2%	–
Primary 3	42.0%	–
Primary 4	44.2%	–
Primary 5 or 6	3.5%	–
Academic skills		
Literacy (wave 1)	0.48	0.22
Math (wave 1)	0.46	0.19
Literacy (wave 5)	0.53	0.23
Math (wave 5)	0.64	0.20
No. of remote learning activities (child-report)	1.91	1.12
No. of remote learning activities (caregiver-report)	2.20	1.08
Caregivers *(N = 2048)*		
Male	38.0%	–
Age (years)	42.22	8.76
Highest education level		
Less than primary school	17.6%	–
Primary school	10.1%	–
Middle school	40.5%	–
Senior high school (SHS)	12.8%	–
More than SHS/SSS, but not Bachelor's	13.9%	–
Bachelor's degree or more	5.2%	–
Married	77.1%	–
Relationship to child		
Biological mother	52.6%	–
Biological father	35.0%	–
Other	12.5%	–
Household economic shocks		
Disruption of daily wage/earnings	65.1%	–
Increase in prices of major food items	56.0%	–
Illness or death of household member	14.2%	–

[a] Grade level based children's grade level when tracked in February 2020 before schools closed. All children were enrolled in primary school.

Primary caregivers of these children (88% biological parents) were invited to participate in a phone survey and identified as "… the person who takes primary responsibility for the child's education and who could best talk about the child and his or her experiences in school and at home. It may be the child's parent, a family member, guardian, or another individual." Caregivers were, on average, 42.1 years-old ($SD = 8.8$) and 62% female. Families were spread across eleven districts in the Greater Accra Region. Thirty-two percent ($n = 650$) of caregivers had at least completed senior high school; we classify these caregivers as having high socioeconomic status, with the remaining 68% ($n = 1390$) of caregivers characterized as having low socioeconomic status. Table 1 presents a more detailed breakdown of caregivers' education levels and other key child and caregiver demographics.

Children's teachers prior to schools closuring were also recruited prior to school closures as part of the longitudinal follow-up of this sample. Data were collected through a phone survey by trained interviewers. Nearly all interviews were conducted in English; three were administered in Twi. There were notable differences in teachers' sociodemographic characteristics by school type: on average, public-school teachers had nine years additional teaching experience ($M = 14.7$ versus 5.5 years) and were 12 years older than private-school teachers (39.5 versus 27.5 years of age). Moreover, 82% of public-school teachers had at least bachelor's degrees, compared to only 14% of private-school teachers.

5.3. Measures

5.3.1. Remote learning activities offered by schools

Teachers who reported that their schools engaged in remote learning (54%, $n = 274$ across 203 schools) were asked about the ways in which their schools participated: (i) online classes (live and/or prerecorded); (ii) distribution of hardcopy materials to children; (iii) materials distributed via WhatsApp or email or text; (iv) encouragement of students to follow TV and radio learning programs; and (v) community-based group learning. These items were adapted from Hamilton et al. (2020). See Table 2 for descriptive statistics for each item by school type.

5.3.2. Engagement in remote learning

Children and caregivers were asked the same set of five items to assess the various modes in which children were *engaged in distance learning* since schools were closed in mid-March 2020. Respondents were asked whether the child had pursued each of the following activities: (i) independent study (i.e., without direction from teachers); (ii) exercises from teachers; (iii) educational television or radio programming; (iv) online courses; and (v) private tutoring. Sum scores were generated for the child and caregiver report items, resulting in two scales ranging from 0 to 5 ($M = 1.9$, $SD = 1.12$ for child-reports, and $M = 2.20$, $SD = 1.08$ for caregivers-reports). These items were adapted from the Gender and Adolescent Global Evidence Core Respondent survey module (Baird, Małachowska & Jones, 2020).

5.3.3. Literacy and math test scores

We adapted select modules from the Early Grade Reading Assessment (EGRA; RTI International, 2016), Early Grade Mathematics Assessment (EGMA; RTI International, 2016a), and the Young Lives study (Boyden, 2018). *Literacy* included three sub-tasks measuring oral vocabulary (children were asked to list words that began with the letter "B"; 50% correct), spelling (children were asked to spell words such as "flower" and "sun"; 47% correct), oral comprehension (children were read a brief passage in English or local language

Table 2
One-way Analyses of Variance of Teacher, Child, and Caregiver Reports of Engagement in Remote Learning by School Type.

Measure	Private School %	Public School %	*F*-statistic	*p*-value	*q-value*
Remote Learning Activities Offered by Teachers (n = 274)[a]					
Online classes (live and/or prerecorded)	42.3%	5.5%	59.10	0.000	0.001
Provide hardcopy materials	32.2%	78.0%	72.29	0.000	0.001
Provide materials via WhatsApp, email, or text	61.7%	15.7%	76.37	0.000	0.001
Encouraged TV and radio learning	26.2%	78.0%	99.50	0.000	0.001
Community-based group learning	2.0%	5.5%	2.41	0.122	0.056
Child-report Engagement in Remote Learning (n = 1709)					
Online courses	9.0%	2.9%	27.01	0.000	0.001
Private tutor	32.6%	20.4%	32.58	0.000	0.001
School assignments (exercises given by teacher)	38.2%	25.7%	30.62	0.000	0.001
Educational TV or radio	47.8%	46.2%	0.48	0.489	0.174
Independent study	79.0%	76.5%	1.60	0.206	0.090
No participation in remote learning	2.4%	5.8%	13.07	0.000	0.001
Caregiver-report Engagement in Remote Learning (n = 1554)					
Online courses	9.9%	2.9%	29.64	0.000	0.001
Private tutor	38.1%	27.4%	19.72	0.000	0.001
School assignments (exercises given by teacher)	50.0%	36.2%	29.96	0.000	0.001
Educational TV or radio	54.7%	54.9%	0.00	0.945	0.201
Independent study	81.7%	78.0%	3.32	0.069	0.036
No participation in remote learning	0.2%	0.8%	2.44	0.119	0.056

[a] Represents over half (54%) of teachers surveyed who reported offering some form of remote learning to students.

and asked to respond to comprehension questions [17 items total; α = 0.68]; 62% correct). The percentage correct was calculated for each of the individual sub-tasks (scored from 0 to 1), the average score was subsequently calculated across the three components. *Math* included two sub-tasks measuring number discrimination (identifying the larger number out of a pair; 81% correct), and operations and numbers (solving for mathematics problems including addition, subtraction, and multiplication [16 items total; α = 0.61]; 46% correct). The percentage correct was calculated for each of the individual sub-tasks (scored from 0 to 1), the average score was subsequently calculated across the two components. Both literacy and math composite variables were standardized with mean (M) of zero and standard deviation (SD) of one for analysis.

5.3.4. *Children's access to learning materials*

We asked children to report on a total of ten (1) 'yes' / (0) 'no' items to capture whether children had access to necessary materials, resources, and space to adequately learn from home. These ten items included books (both school textbooks and other reading material), technological devices (TV, radio, computer or laptop, tablet or e-reader, and internet connectivity), electricity, basic writing materials (i.e., pen, paper, notebook, etc.), and appropriate physical spaces to study and/or attend the virtual class in the home (i.e., desk, chair/mat, access to natural, solar, or electric light). See Fig. 1 for descriptive statistics for each of the items by public and private school enrollment status.

5.3.5. *Food insecurity and household hardship*

Child food insecurity was measured by a single item from Baird et al. (2020), in which children were also asked to report how often they felt hungry within the past four weeks (0 = never; 1 = at least once). Note that child food insecurity had only a small correlation with household socioeconomic status ($r = 0.11$, $p < .001$).

Household economic hardship was captured by asking caregiver respondents whether they had experienced the following three events within the past 15 days: "disruption of daily wage/earnings"; "increase in prices of major food items consumed"; and "illness, injury, or death of household members". These items were developed by the World Bank as part of an initiative to look at the impacts of COVID-19 on families with young children. We model household economic shocks and child food insecurity as a cumulative risk index ($M = 1.67$, $SD = 1.04$, *range* = 0 – 4), summing the number of shocks that households experienced as the key predictor, while controlling for several key demographic characteristics (children's ages and sex, private vs. public school, district, and baseline academic scores).

6. Analytic plan

We first describe the rates of barriers and enablers to children's engagement in remote learning activities. Then, we employ

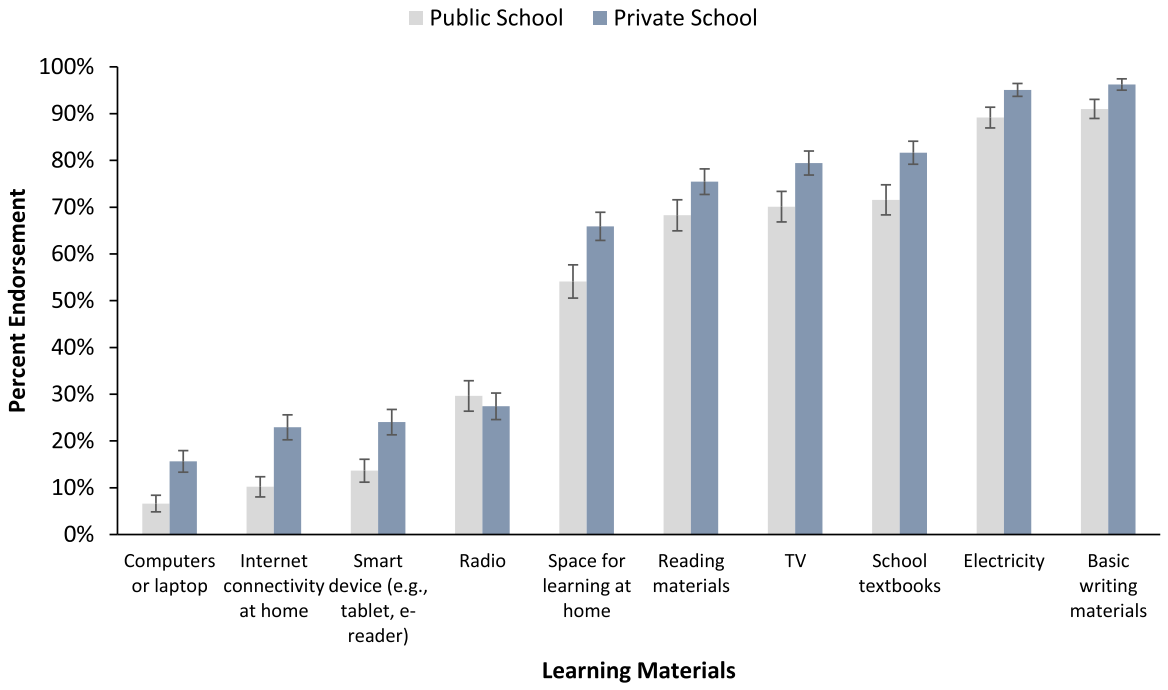

Fig. 1. Children's Access to Learning Materials at Home
Notes. Data reported by the child. Bars represent 95% confidence intervals. All differences are statistically significant at $p < .001$, except for access to radio ($p = .314$).

multivariate analysis that adjusted for baseline covariates—including children's baseline literacy and math outcomes—and for clustering of children within baseline schools to assess how economic hardship experienced during the pandemic predicted engagement in remote learning and learning assessment scores, as well as gaps in learning assessment scores across sociodemographic subgroups. Our 'value-added' estimates, which control for children's early childhood test scores, in addition to a range of family and child covariates, adjusts for unobserved factors associated with our outcomes, including individual child-level heterogeneity in ability levels, as well as in unobserved parental preferences and investments related to child development.

7. Results

Research Question 1: What activities did primary schools offer for remote learning in peri-urban Ghana across private and public schools, and at what rates did students engage with remote learning opportunities?

The first panel in Table 2 show differences observed in the provision of remote learning activities provided by private and public schools, as reported by children's teachers. Only 53% of teachers ($N = 274$ across 203 schools) reported that their schools offered any remote learning activities. Private schools were more likely than public schools to promote individualized learning, provide online classes (42.28% versus 5.51%, $p < .001$) and provide materials via WhatsApp, email, or text (61.74% versus 15.75%, $p < .001$). In contrast, public schools were more likely to supply generalized learning support through the encouragement of participating in educational TV and radio programming (77.95% versus 26.17%, $p < .001$) and providing hardcopy materials to their students (77.95% versus 32.21%, $p < .001$).

Reports from children and caregivers reflect the same patterns. Notably, only 8.2% of children did not report engaging in any form of remote learning activity, though rates for most of these activities were generally low. The second and third panels of Table 2 display rates of participation in five common remote learning activities. In both caregivers' and children's reports, children in private schools were significantly more likely to engage in online courses (9.1% versus 2.9% and 9.9% versus 2.89%, $p < .001$, for children's and caregivers' reports, respectively), have access to private tutors (32.6% versus 20.4% and 38.1% versus 37.4%, $p < .001$, for children's and caregivers' reports, respectively), and receive assignments from their teachers (38.2% versus 25.7% and 50.0% versus 36.2%, $p < .001$, for children's and caregivers' reports, respectively). No statistically significant differences were found for children's independent study or use of educational TV or radio for children's or caregivers' reports.

Research Question 2: What supports and barriers to remote learning engagement did students encounter?

Most children, across both private and public schools, had access to basic writing materials, electricity, school textbooks, and televisions (Fig. 1). However, few children had access to technological devices including tablets, computers or laptops, and internet connectivity, particularly children in public schools. The largest disparities in children's access to learning materials at home by school type were for internet connectivity, space for learning at home, access to school textbooks, and access to tablets or e-readers. Table 3 presents child reports on how caregivers supported children's remote learning during school closures. Children who attended private schools generally reported higher levels of support, including in organizing study groups, help accessing mobile applications, calling teachers or head teachers, helping with homework, buying learning materials, and telling children to study.

Research Question 3: Controlling for previous test scores, were household economic shocks associated with less remote learning engagement and worse literacy and math test scores for students?

Most caregivers reported a disruption in daily wages/earnings (65.1%) and increases in prices of major food items (56.0%) in the past 15 days due to the pandemic. In addition, 30% of children reported that they felt hungry within the past four weeks due to lack of food. As shown in Table 4, controlling for previous test scores, cumulative economic hardship did not strongly predict engagement in remote learning, with a marginally statistically significant negative association with child-reported engagement ($b = -0.048$, $SE = 0.027$, $p < .10$), and no significant association with caregiver-reported engagement. Cumulative economic hardship was associated with lower literacy test scores ($b = -0.062$, $SE = 0.023$, $p < .01$) and math test scores ($b = -0.052$, $SE = 0.023$, $p < .05$).

Research Question 4: Controlling for previous test scores, were there gaps in children's engagement in remote learning, literacy, and math test scores across public and private school students, between boys and girls, by household SES, and food security/insecurity?

Fig. 2 displays the regression-adjusted inequalities in children's remote learning engagement by plotting the gaps between food-insecure and food-secure children, boys and girls, children in public and private schools, and high- and low-SES households in the number of activities reported by children and caregivers. These models control for baseline KG class type (KG1, KG2, or mixed KG class), district, children's ages, as well as children's 2015 test scores for each respective outcome in a 'value-added' estimation framework and adjust standard errors for the clustering of children within baseline schools.

Small gaps in participation were observed for all groups. Specifically, food insecure children reported lower engagement than food secure children ($b = -0.16$, $SE = 0.06$, $p = .009$; $b = -0.09$, $SE = 0.06$, $p = .159$, for child- and caregiver-reports, respectively); girls reported great engagement than boys ($b = 0.15$, $SE = 0.05$, $p = .002$; $b = 0.21$, $SE = 0.05$, $p < .001$, for child- and caregiver-report, respectively); children enrolled in public schools prior to school closures reported less engagement than those enrolled in private school ($b = -0.26$, $SE = 0.06$, $p < .001$; $b = -0.28$, $SE = 0.06$, $p < .001$, for child- and caregiver-reports, respectively); and children living in low-SES households reported less engagement than those living in high-SES households ($b = -0.28$, $SE = 0.07$, $p < .001$; $b = -0.17$, $SE = 0.06$, $p = .005$, for child- and caregiver-report, respectively).

Fig. 3 displays the regression-adjusted inequalities in children's literacy and math test scores by plotting the standardized gaps between food-insecure and food-secure children, boys and girls, children in public and private schools, and high- and low-SES households. For math scores, statistically significant differences were found between high-SES children. These perform 0.31 SD higher than their low-SES peers ($SE = 0.05$, $p < .001$). Similarly, children in public schools performing 0.27 SD lower than their

Table 3
One-way Analyses of Variance of Child Reports of Caregiver Support with Remote Learning by School Type and SES.

Measure	Private School %	Public School	*F*-statistic	*p*-value	*q*-value
Organize group study	13.6	5.6	25.55	0.000	0.001
Help with accessing mobile app	16.9	10.1	13.4	0.000	0.001
Call teacher or head teacher	33.7	22.4	22.43	0.000	0.001
Pay for tutor	49.6	35.8	28.06	0.000	0.001
Help with schoolwork	64.0	57.8	5.66	0.018	0.013
Provide a space to study	65.8	59.2	6.70	0.010	0.008
Teach with school material	61.7	60.9	0.09	0.765	0.189
Buy learning materials	69.0	63.4	5.03	0.025	0.016
Tell child to review books	75.6	66.2	15.57	0.000	0.001
Reduce household chores	67.0	64.2	1.20	0.273	0.074
Allow time for TV classes	65.0	61.1	2.25	0.134	0.038
Allow time for radio classes	13.6	20.8	12.99	0.000	0.001
Provide internet access	26.3	15.8	22.96	0.000	0.001

Note. Only asked if children reported receiving support from caregiver ($N = 1566$); 54% of which attend private school.

Table 4
OLS Regression Models of Cumulative Risk Index Predicting Child Learning and Engagement in Remote Learning.

	Literacy	Math	ERL (child-report)	ERL (caregiver-report)
Cumulative risk index (0–4)[a]	−0.062**	−0.052*	−0.048+	0.022
	(0.023)	(0.023)	(0.027)	(0.027)
Baseline academic outcome	0.307***	0.292***	0.147***	0.149***
	(0.030)	(0.030)	(0.038)	(0.038)
Private school	0.340***	0.258***	0.259***	0.278***
	(0.060)	(0.058)	(0.060)	(0.061)
Child female	0.114*	0.022	0.165**	0.209***
	(0.048)	(0.049)	(0.057)	(0.057)
Child age	−0.092***	−0.085***	−0.064*	−0.139***
	(0.024)	(0.023)	(0.025)	(0.027)
Constant	0.613*	0.634*	2.260***	3.096***
	(0.262)	(0.256)	(0.278)	(0.290)
Observations	1476	1476	1476	1369
R-squared	0.160	0.119	0.050	0.070

Notes. Robust standard errors in parentheses. ERL = engagement in remote learning. Coefficients for additional covariates not shown. Additional covariates include grade-level and district dummies from first wave of data collection.

+ $p < .10$.
* $p < .05$,.
** $p < .01$.
*** $p < .001$.
[a] Sharpened *q*-values were calculated to compare to the original *p*-values (Anderson, 2008), with $q = 0.031$, 0.042, 0.056, and 0.103 for cumulative risk predicting literacy, math, child-reported ERL, and caregiver-reported ERL, respectively.

private-school peers ($SE = 0.06$, $p < .001$), while food-insecure children score 0.21 SD worse than their food-secure counterparts ($SE = 0.05$, $p < .001$). No differences were found by child sex.

Similar patterns emerged for literacy scores. Statistically significant group differences were found with high-SES children performing 0.40 SD higher than their low-SES peers ($SE = 0.05$, $p < .001$), children in public schools performing 0.33 SD lower than their private-school peers ($SE = 0.06$, $p < .001$), and food-insecure children scoring 0.21 SD worse than their food-secure counterparts ($SE = 0.05$, $p < .001$). Unlike math, there was variation by child sex with girls scoring 0.10 SD higher than boys ($SE = 0.05$, $p = .026$).

8. Discussion

This study provides an in-depth snapshot into children's learning opportunities during COVID-19 induced school closures in Ghana. By providing rich descriptive data, as well as robust statistical models examining inequities in access to remote learning opportunities and learning outcomes by controlling for previous test scores, the results highlight the potential consequences of growing inequalities schools have been dealing with since schools have re-opened in Ghana and around the world. Our results provide insight into the types of issues schools have been encountering since re-opening and inform ongoing efforts to address inequalities. Our sample is drawn from the Greater Accra Region, the fastest growing and most developed region in Ghana, and communities were mostly urban or *peri* urban. Evidence suggests that children in rural communities were less likely to access remote learning opportunities and that learning loss might have been greater in these more previously disadvantaged communities (UNICEF, 2020); if data were available, replicating these findings in rural, poorer parts of Ghana would be critical to provide a fuller picture of how children and their families were

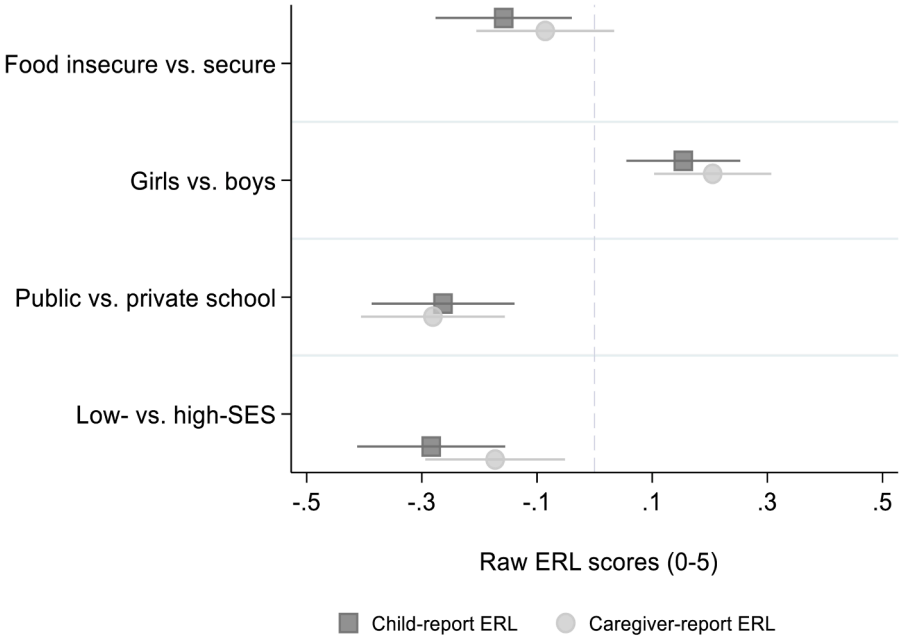

Fig. 2. Inequalities in Child- and Caregiver-report Engagement in Remote Learning Activities
Note. $N = 1612$ and $N = 1497$ for child- and caregiver-report, respectively. ERL = engagement in remote learning. Unstandardized coefficient plots estimated from separate regression models that control for children's 2015 academic scores, grade level at baseline, district fixed effects, and child age, with clustered standard errors at the baseline school-level. Food insecure vs. secure ($b = -0.16$, SE = 0.06, $p = .009$; $b = -0.09$, SE = 0.06, $p = .159$, for child- and caregiver-report ERL, respectively); girls vs. boys ($b = 0.15$, SE = 0.05, $p = .002$; $b = 0.21$, SE = 0.05, $p < .001$, for child- and caregiver-report ERL, respectively); public vs. private school ($b = -0.26$, SE = 0.06, $p < .001$; $b = -0.28$, SE = 0.06, $p < .001$, for child- and caregiver-report ERL, respectively); and low vs. high-SES ($b = -0.28$, SE = 0.07, $p < .001$; $b = -0.17$, SE = 0.06, $p = .005$, for child- and caregiver-report ERL, respectively).

impacted overall in the country.

9. Access to learning opportunities

First, in line with evidence from other settings, we find significant inequalities in who had access to learning opportunities while schools were closed controlling for pre-pandemic learning outcomes and sociodemographic characteristics. We show that gaps were especially marked by school type. In public schools, teachers primarily encouraged children to engage with the TV and radio learning programs provided by the government and provided hardcopy materials to students, while private schools were much more likely to provide students with individualized learning opportunities and direct supports including assignments given by teachers and online courses. These differences were very consistent across child- and caregiver-reports of children's engagement in remote learning activities. Beyond public- and private-school differences, we observed economic hardship as a key additional factor in predicting disparities in children's learning opportunities. In regression-adjusted models, we documented that children living in lower-SES households, food insecure children, and children experiencing more severe recent household economic shocks were all less likely to engage in remote learning opportunities.

Importantly, each of these measures represented distinct elements of economic disadvantage, with significant but small to moderate correlations ($r = 0.11$ between food insecurity and low-SES; $r = 0.56$ between food insecurity and cumulative economic hardship; $r = 0.16$ between low-SES and cumulative economic hardship). Further, while not reported in the results, important differences in indicators of household economic hardship were found by primary caregiver sex. Specifically, female caregivers were more likely to report experiencing disruptions in their daily earnings (68% versus 60%, $p < .001$ for females and males, respectively) and an increase in major food prices (59% versus 51%, $p < .001$ for females and males, respectively) within the last 15 days compared to male respondents. No statistically significant differences were found by caregiver sex related to whether households experienced deaths or illnesses. Of the three shocks assessed, 80% of all households experienced at least one, and 7% experienced all three.

We also identified several key barriers to distance learning as reported by children and their caregivers, which have been reported in other studies as well (e.g., UNICEF, 2020). These included a lack of access to devices and internet for both teachers and students, as well as a lack of support at home to participate in remote learning activities. Importantly, the most common form of learning engagement was studying alone, and less than half of all children in our sample reportedly engaged in organized learning activities. Teachers reported several challenges with remote learning (results available upon request), with the most common including both students and teachers lacking access to internet or devices, and more than half of teachers reporting poor support from their schools

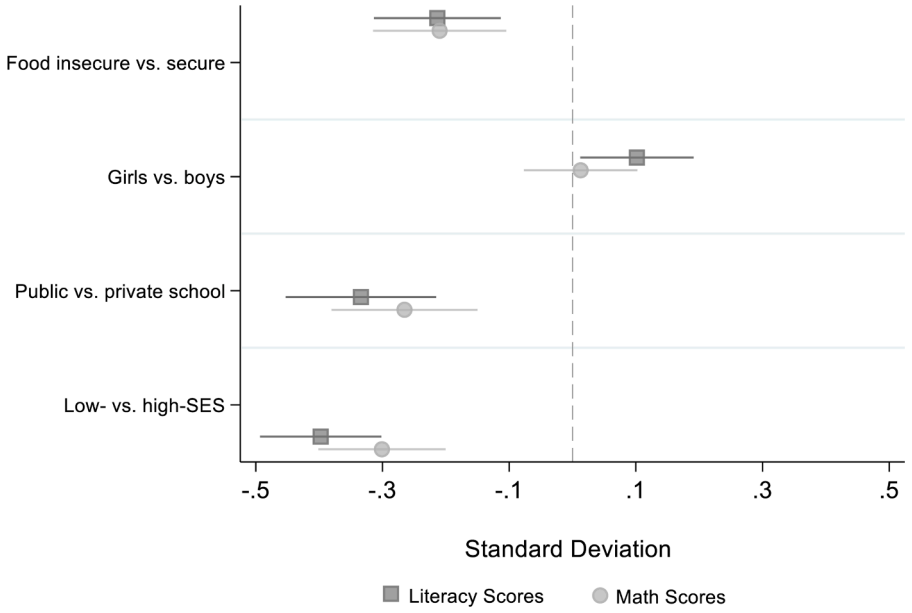

Fig. 3. Standardized Learning Inequalities in Literacy and Math Test Scores
Note. $N = 1628$. Standardized coefficient plots estimated from separate regression models that control for children's 2015 academic scores, grade level at baseline, district fixed effects, and child age, with clustered standard errors at the baseline school-level. Food insecure vs. secure ($\beta = -0.21$, SE = 0.05, $p < .001$; $\beta = -0.21$, SE = 0.05, $p < .001$ for literacy and math, respectively); girls vs. boys ($\beta = 0.10$, SE = 0.05, $p = .026$; $\beta = 0.01$, SE = 0.05, $p = .777$ for literacy and math, respectively); public vs. private school ($\beta = -0.33$, SE = 0.06, $p < .001$; $\beta = -0.27$, SE = 0.06, $p < .001$ for literacy and math, respectively); and low vs. high-SES ($\beta = -0.40$, SE = 0.05, $p < .001$; $\beta = -0.30$, SE = 0.05, $p < .001$ for literacy and math, respectively).

and from children's caregivers. Nearly half of teachers reported feeling overwhelmed and unsupported during the period of school closures, suggesting that these barriers likely limited the types of opportunities teachers and schools could offer.

10. Documenting learning gaps

We capitalized on a unique longitudinal sample where we had measured learning levels of children before the pandemic, allowing us to examine differences in both literacy and math outcomes controlling for previous learning levels. Our results for learning outcomes paralleled our findings for learning opportunities. Controlling for pre-pandemic learning outcomes, high-SES children performed better than their low-SES peers in both math and literacy (0.31 and 0.40 SD, respectively); food-secure children scored better than food-insecure children (0.21 SD for both math and literacy), and children in private schools performed better than those in public schools (0.27 and 0.33 SD, respectively). Importantly, there were no gaps in math scores between boys and girls, but boys did perform slightly worse than girls in literacy (0.10 SD). This is important to document given that a previous study in Ghana have showed that girls experience greater learning loss than boys when schools close (Akyeampong et al., 2021).

11. Implications for policy and practice

Schools re-opened in Ghana in January 2021 after ten months of being closed. To reopen schools safely, the Ghana Education Service (GES) implemented structural changes to address both health and educational needs. For example, each school was to be provided with disinfectant and water, sanitation, and hygiene (WASH) facilities, as well as washable and reusable facemasks for all staff and students. Further, school buildings were no longer being used for any outside activities.[2] School heads were also tasked with splitting large classes into smaller classes to ensure that student seating adhered to social distancing guidelines. In addition, adjustments to students' grade transition requirements, curriculum, and assessments were prominent at the kindergarten to the primary-school level.

Our findings suggest that some additional strategies may help to address inequalities that likely grew during the pandemic and may grow if schools close again in the future. These lessons are likely relevant for other countries, given widespread documentation of inequalities in access to learning opportunities during school closures within several LMICs (UNICEF, 2020). First, it is key to meet

[2] Ghana Education Service. 2021. Guidelines for school re-opening during covid-19 for safe and healthy schools. A resilient education system. Retrieved from https://ges.gov.gh/wp-content/uploads/2021/01/REOPENING-GUIDELINES-2021.pdf

students at their learning levels in the classroom. Even before school closures, differing learning levels within the same class groupings posed challenges for teachers and students, and our findings suggested that school closures may have exacerbated this problem given children's varying levels of access to educational support. Targeted instruction—or differentiated learning—includes grouping children according to learning level and teaching to that level. This technique can be particularly effective in contexts where class sizes are large and many students repeat grades, meaning that students in any one class have an extraordinarily wide range of skill levels and abilities (Banerjee et al., 2016).

Second, engaging parents to improve the quality of the home-learning environment is widely recognized as a key factor supporting young children's early literacy and math skills, and this may be even more the case while older children were not in school. There are few studies in the African context, but the limited evidence suggests that a similar approach can enhance parental engagement in children's education in both Cote d'Ivoire (Lichand & Wolf, 2021) and Ghana (Authors).

Third, while our sample is relatively more advantaged compared with the rest of Ghana, we still found high rates of hunger reported by study children. This is consistent with a recent study documenting widespread food insecurity in poor households in several LMICs, including Ghana (Egger et al., 2021). Household food security, defined as stable access to sufficient and nutritious food, is critical to meet children's developmental and learning needs (Aurino, Fledderjohann & Vellakkal, 2018; Fram, Bernal & Frongillo, 2015; Frongillo et al., 2022). Even intermittent food insecurity and malnutrition during early childhood can have detrimental long-term and intergenerational effects on health, education, and income (Authors; Behrman et al., 2009), leading to considerable losses for both individuals and societies (Subramanian, Mejía-Guevara & Krishna, 2016). Similar results were found among primary school-aged children in Ghana (Aurino et al., 2020). One key factor behind this rise in child hunger among low-SES and public-school children may be the discontinuation of the Ghana School Feeding Program, as the vast majority of public (but not private) school children reported receiving free school meals before the pandemic. Research from Ghana and elsewhere shows school meals are scalable and effective and improve nutrition and learning, especially for the poorest children and girls (Aurino et al., 2020), suggesting that school-feeding programs are key safety nets. It is critical to consider strategies that support children's food security if schools close again and to ensure children have access to school meals as they return to school to support their learning. Take-home food rations to distribute at school or cash transfers focused on families with children could help mitigate adverse impacts if schools close again, though such rations and transfers are at risk to be shared with other family members (Islam & Hoddinot, 2009).

12. Limitations and conclusions

This study provided an in-depth examination of children's learning experiences during school closures in Ghana. It is one of few studies that documented in such depth and from multiple perspectives—including children, caregivers, and teachers—engagement in remote learning opportunities, inequities in access, and inequities in learning outcomes. But two critical limitations are worth considering when interpreting our results. First, our sample focused on a select group of children in the Greater Accra Region who were enrolled in pre-primary school in the 2015–16 school year and were part of a previous study. Mobility and school dropout are common challenges to the school system in Ghana and many other LMICs, with disadvantaged children experiencing both at higher rates (Kamanda & Sankoh, 2015). This sample is not representative of all of Ghana, and likely represents a more advantaged sub-sample within the broader study given that children were able to be tracked and surveyed. Second, our learning assessments were brief and administered to children over the phone and do not represent the whole of children's literacy and math skills. They provide a very cursory estimate of children's skills. Phone-based learning assessments are new and best practices are still being developed (Angrist et al., 2020). In our sample, 14% of children reported that someone in the household helped them during the phone-based assessment; assessors reported hearing more than 25% receiving help during the assessment. Thus, interpreting the findings related to learning outcomes should consider these key challenges.

Recent efforts to harmonize global data on learning and human capital development show that countries in SSA have the lowest learning levels globally (Angrist et al., 2021). The COVID-19 pandemic led to school closures all over the world, leaving children across diverse contexts without formal education for many months, and schools have been grappling with the aftermath of this for over two years. Against an already low learning base and existing inequalities in children's access to quality education, these new challenges brought on by the 2020 school closures pose a significant challenge to governments and schools moving forward to ensuring all students learn. Additional research—including retrospective research and documenting the struggles and successes of schools in the years after schools re-opened—is needed to ensure all children's learning needs are met.

Acknowledgments

This paper reflects contributions from many organizations and individuals. We thank the committed staff and thought partners at Innovations from Poverty Action and the talented data collection supervisors and enumerators. We thank personnel at the Ghana Ministry of Education and Ghana Education Services for supporting this research. This research was funded by the UK Research and Innovation (UKRI)-Newton Fund. In addition, funding for the original study came from the UBS Optimus Foundation and the World Bank Strategic Impact Evaluation Fund and Early Learning Partnership, and the British Academy's Early Childhood Development Programme, supported under the United Kingdom Government's Global Challenges Research Fund and by the Department for International Development. Finally, we thank NYU Abu Dhabi Research Institute for core support to the Global TIES for Children Center, which provides intramural support to the seventh author for research activities that directly contributed to this article.

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