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Agriculture, nutrition and education: On the status and determinants of primary schooling in rural Mali before the crises of 2012



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ABSTRACT

This cross-sectional study examines the status and the determinants of primary education in food insecure areas of Mali. Net and gross enrolment ratios in primary school were between 0.3 and 0.4 for both girls and boys and well below national levels, highlighting a critical gap in terms of access to primary education. Schooling was found to respond to a broad range of determinants, including child's age and nutrition status, as well as on household consumption, on farm labour, teacher availability, and village level remoteness. Interestingly, no significant gender differences were found in terms of primary education. School meals were found to be associated with increased enrolment, attendance and attainment. The scale of the problem in Mali strongly suggests the need for investments in education and social protection to be prioritised and funded as part of national education policy and development strategies.

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1. Background

There is considerable evidence on the importance of primary education in fostering development outcomes in low- and middle-income countries. A number of studies using country level data have shown that primary education promotes economic growth by increasing country productivity and human capital (e.g. Hanushek and Woessmann, 2008; Cooray, 2009). Using household data, other studies highlighted that primary education may contribute to development not only through increasing workers wage (e.g. Psacharopoulos and Patrinos, 2004) and agricultural productivity (Alene and Mayong, 2007) but also through improving child and maternal health and reducing mother fertility (Breierova and Duflo, 2004). Policymakers in low- and middle-income countries are increasingly prioritising interventions aimed at improving primary school enrolment and education quality (Glewwe et al., 2011). The Millennium Development Goals (MDG) declaration set universal primary education as a key development target. Governments in low- and middle-income countries and development partners responded to the MDG call by dedicating large amount of resources to improve primary education. As a result, the last decade has seen remarkable improvements in terms of access

to education across many low- and middle-income countries (UN, 2013).

Yet challenges remain: the burdens of hunger, malnutrition and ill-health on school-age children are major constraints in achieving the Education for All (EFA) and MDGs on education (WFP, 2006). Poor nutrition and health among schoolchildren contributes to the inefficiency of the educational system (Politt, 1990). Children with diminished cognitive abilities perform less well and are more likely to repeat grades and to drop out of school; they also enrol in school at a later age, if at all, and finish fewer years of schooling (Jukes et al., 2007). The irregular school attendance of malnourished and unhealthy children is another factor in poor performance. Short-term hunger, common in children who are not fed before going to school, can have an adverse effect on learning. Children who are hungry have more difficulty concentrating and performing complex tasks (Grantham-McGregor et al., 1998).

The scale-up of school feeding programmes has been a key education sector response to recent food price and economic crises (WFP, 2013). Recent analyses suggest that every country in the world is seeking to feed its school children, though coverage is weakest where the needs in terms of poverty and food security¹ are

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¹ Food security, as defined by the Food and Agriculture Organisation of the United Nations, "exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 1996).

the greatest (Bundy et al., 2009). The scale-up has often been accompanied with the mainstreaming of school feeding within national education sector policies and plans. The programme theory on the educational effects of school feeding is generally well established and underpinned by an increasingly robust evidence base (see Alderman and Bundy, 2011; Kristjansson et al., 2007; Adelman et al., 2008, for recent reviews). School feeding programmes can support enrolment and attendance; and once children are in school, the programmes can contribute to their learning, through avoiding short-term hunger, enhancing attention and cognition, though the evidence on the latter point is mixed. In practice, school feeding programmes are complex interventions with many possible configurations, involving a broad range of activities by different stakeholders at different levels (Gelli and Suwa, 2014). As a result, the impact of school feeding programmes is heterogeneous and context specific. There is also little evidence however on the interaction between the quality of school food service and benefits to schoolchildren. This evidence is critical to further advocate for school feeding at policy level within the broader education sector planning and multi-sectoral collaboration framework.

1.1. The setting in Mali

Mali is, according to the Food and Agricultural Organisation of the United Nations (FAO) definition, a low-income food deficit country (LIFDC) with a population of 14 million people, over half of whom are under 15 years of age. According to the United Nations Development Programme (UNDP), Mali is ranked 178th in the Human Development Index table, with an average life expectancy at birth of 48 years, adult literacy rate of 26% and a gross domestic product (GDP) per capita (PPP) of \$1083 USD. The 2005 World Food Programme (WFP) food security and vulnerability analysis estimated that 4 million people, or 40% of the population lived in food insecurity or were highly vulnerable to food insecurity. According to this assessment, the regions most at risk were Kayes, Koulikoro, Mopti, Tombouctou, Gao and Kidal. Thirty-eight percent of children under five years of age were chronically malnourished or stunted in their growth (low height for age), 15% were acutely malnourished or wasted (low weight for height), and 27% were underweight (low weight for age), which is a composite measure of stunting and wasting (MDHS, 2007). The majority (81%) of children 6–59 months of age were anaemic, caused mainly by iron deficiency, malaria and helminth infections. Anaemia prevalence in school-age children was lower but still unacceptably high with 56% of school children affected (PCD, 2001). Thirty-seven percent of five year olds, when they were soon to be entering primary school, were stunted in their growth.

1.1.1. Primary education in Mali

According to official statistics, the net enrolment ratio increased from 20% in 1990 to 66% in 2007. Despite this progress, enrolment levels are still approximately 10 points below the average for Sub-Saharan Africa (see Fig. 1), and a large proportion of children are still excluded from schooling system. There is also indication of large intra-country disparities, in the regions of Koulikoro and Mopti for example, net enrolment ratios were estimated at 44% (WFP, 2005). Net daily attendance rates were also low across the country (Table 1). There is a paucity of literature on the determinants of primary education in Mali. Whilst a recent Oxfam report highlighted a number of constraints in terms of access to primary education and quality of schooling (Pearce et al., 2009), the paucity of data and country specific literature on these issues limits the effectiveness of possible policy responses.

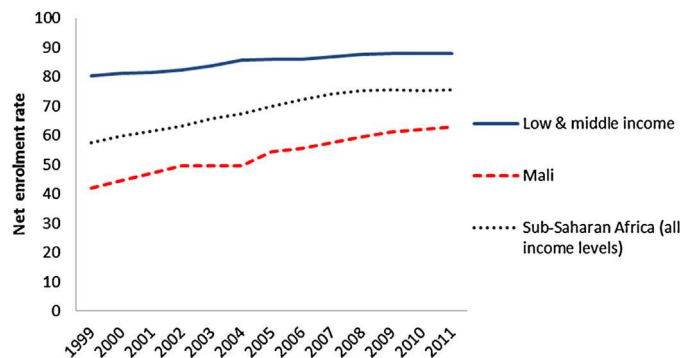


Fig. 1. Trends in the average primary net enrolment ratio in Mali, low- and middle-income countries, and in sub-Saharan Africa. Source: World Bank (2011).

1.1.2. The national school feeding programme in Mali

A national school feeding intervention was a key component of the Government of Mali's support to primary education in food insecure areas of the country. School feeding was included within Mali's ten-year Education Development Programme and its Education Sector Investment Programme as a way of increasing enrolment, reducing dropout, promoting schooling for girls, and supporting regions with poor access to education. In addition to the efforts of development partners, the Government of Mali demonstrated ownership of the programme by adopting a national school feeding policy in 2009, which called for "sustainably feeding pupils in schools so that hunger no longer constitutes a barrier to the education and development of a child" (Government of Mali, 2009). The policy provides both a formal reference for school feeding interventions across the country, and a platform to promote sustainability, resource mobilisation, and stronger partnerships between key stakeholders. A school feeding framework law, which provides guidelines for implementation and monitoring as well as further details on the roles and responsibilities for key stakeholders, is currently being validated by Parliament. Following the adoption of the national policy, the Government launched a national school feeding programme and earmarked \$8.5 million (USD) for implementation over three years. The areas targeted for scale-up included the 166 most vulnerable communes within the regions of Kidal, Tombouctou, Gao, Mopti, Koulikoro and Kayes (Fig. 2). The funds for the programme are channelled through the Ministry of Finance to its regional offices which in turn direct the funds to the Communes. Food commodities are procured on the market by the local authorities or by the school management committees. To date, there is no fixed food basket nor fixed nutrition specification for the school meals. The funds cover the procurement of staples, including cereals, pulses and oil. The fresh vegetables that complement the staples are provided by parents and other community stakeholders through cash or in-kind contributions.

1.1.3. The crises of 2012

A baseline survey for an impact evaluation of the national school feeding programme on small-holder agriculture, as well

Table 1
Trends in net attendance rates in Mali.

	1996	2001	2005
All Mali	26	35	41
Rural Mali	16	30	34
Rural Kayes	17	26	32
Rural Koulikoro	22	33	39
Rural Mopti	9	15	28

Source: DHS.

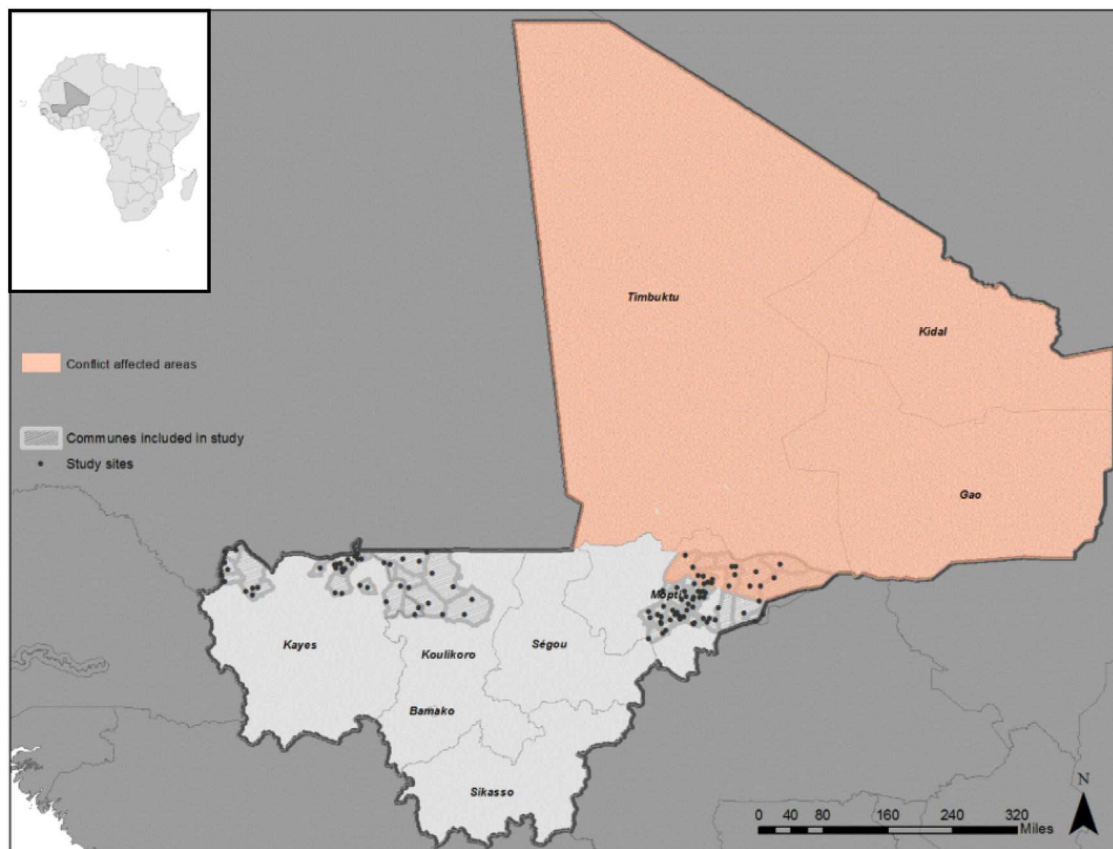


Fig. 2. Map of the survey and intervention area in Mali.

as on school children's education, health and nutrition in Mali was undertaken in January and February 2012 (Masset and Gelli, 2013). The survey work was completed only a few weeks before a coup d'état and a conflict within Mali's Northern regions involving ethnic Tuareg separatist and al-Qaeda-linked rebels. The crisis peaked in March and April 2012, when the whole of northern Mali fell into the hands of rebel groups. As a result, an estimated 500,000 people were displaced, both within Mali and into neighbouring countries. The political crisis also coincided with an increase in food prices across the country, another shock in a "perfect storm" affecting the country.

1.1.4. Objectives

This descriptive study is aimed at bridging the evidence gap on the status and the determinants of primary education in food insecure areas of Mali, based on a cross-sectional survey that included detailed household, school and village level characteristics before the crises of 2012. In addition, we take advantage of a sub-sample of children in the survey who received school meals, to also examine the influence of school feeding on primary education in food insecure areas.

The main research questions include:

- What was the status of primary school enrolment, attendance and attainment in food insecure areas of Mali before the crises of 2012?
- What were the determinants of primary school enrolment, attendance and attainment in food insecure areas of the country?
- What was the influence of school feeding programmes on primary school age children living in food insecure areas?

Whilst the focus of this paper is on primary education, a set of other complementary analyses are underway to examine food consumption patterns, and the links between consumption and nutrition status. The rest of this paper is structured as follows: after an overview of the survey and the data, we describe the methods of analysis, describe and discuss the main findings, and conclude.

2. Methods

2.1. Data sources

The data was collected as part of a baseline survey undertaken in 116 villages in Mali in 2012. The villages were part of a cluster randomised trial and were randomly selected among a set of food-insecure villages in the targeted regions. For all the details on the design and sampling procedure see Masset and Gelli (2013). 25 households were randomly selected for interview in each village. Village, mayor and school level surveys were also undertaken in all the communities. The household surveys included demographic characteristics, household and farm assets, economic activities, expenditure, farming and other income, anthropometry for all children aged over 2 years old, and a range of education indicators for all children aged 5–15 years of age. Table 2 summarises the data collection details. A total of 2719 households were surveyed out of 2900 originally planned. Due to the deteriorating security situation and to an on-going strike in the education sector, data was collected in 103 out of 116 schools in the sample.

2.2. Issues and hypotheses

We formulate hypotheses regarding the impact of school feeding on child schooling and learning starting from an economic

Table 2
Data collection coverage, cross sectional survey in rural Mali.

	Households		Schools		Mayors	
	Sample	Surveyed	Sample	Surveyed	Sample	Surveyed
Kayes	250	149	10	5	5	3
Diema	150	140	6	3	3	3
Nioro	450	450	18	16	9	8
Nara	300	263	12	11	6	5
Mopti	50	50	2	2	1	1
Bandiagara	800	789	32	30	16	16
Koro	400	398	16	16	8	6
Douentza	500	480	20	20	10	9
Total	2900	2719	116	103	58	51

model of parental educational choices in developing countries adapted from (Drèze and Kingdon, 2001, 1999; Glewwe, 2002). Fig. 3 below illustrates the determinants of schooling and learning. Schooling produces learning, which in turn has welfare effects. Schooling can be thought of as enrolment, attendance, and drop-out or school completion. Learning is the acquiring of basic skills, such as language and mathematics. These skills are valued in the labour markets and educated children are expected to generate higher incomes and wages. In addition, more educated individuals

may conduct healthier lives. In this model, the main determinants of schooling and learning include child characteristics, schooling costs, households' characteristics and school quality. Cognitive ability and motivation facilitate learning and encourage families to send children to school.

Children do not participate in schooling for various reasons; at the household level, it is often a trade-off between the costs and benefits of schooling that determine whether a child will go to school or not (Drèze and Kingdon, 2001). Costs are not only direct, such as school fees. For example, the opportunity cost of sending a child to school would mean foregoing the benefits of any work that the child could be doing instead of attending school. Often, the opportunity costs follow seasonal patterns, or increase with age, meaning that older children might need stronger incentives than younger children in order to stay in school (Hadley, 2010). The opportunity costs of schooling may also be higher for girls – girls are often kept at home to look after siblings, help with other work, or simply for cultural reasons. These costs have a direct effect on schooling but should not affect learning. Household characteristics such as income and preferences (including attitudes towards education, and time discounting) affect schooling directly, while other characteristics may affect learning directly (for example, more educated parents may improve learning by helping children with their homework). School quality affects learning directly

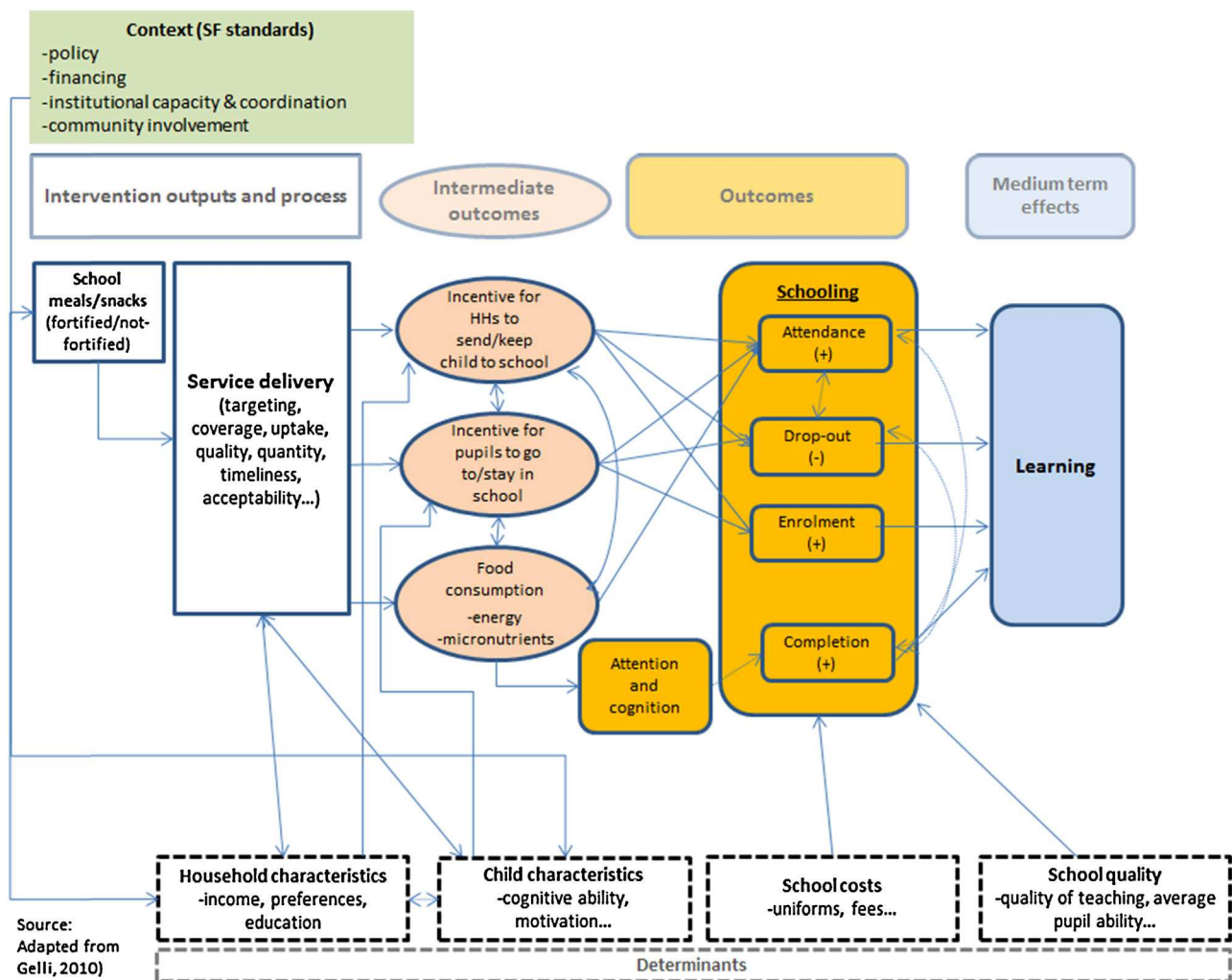


Fig. 3. A model tracing school feeding impact pathways leading to educational goals. The main determinants of schooling and learning are child characteristics, schooling costs, households' characteristics and school quality. Children do not participate in schooling for different reasons; at the household level, it is often a trade-off between the costs and benefits of schooling that determine whether a child will go to school or not. Source: Adapted from Masset and Gelli (2013).

through the quality of the teaching, the teaching environment and schooling, by affecting household schooling decisions. The provision of educational infrastructure and improvement of facilities can have substantive effects on enrolment (Burde and Linden, 2013; Kim et al., 1998). Reducing school fees reduces the direct costs of schooling which increases enrolment (Grogan, 2009). Similarly, the provision of free school meals reduces the financial and opportunity costs of schooling and provides an incentive to parents for sending children to school (Kazianga et al., 2008). School feeding may also have an incentive effect on pupils actually wanting to go to school to receive food rather than staying at home and foregoing a meal. The incentive to households to send children to school is an initial outcome that drives increased school participation. Generally, this incentive is achieved through an income transfer and also through an enhancement of the services provided in school. In theory, both of these effects will contribute to shift short-term household decisions towards increased schooling. Two recent systematic reviews also identified positive effects of school feeding on enrolment, attendance and drop-out (Krishnaratne et al., 2013; Kristjansson et al., 2007). School meals are in this sense also similar to conditional-cash transfers (CCTs): a recent meta-analysis of education interventions showed that CCTs increase enrolment and attendance, with stronger effects amongst the poorest children (Krishnaratne et al., 2013). The specific effect of the incentive will very much depend on the context in which the programme is operating.

School feeding may also generate positive feedbacks. Healthier and better nourished children are more likely to learn in class (Powell et al., 1998). School-age children typically have the highest intensity of worm infection of any age group (PCD, 2003). Deworming interventions have been shown to reduce the prevalence of anaemia and school absenteeism and contribute to the improvement of cognitive function in school age children (Grigorenko et al., 2006). However, a recent systematic review of deworming on nutrition and school performance found mixed effects (Taylor-Robinson et al., 2012). When infected children were treated, the evidence suggests that the intervention probably improves weight and may improve haemoglobin values. However, when all school children are treated, the evidence was much weaker. The income transfer incentive and the improved health and nutrition status resulting from school feeding service provision would lead to improved access and learning outcomes, though the evidence on the overall effects on learning is mixed. This is not surprising though, as the pathways leading from improved school access to improved learning via better health and nutrition are complex, involving direct and indirect effects that are not yet well understood. However, the two meta-analyses identified small but significant improvements in attendance, cognition and nutritional status in students receiving onsite meals compared to students in control groups (Krishnaratne et al., 2013; Kristjansson et al., 2007).

An important issue that affects the potential impact of school feeding involves the substitution effect, where children consume less at home when they benefit from a meal in school, therefore limiting the overall nutrient intake of participating students. If the children receiving the transfer consume sufficient calories already, then the reallocation may in fact allow the household to address the needs of younger siblings. If children benefitting from school feeding are malnourished, substitution within the household could reduce the potential health and nutrition benefits. The evidence on reallocation in households with beneficiaries of onsite feeding generally indicates that most of the calories provided by the programme “stick” with the beneficiaries (Jacoby, 2002; Ahmed, 2004). Another possible negative effect on learning of increasing class size through interventions has received considerable attention, however

evidence on this issue in the context of school feeding is also mixed (Ahmed and Arends-Kuening, 2003).

2.3. The dataset

The primary objective is to identify the status and determinants of primary education in food insecure areas of Mali. The main outcomes of interest are current enrolment, attendance and grade attainment (or years of schooling). Based on the conceptual framework presented in the previous section, the explanatory variables consist of a set of child, household, school and village level characteristics. The variables are listed alongside their descriptive statistics for the sample in Table 3. The analysis is conducted for children of primary school age which, allowing for late entrants and high levels of repetition, was set to 5–15 years of age.

The covariates for the regressions were selected on the basis of the model outlined in our hypotheses. Two child level variables describing the nutritional and health status were included. Height-for-age was used a proxy measure of chronic hunger and poverty (Alderman, 2000). Body-mass-index (BMI) was used to gauge the more immediate nutrition status. An indicator of labour related activities was also included at child level. The household level variables encompassed a range of socio-economic dimensions, including distance from school, parental education, a set of wealth related indicators (expenditure, farmland, and farm assets). The data also included school quality related indicators, including infrastructure and teaching. Village level indicators included overall safety, whether the village was considered to be food self-sufficient, as well as the proportion of children reached by school feeding. The overall distance to the closest secondary school was used as a measure of access and/or remoteness of the community. These indicators are also generally used to select schools that are eligible for the national school feeding programme, allowing some level of control for selection on these variables when examining the influence of school feeding on education.

2.4. Estimation strategy

We conducted a multivariable regression analysis of the determinants of three primary education outcomes, namely enrolment, attendance and attainment (years of schooling). Enrolment was captured as a dichotomous variable taking the value 1 if a child is currently enrolled in school and 0 if not. Attendance rate was an ordered categorical variable calculated as the number of school days attended over the last 5 school days, divided by 5. Logit and ordered logit regression were used to model enrolment and attendance rate respectively. Fixed effects models with covariates at regional, village, household and individual level variables were developed to account for the hierarchical nature of the data, and standard errors were clustered at village level. Covariance matrices and alternative model specifications were used to assess the influence of colinearities across the covariates and robustness of the models. Average marginal effects were estimated to provide measures of the average change in the outcome associated with a unit change in the covariate of interest whilst holding all other covariates constant. When analysing school attainment, the dependent variable was the highest school level achieved by each child. Because the sample includes children of different ages, different children have different attainment probabilities. For example, a child aged 8 is very unlikely to be in grade 5. Thus ordinary least square estimations of the determinants of attainment correlated with age, such as for example, birth order, per capita expenditure and the dependency ratio, are biased. This is a problem of censoring which can be addressed by using a Cox regression model with time invariant covariates (Jenkins, 2004). Survival time is taken as the years of schooling,

Table 3
Descriptive statistics for key variables in the study population.

Type	Variable	Obs.	Mean	Std. dev.	Min.	Max.	
Outcomes	Enrolled in primary school and aged 5–15	7503	0.394	0.489	0	1	
	School attendance rate over last 5 days	6916	0.334	0.466	0	1	
	Years of schooling	7503	2.07	1.72	0	14	
Covariates	Gender (girl = 1, boy = 0)	7503	0.47	0.5	0	1	
	Age in years	7503	9.3	3.08	5	15	
	Square of age in years	7503	95.99	60.7	25	225	
	Height for age z-score	6368	-1.4	1.78	-6	6	
	BMI for age z-score	6248	-0.95	1.28	-4.98	4.93	
	Child labour involvement	7503	0.38	0.48	0	1	
	Birth order	7503	3.94	2.19	1	17	
	Distance from school dummy (=1 if distance >1 km)	7503	0.25	0.44	0	1	
	Years of education of mother	7503	0.05	0.5	0	8	
	Years of education of head of household	7503	0	0.13	0	5	
	Per capita expenditure quintile	7503	2.76	1.36	1	5	
	Female headed household	7503	0.16	0.12	0	1680	
	Natural logarithm of value of farm capital	7388	11.74	1.55	6.62	15.77	
	Cultivated land in hectares	7503	4.13	4.84	0	80	
	Main occupation of household head is wage labour	7471	0.04	0.2	0	1	
	Count of food groups consumed in household	7454	6.74	1.42	1	10	
	Dependency ratio	7501	1.98	0.9	0.1	7	
	Polygamous household	7471	0.47	0.5	0	1	
	Ratio of classrooms with blackboard	6853	0.88	0.28	0	1	
	Number of teachers	6907	3.29	1.88	1	12	
	Village/school safety variable	6811	1.18	0.45	1	4	
	Schools receive free textbooks	6907	0.54	0.5	0	1	
	Proportion of children receiving school meals >10%	7503	0.19	0.4	0	1	
	Distance to secondary school	7503	3.69	1.29	1	5	
	Village participated in development project	7503	0.49	0.5	0	1	
	Village is food sufficient	6954	0.11	0.32	0	1	
	Region						
	Koulikoro	7503	0.09	0.29	0	1	
	Mopti	7503	0.62	0.49	0	1	

Source: HGSF baseline survey 2012.

with drop-out status used as censoring indicator representing the failure event. Missing data was analysed using tests for balance across the key covariates of interest and sensitivities to alternative imputation model specifications were also explored. The analysis was undertaken using STATA 13.

3. Results

A total of 7503 children aged between 5 and 15 years of age were interviewed. Thirteen of the 116 schools in the original sample could not be surveyed due to the security situation and the education sector strike. The results are presented starting with the status of education, followed by the analysis of the determinants of schooling and influence of school meals.

3.1. Descriptive statistics on status of primary education

3.1.1. Enrolment

A summary of the main policy relevant descriptive statistics for primary education in rural Mali are presented in Tables 4 and 5. Net and gross primary school enrolment ratios in the survey

population were estimated at approximately 0.4 for both girls and boys, about 20 points below national levels, highlighting a critical gap in terms of access to education. The main reasons for non-enrolment were children's low interest in schooling, labour related constraints and parental attitudes on schooling.

Average net enrolment ratios were higher in wealthier households, with the overall increases across quintiles ranging from 5 points for boys and 8 points for girls (Fig. 4).

Age effects appeared to be more complex, with enrolment ratios increasing from 0.14 at age 6 (the official age of entry at primary school) to 0.55 at age 9 and then dropping to 0.32 at age 15 (Fig. 5). Similar trends were observed for both girls and boys.

The age distribution within each school grade showed increasing average age across the grades as expected but also a broader spread in grade 4. These findings were also reflected in peaks in absolute enrolment in grade 4 and will require further analysis.

3.1.2. Attendance

At population level, mean children's attendance rates were very low, at just over 30% with similar trends for boys and girls, about 20

Table 4
Descriptive statistics, status of primary school enrolment and attendance in Mali.

Unit of analysis	Indicator (5–15 year age group)	Sample			National level		
		All	Girls	Boys	All	Girls	Boys
Child	Net enrolment ratio	0.39	0.39	0.40	0.63	0.59 ^a	0.67 ^a
Child	Gross enrolment ratio	0.43	0.42	0.45	0.82	0.87 ^a	0.76 ^a
Child	Mean weekly attendance ratio	0.33	0.34	0.33		0.55 ^b	0.62 ^b
School	Mean drop-out ratio	0.06	0.07	0.08			

Source: Mali HGSF baseline survey 2012.

^a UIS.

^b UNICEF, most recent available data.

Table 5
Descriptive statistics, status of schooling infrastructure in Mali.

Unit of analysis	Indicator	Sample	National level
School	Pupil to classroom ratio	43	52 ^a
School	Pupil to teacher ratio	45	54 ^a
School	Mean share of women teachers	0.21	0.26 ^a
School	Share of schools with school management committees (SMC)	0.93	
School	Share of schools with up to date registers	0.74	
School	Mean number of classrooms	3.5	
School	Mean number of classrooms with blackboard	3.2	
School	Share of schools where classes are taken outdoors	0.23	

Source: Mali HGSF baseline survey 2012.

^a UIS.

points lower than reported national levels. Average attendance rates increased marginally across consumption quintiles by 4 points in total for boys (from 0.31 to 0.35) and 7 points for girls (from 0.33 to 0.40). School-level drop-out ratios across all grades were 7% and 8% for girls and boys respectively. Classroom conditions in terms of lower pupil-to-classroom and pupil-to-teacher ratios appeared to be better in the sample schools compared to the national level, though there were fewer women teachers on average in the sample compared to the national average. The trends in attendance by age and consumption groups were similar to those observed in the case of enrolment.

3.1.3. Attainment or years of schooling

Approximately 64% of children aged 5–15 years had not completed a single year of formal schooling. In terms of adult literacy, over 95% of people aged over 15 and under 65 years had not achieved one year of formal schooling, while only just over 2% had completed primary school. These findings confirm both the very low levels of education in the survey population and the recent improvements in terms of enrolment.

3.1.4. Schooling infrastructure

In terms of school quality and infrastructure, pupil-to-classroom and pupil-to-teacher ratios were lower in the sample schools when compared to the national average (Table 5). Approximately one in five teachers was found to be female in the sample schools. Over a quarter of sample schools were found not to have up to date registers. Just over a fifth of sample schools were found to have classes outdoors, highlighting considerable infrastructure constraints.

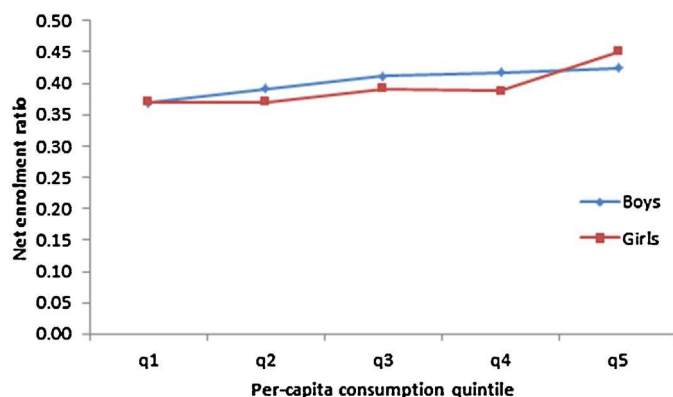


Fig. 4. Net enrolment ratio by gender and per-capita consumption quintiles in Mali. Enrolment ratios increase with consumption, and girl's enrolment is generally lower than that of boys except in the highest quintile. Source: HGSF baseline survey.

3.2. Determinants of primary school enrolment, attendance and attainment

The results for the regression models on enrolment, attendance rate and years of schooling are presented in Table 6. The findings are generally similar and fairly consistent across the three outcomes of interest.

3.2.1. Child level variables

Girls are not less likely to enrol in or attend primary school than boys. Separate regressions for boys and girls were also estimated and no gender differences were found, nor were significant effects found when the gender dummy was interacted with other covariates. Age and age-squared associations were highly significant and had opposite signs, confirming the complex age related schooling patterns observed in Fig. 5. Height for age z-scores had a strong positive association ($P < 0.001$) with enrolment and attendance, with similar effects sizes. BMI z-scores were negatively associated with both schooling outcomes ($P < 0.05$). Child labour was associated with lower likelihood of enrolment (marginally significant) but was not associated with lower attendance.

3.2.2. Household variables

Surprisingly both distance to school and parental education were not associated with schooling outcomes. Children of poorer households, as measured by per capita expenditure, were not less likely to enrol but were less likely to attend ($P < 0.05$). Cultivated land was negatively associated with both enrolment and attendance ($P < 0.05$) whilst farm capital was associated with higher attendance only ($P < 0.05$). Children from female headed households were found to have lower likelihoods of enrolment, though

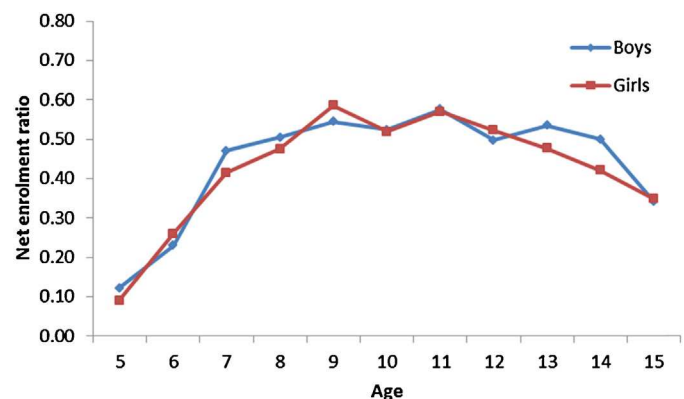


Fig. 5. Net enrolment ratios by gender and age in Mali. Enrolment ratios increase until age 9, peaking close to the end primary school and then decline. Source: HGSF baseline survey.

Table 6
Regression statistics of (a) logit model on primary school enrolment, (b) ordered logit model on primary school attendance rate and (c) Cox model on school attainment in Mali for children aged 5–15 years.

Variable	(a) Enrolment (logit)				(b) Attendance (ologit)				(c) Attainment (Cox)		
	Coef.	Std. err.	P	Marginal effect	Coef.	Std. err.	P	Marginal effect	Haz. ratio	Std. err.	P
Girl	−0.063	0.073	0.391	−0.013	−0.029	0.074	0.69	−0.006	1.036	0.037	0.316
Age in years	1.416	0.085	<0.001	0.296	1.484	0.093	<0.001	0.292	0.624	0.025	<0.001
Square of age in years	−0.066	0.004	<0.001	−0.014	−0.070	0.005	<0.001	−0.014	1.022	0.002	<0.001
Height for age z-score	0.097	0.021	<0.001	0.020	0.106	0.021	<0.001	0.021	0.963	0.010	<0.001
BMI for age z-score	−0.081	0.031	0.008	−0.017	−0.071	0.033	0.032	−0.014	1.024	0.015	0.100
Child labour involvement	−0.187	0.098	0.056	−0.039	−0.129	0.108	0.234	−0.025	1.075	0.043	0.072
Birth order	0.035	0.026	0.173	0.007	0.049	0.028	0.084	0.010	0.983	0.013	0.207
Distance from school dummy	0.139	0.148	0.345	0.029	0.028	0.146	0.85	0.005	0.930	0.040	0.092
Years of education of mother	0.015	0.050	0.771	0.003	0.017	0.060	0.779	0.003	0.997	0.036	0.932
Years of education of head of household	0.135	0.183	0.46	0.028	0.103	0.109	0.346	0.020	0.933	0.143	0.654
Per capita expenditure quintile	0.083	0.048	0.085	0.017	0.106	0.052	0.043	0.021	0.966	0.016	0.034
Female headed household	−0.516	0.280	0.065	−0.108	−0.409	0.299	0.171	−0.081	1.159	0.163	0.293
Natural logarithm of value of farm capital	0.066	0.040	0.098	0.014	0.079	0.040	0.051	0.016	0.978	0.012	0.071
Cultivated land in hectares	−0.018	0.007	0.015	−0.004	−0.023	0.009	0.014	−0.004	1.006	0.004	0.148
Main occupation household head is wage labour	0.044	0.130	0.737	0.009	0.124	0.157	0.43	0.024	0.978	0.093	0.818
Count of food groups consumed in household	−0.030	0.035	0.393	−0.006	−0.041	0.036	0.258	−0.008	1.013	0.014	0.359
Dependency ratio	−0.063	0.052	0.225	−0.013	−0.057	0.053	0.282	−0.011	1.030	0.027	0.246
Polygamous household	−0.009	0.083	0.911	−0.002	−0.024	0.089	0.79	−0.005	0.999	0.041	0.988
Ratio of classrooms with blackboard	−0.309	0.258	0.232	−0.065	−0.460	0.273	0.092	−0.091	1.112	0.078	0.133
Number of teachers	0.166	0.049	0.001	0.035	0.168	0.051	0.001	0.033	0.926	0.014	<0.001
Village/school safety variable	−0.160	0.190	0.401	−0.033	−0.170	0.199	0.392	−0.034	1.063	0.048	0.174
Schools receive free textbooks	−0.134	0.162	0.406	−0.028	−0.012	0.161	0.941	−0.002	1.045	0.043	0.284
Prop. of children receiving school meals >10%	0.626	0.161	<0.001	0.131	0.605	0.173	<0.001	0.119	0.781	0.038	<0.001
Distance to secondary school	−0.162	0.068	0.018	−0.034	−0.111	0.071	0.119	−0.022	1.072	0.019	<0.001
Village participated in development project	−0.077	0.148	0.604	−0.016	0.020	0.160	0.902	0.004	1.027	0.041	0.504
Village is food sufficient region	0.568	0.383	0.138	0.119	0.237	0.323	0.463	0.047	0.810	0.061	0.005
Koulikoro	0.514	0.306	0.093	0.107	0.775	0.279	0.005	0.153	0.823	0.064	0.013
Mopti	0.267	0.232	0.249	0.055	0.406	0.241	0.093	0.077	0.905	0.052	0.084
_Cons	−7.771	0.891	<0.001								
Log L	−3328				−3651				−27,337		
Pseudo R ²	0.109				0.096						
N	5511				5105				5511		

Source: HGSF baseline survey.

Note: Standard errors were clustered at village level.

the association was only marginally significant. The household dependency ratio, and the quality of household diets as measured through diet diversity were not associated with enrolment and attendance.

3.2.3. School and village level

At the school level, though school infrastructure was not associated with improved schooling outcomes, the number of teachers had a strong positive association with enrolment and attendance ($P = 0.001$). At village level, the proportion of children aged 5–15 with access to school meals over last 5 days was also strongly associated with increased enrolment and attendance ($P < 0.001$), with substantive effect sizes. Remote villages, as measured by access to secondary schools, were also found to have lower levels of enrolment ($P < 0.05$), though self-reported village level food sufficiency appeared not to influence enrolment or attendance. No statistically significant regional level associations were observed for enrolment, whilst attendance was found to be greater in the Koulikoro region ($P < 0.01$).

3.2.4. Survival analysis of school attainment

The Cox regression statistics for school attainment summarised in Table 6 are generally consistent with the findings on enrolment and attendance, though a few additional points are

worthy of note. BMI was not found to be associated with attainment. There was a negative association between household per capita expenditure and drop-out, with poorer households dropping out earlier ($P < 0.05$). A strong negative association was also found between attendance and the remoteness of communities, as measured through the distance to secondary school proxy. Village level food sufficiency was found to be positively associated with attainment. The plot of the survivor function for years of schooling highlights the main barrier at entry level (Fig. 6).

The plot of the smoothed hazard function confirms declining hazard post primary school entry until the end of primary school followed by an increase in hazard in the transition to secondary school (Fig. 7).

The plots of the survivor and smoothed hazard functions can also be used to illustrate the influence of school feeding on attainment. Villages with school feeding coverage above 10% had higher initial enrolment and higher retention (Fig. 8). The declining hazard rates until the end of primary are lower in villages that have school feeding coverage above 10% (Fig. 9). The regional effects identified in the Cox regression model were observed in similar plots of survival function by region not reported, suggesting that villages in Mopti had lower initial enrolment but higher retention than villages in Kayes or Koulikoro.

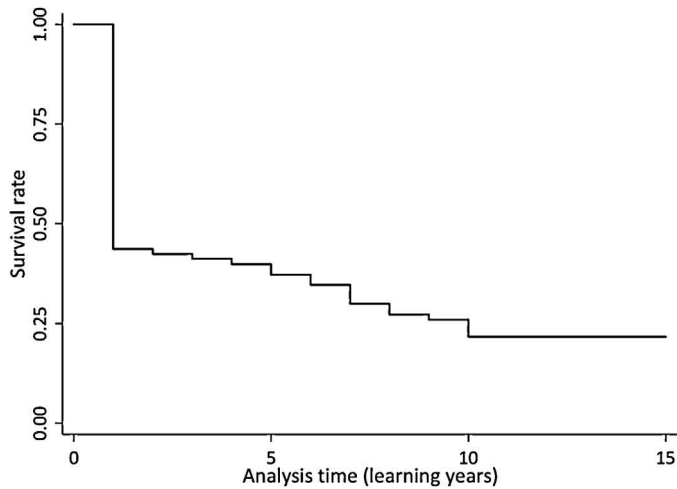


Fig. 6. Plot of the survivor function against years of schooling for children aged 5–15 in Mali. The main drop at entry level reflects the low enrolment rates in the survey population.
Source: HGSG baseline survey.

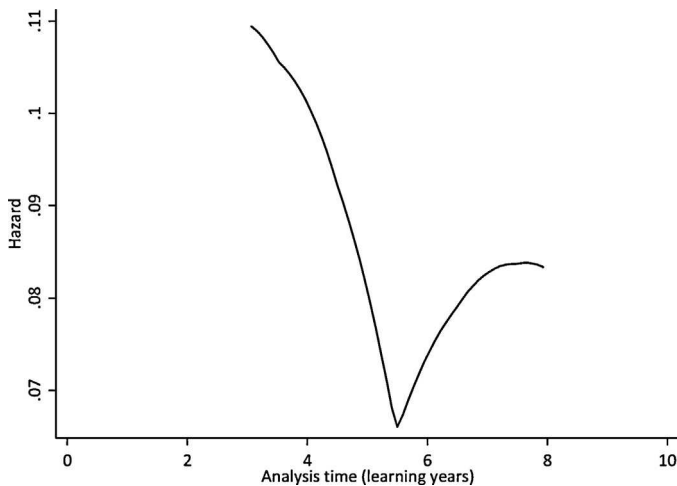
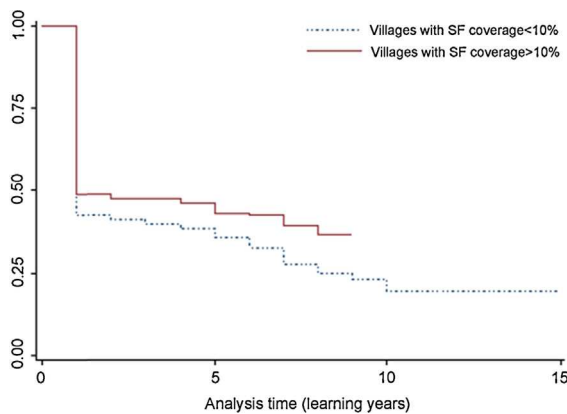


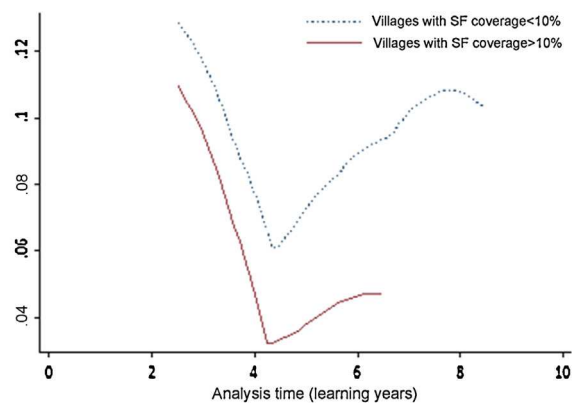
Fig. 7. Plot of the smoothed hazard function against years of schooling for children aged 5–15 in Mali. The main barrier at entry level reflecting the low enrolment rates is followed by uneven hazard rates.
Source: HGSG baseline survey.



4. Discussion

This study is the first in the literature to focus on the status and determinants of primary education in rural Mali. The findings of this analysis are bleak: primary net enrolment ratio was estimated at 40% for this population, about 20 points lower than national level statistics and well below Education for All and Millennium Development Goal targets. Enrolment trends by age showed signs of inefficiencies, likely due to a combination of late enrolment and repetition resulting in an increased density of students in grade 4, though this finding will require further analysis. Though the use of a dichotomous variable for measuring enrolment will not capture the nuances and variability of enrolment, where for instance children may only attend a few hours of school per day, the enrolment ratios were consistent with the estimated attendance rates, confirming the overall very low school participation. Moreover, the low levels of education were pervasive across all age groups, with only 2% of adults having completed at least a single year of primary school. Enrolment levels were higher in wealthier households, though the gradient across income groups was fairly flat. Importantly, differences across gender appeared to be negligible. The changes in primary enrolment with age were complex and roughly followed the shape of an inverted U-curve, increasing from about 14% at entry, peaking at 54% at age 9 and then dropping by nearly 20 points by age 15. At school level, though the findings suggested that the villages were slightly better off in terms of infrastructure when compared to national level statistics, the data on teaching and infrastructure highlighted a number of school quality constraints, including lack of teachers and classrooms, as well low school management capacity.

In the analysis of the determinants of education, as expected, child and household level variables tended to perform better than school and village level variables and in most cases had the expected sign. At child level, the complex age effects observed in the descriptive statistics were confirmed, highlighting an important area of future research. Strong associations were also found between nutrition status and schooling outcomes. The link between stunting and delayed enrolment is well known (Glewwe and Jacoby, 1995), and coupled with the negative association with BMI in the case of enrolment and attendance, highlights the complex nature of the nexus between nutrition status and schooling in contexts of poverty and food insecurity that requires further investigation. Gender, surprisingly, appears not to be a major determinant of schooling in Mali. Parental education was also not significant. The low influence of parental education is



Figs. 8 and 9. Survivor and smoothed hazard functions against years of schooling, with villages with school feeding coverage above and below 10%, for children aged 5–15 in Mali. Villages with school feeding coverage above 10% have higher initial enrolment and higher retention. Hazard rates decline until the end of primary school and are lower in villages with school feeding coverage above 10%.
Source: HGSG baseline survey.

likely explained by the strikingly low levels of adult literacy in the survey population. Distance to school was not significant, which may be partly explained by the school level data indicating important infrastructure constraints. Not surprisingly education was enhanced by household income. The negative association between enrolment and attendance with agricultural land suggests that some of the trade-offs between labour and education were not fully captured in the child level labour dummy variable.

The quality of schooling is clearly also a major constraint. As expected, at the school level the number of teachers had positive, significant coefficients for all the outcomes considered. The quality of the classrooms was negatively, though not significantly, associated with education status. At school level, a highly significant association was found between shares of children receiving school feeding and schooling outcomes, in terms of enrolment, attendance and years of schooling. The size of this effect was consistent with those found in the literature. Village level remoteness, as captured by the distance to secondary school variable, was also significantly associated with lower levels of schooling.

4.1. Limitations

A number of important considerations limit the findings of this analysis. Firstly, as this study is based on a cross-sectional survey, we focus on describing the current status and associations between different covariates and outcomes of interest, not on assessing causal effects. With regards to internal validity, attribution, or causal interpretation of the effects is limited by the inability to control for selection bias or confounding from characteristics correlated with the outcomes of interest. In the case of school feeding, though the regression models control for a number of child, household and school level characteristics, a range of unobservable factors including child and parent motivation, and school quality, for example, will also influence schooling decisions. Data from an on-going evaluation will allow for a more detailed assessment of causal pathways and potential impact. In terms of external validity, this analysis is only representative for the survey population in 58 districts selected on the basis of eligibility for receiving school feeding. However, as this selection was based on food insecurity criteria as set by the national school feeding policy, the intervention areas share similar characteristics to the other 108 vulnerable districts across the country.

In terms of measurement, using dichotomous variables as a basis for enrolment and attendance estimations does not account for partial attendance. In this case the effects are likely to bias the estimates upwards, which suggests that the gap in terms of primary school participation may in fact be even greater than what was found. The attendance rate measurements are also limited by the reference period of 5 days. This indicator by definition will not cover exceptional circumstances that may be relevant in the context of this study, as for example attending school over the last five days after a long period of absenteeism due to seasonal labour or health related issues. Alternative methods of estimating attendance, either using longer recall periods or relying on school registers, are also limited by recall and reporting bias, though using a combination of indicators is clearly necessary to provide a more complete picture.

A number of statistical analyses were used to explore issues related to data missing not at random, including missing school (596 children) and anthropometry data (1009 children). Dummy variables for the two types of missing data were initially included in the regression models for the outcomes of interest. A significant negative association was found between the missing school level data coefficient and attendance rate, though a positive non-significant association was found with both school enrolment and

years of schooling, suggesting some bias effects in both directions. The dummy variable for missing anthropometry data was negative and significant for all the three outcomes. We explored the issue of missing anthropometry further, imputing the missing data by using height and weight estimates modelled with age and age-squared as predictors and included them in the main regression models for schooling outcomes. The resulting regression statistics were generally consistent with those reported in Table 6. The main differences included significant associations between enrollment and both child labour and the female headed household dummy variable ($P < 0.05$). Interestingly, the negative association between the share of classrooms with blackboards and years of schooling was significant in the Cox regression model and will require further investigation alongside other elements of school quality.

5. Conclusions

With only 40% of primary school-age children found to be enrolled in schools, access to school in food insecure areas of Mali is well below regional and global levels, and achieving the goals of universal primary education remains a critical challenge. This analysis confirms that the determinants of primary education are complex: poverty is clearly one of the main drivers of educational exclusion and the manifold nature of this challenge has no simple solution. Interestingly, no significant gender differences in terms of primary school access were found. Nutrition and health status though play an important role in shaping schooling outcomes, though the relationships are complex and require further investigation. These findings have important policy implications: both the magnitude and nature of the problem described in this analysis suggest the need for overarching policies and programmes aimed at supporting school access and learning. In this context, school meals were found to have substantive, positive associations with all the different education outcomes considered. Though this finding is not indicative of a causal relationship and will require further research, it confirms the potentially critical role of the national school feeding programme as a social protection intervention (Alderman and Bundy, 2011).

This study provides a first step in building the evidence to support investment decisions at a critical time in Mali's development trajectory, and more detailed questions on the feasibility and cost-effectiveness of scaling-up school feeding remain, and are being examined in an on-going evaluation (Masset and Gelli, 2013). This paper has highlighted the need for investments in education to be prioritised and sufficiently funded as part of national policy and education development strategies, but also as a key element in the efforts of rebuilding Mali's conflict stricken Northern regions and the return of displaced populations. As the country struggles to restore peace and unity, so too, do Mali's children face an uphill task to fulfil their developmental potential.

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