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The impact of food assistance on food insecure populations during conflict: Evidence from a quasi-experiment in Mali

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ABSTRACT

Mali, a vast landlocked country at the heart of West Africa in the Sahel region, is one of the least developed and most food insecure countries in the world. Mali suffered from a series of political, constitutional and military crises since January 2012, including the loss of government control of northern territories from April 2012 until January 2013. A range of humanitarian aid interventions were scaled up in response to these complex crises. In this study, we exploit data from a unique pre-crisis baseline to evaluate the impact of humanitarian aid on the food security of rural populations. We design a quasi-experimental study based on two survey rounds, five years apart, in the Mopti region in Northern Mali. Data was collected from 66 communities randomly selected from within food-insecure districts. Study outcomes include household expenditures and food consumption and a proxy for child nutritional status (height measurements). We estimate program impact by combining propensity score matching and difference-in-difference. Food assistance was found to increase household non-food and food expenditures and micro-nutrient availability. Disaggregating by degree of conflict exposure showed that the effects on children's height and caloric and micro-nutrient consumption were mostly concentrated in areas not in the immediate vicinity of the conflict, unlike the increase in food expenditures that were driven by households located in close proximity to armed groups. The effects were also concentrated on households receiving at least two forms of food assistance. In villages where armed groups were present, food assistance improved household zinc consumption and also appeared to support food expenditures. Food transfers are thus found to exert a protective effect among food insecure population in conflict context.

1. Introduction

An estimated 700 million people live in extreme poverty (World Bank, 2016). Undernutrition affects 800 million people globally, with the vast majority of undernourished people living in low- and middle-income countries (FAO, IFAD, & WFP, 2015). Despite recent progress, undernutrition causes over three million child deaths per year and stunting prevalence in children under 5 affects at least 165 million children (Black et al., 2013).

Conflict and political instability are important drivers of undernutrition. Out of the six emergency situations currently listed on the World Food Programme website, five (Iraq, Lake Chad Basin, South Sudan, Syria and Yemen) are directly the result of conflict. Depriving populations from access to food is often an explicit war tactics. Armed conflicts are also responsible for weakening food production and health systems, and for undermining the functioning of markets and institutions (Justino, 2012). Armed conflicts have been found to profoundly impact mortality, morbidity and malnutrition, among other health outcomes (Altare & Guha Sapir, 2013). Children exposed to violent conflict at an early age or in utero are found to be more likely to suffer from Moderate or Severe Acute Malnutrition (MAM/SAM), even controlling for household backgrounds and non-randomness of conflict location (Alderman, Hoddinott, & Kinsey, 2006; Camacho, 2008; Akresh, Bhalotra,

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Leone, & Osili, 2012; Domingues & Barre, 2013; Minoiu & Shemyakina, 2014).

The identification of the mechanisms linking conflict exposure to mortality, morbidity and malnutrition, however, remains elusive. Only an estimated 20% of excess mortality stems from direct deaths due to warfare violence (Altare & Guha Sapir, 2013) and while the literature has identified several potential mechanisms underlying the impact of conflict, more systematic evidence is needed, especially in contexts of low to moderately violent conflicts. Conflicts of low to moderate intensity, which do not kill a substantial number of civilians, can still be responsible for catastrophic increases in undernutrition. Tranchant, Justino, and Mueller (2014) show that populations living in the shadow of the Naxal insurgency in India do not directly suffer on the long run from the conflict. However, they are unable to cope with income shocks (such as droughts and illness) because of the restriction in mobility due to the conflict, and because of the absence of the state and NGOs. Droughts and illnesses in this environment result in a catastrophic increase in odds of stunting for young children.

Delivering timely and adequate food assistance to conflict-affected populations is therefore critical to avoid increases in the prevalence of acute malnutrition. Yet, it is challenging for aid actors to reach these populations due to a variety of logistical challenges and because it often means taking siding with conflict actors. Little is known as to the effectiveness of aid in conflict areas to guide program design and implementation. While there exists some evidence of the effectiveness of the type of safety net interventions WFP implemented in Mali in 2012–2013, this evidence usually comes from non-emergency, non-conflict contexts. Safety nets, involving either cash or in-kind transfers, are estimated to reach 1.3 billion people globally (Honorati, Gentilini, & Yemtsov, 2015). Safety nets program designs are heterogeneous, with important differences in targeting, transfer modality, size and distribution frequency. There is growing evidence that safety net transfers increase food consumption, improving the quantity and quality of food consumed by poor households (Hidrobo, Hoddinott, Kumar, & Olivier, 2018; Ruel, Alderman, & Maternal & Child Nutrition Study Group, 2013). Reviews also highlight that the potential of safety nets to improve nutrition has been to date largely untapped (Ruel et al., 2013).

Moreover, there is a dearth of evidence from rigorous studies on the effectiveness of any type of humanitarian aid during conflict. Rossi, Hoerz, Thouvenot, Pastore, and Michael (2006) investigate health, nutrition and food security programs in a complex emergency, Willibald (2006) and Haider (2011) discuss cash transfers in a conflict setting and Bozzoli, Bruck, and Wald (2013) provide a framework for evaluations in conflict settings, but rigorous evaluations tend to focus on peace promotion and conflict resolution initiatives; on interventions to mitigate the psychological costs of exposed populations and former (child) soldiers; or on development programs in post-conflict settings (Fearon, Humphreys, & Weinstein, 2009; Casey, Glennerster, & Miguel, 2012). This study contributes to filling this gap by generating evidence of the effectiveness of WFP's food assistance interventions in conflict-affected areas of Mali. In so doing we also add to review articles looking at how nutrition programs could be designed to best work in emergency settings (Harvey, Proudlock, Clay, Riley, & Jaspars, 2010; Webb et al., 2014).

We exploit data from a unique pre-crisis household survey to evaluate the impact of humanitarian aid on the food security of rural populations in Mali. This baseline survey, collected in January 2012, provided extensive demographic, economic, consumption, or anthropometric information (among others) prior to the outbreak of the conflict on 1,500 households in 66 villages of Mopti region as well as information from teachers and village chiefs. We returned to these same communities and collected a second wave of the household survey in January 2017. In addition to the initial set of questions, the endline survey also included detailed modules on availability of and access to humanitarian aid as well as conflict exposure and presence of armed groups over the last five years. This unique panel dataset allows us to ascertain whether aid provision enabled households to better cope with the effects of the political crisis and insecurity, and whether proximity to the conflict influenced the effectiveness of aid.

Specifically, we estimate with matched difference-in-difference whether access to different forms of food assistance improved household (food) expenditures, food and nutrient consumption, and long-term nutrition status of children (as captured by changes in height). The existence of baseline data allows us to match "treatment" households with comparable "control" households, strengthening the internal validity of the study. The estimations reveal that access to food assistance increases non-food and food expenditures, as well as intake of calorie, protein, iron, zinc and vitamin A. Disaggregating by degree of conflict exposure shows that the increased food consumption is mostly concentrated in areas indirectly affected by the conflict, but that the increase in food expenditures is mostly driven by households located near the armed groups. Food assistance also improved children' growth in villages indirectly affected by the conflict. The analysis also presents evidence on factors that influenced the effectiveness of the transfers.

The paper is structured as follows: in Section 2, we provide an overview of the context in Mali, paying special attention to how aid and conflict were distributed among the study population. In Section 3 we then describe the methods and data. Study findings are presented in Sections 4 and 5; and finally Section 6 discusses implications for program design.

2. Context

Mali is a west-African country of 14 million people classified as a low-income food deficit country by the FAO. In 2016, Mali ranked 175th out of 188 countries by the UNDP human development index, with an average life expectancy at birth of 58 years, an average of two years of schooling per person and an annual per capita gross national product of $853. Agricultural productivity is among the lowest in the world and most farmers produce subsistence crops, particularly millet and sorghum using a primitive technology (USDA, 2009). Production is carried out using a low level of technology: fertilizer use is minimal and access to credit is limited. Crop yields are not only low but also highly variable due to the fact that most farmers depend on rainfed farming while rainfall fluctuates considerably from year to year and season to season (USDA, 2009). The WFP estimates (WFP Mali, 2016) that 24% of the population is chronically food insecure. DHS data collected in 2012–13 report that 38% of children are chronically malnourished (stunted), 13% are acutely malnourished (wasted) and 26% are underweight.

2.1. Conflict in Mali

Since the independence of Mali, there have been four waves of Tuareg rebellions in the north of the country, in 1962, 1990, 2006 and 2010. Persistent feelings of marginalization among the Tuaregs, combined with widespread droughts in the 1970s and the 1980s, and the general failure of the regimes of Modibo Keita (until 1968) and Moussa Traoré (between 1968 and 1991) to address core grievances of Tuaregs are widely thought to explain the renewal of the rebellion since 1990 (Lecoq, 2010). On April 10, 1992 a "National Pact" was signed between the transitional authorities and the Tuareg insurgents. The belligerents agreed on a cease fire,

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a reduced military presence in the north, and meaningful local autonomy through decentralization.

Despite a strong commitment towards decentralization and democratization from President Konaré in the 1990s (Schraeder, 2011), feelings of frustration with the lack of progress in the implementation of the National Pact and continuous marginalization of the north grew. In May 2006, the Tuareg rebellion resumed. The then president Amadou Toumani Touré negotiated with the rebels and the Algiers accords were signed that same year. Core grievances of the Tuaregs were still not addressed though, and in 2010 the MNLA (*Mouvement National pour la Libération de l'Azawad*) was founded, partly from elements who took part in the 2006 rebellion.[1]

Since the mid to late 1990s, militant Islamist and non-Tuareg armed groups such as the GSPC (which later became AQIM) and transnational criminal groups took a hold in the region, thanks to the dysfunctional situation above mentioned. These groups exploited state weakness to use commercial routes and enmesh themselves in the population (Boas & Torheim, 2013). After the Libya crisis, these groups obtained weaponry, former foreign Libyan Legion soldiers came back to northern Mali, and important remittances networks collapsed, all contributing to destabilize the region.

In January 2012, the MNLA attacked a military garrison as part of their call for an independent, secular and plural Azawad. The MNLA joined AQIM, Ansar Dine and the MUJAO (a splinter group from AQIM), and between January and April 2012 they took control of main towns in the three northern administrative regions. The Islamist groups quickly chased the MNLA away from these towns (Boas & Torheim, 2013). Following the Malian army defeat at Aguelhok, unease grew in the south as the government seemed unable to cope with the crisis. This eventually led to the mutiny and then the putsch in March 2012 of junior soldiers under the leadership of Captain Sanogo. Unwittingly, the putsch further weakened the state and the advances of Islamist groups was eventually stopped after the "Serval" military operation. Since then, the groups have retreated from the main towns but are still active, and the international operation is still on the ground (under the new moniker of "Barkhane").

2.2. Conflict in Mopti region

According the ACLED database, the last 20-year period saw a total of 1304 conflict related events and 3071 fatalities in Mali. Over 80% of the total conflict related events and fatalities are concentrated in the five-year period between 2012 and 2016. Fig. 1 highlights the distribution of conflict events per region, confirming the concentration of conflict in the Northern regions of the country.

Although the study region of Mopti is not part of the north of Mali, it experienced substantial conflict. During the last 20 years 6% of total conflict events and 11% of total fatalities in Mali took place in the Mopti region, and these percentages doubled during the 2012–2016 period. In Mopti, over 95% of conflict events and fatalities over the last 20 years took place between 2012 and 2016. As in the other regions in Northern Mali, conflict peaked in Mopti during 2013. However, unlike Gao, Kidal and Timbuktu regions that experienced general declines in conflict events and fatalities from 2013 onwards, conflict related events and fatalities in Mopti increased by 7% and 22% respectively between 2015 and 2016. Between 2012 and 2016, battles between Government and armed groups were the primary cause of conflict related fatalities, and were responsible for 58% of total fatalities. Violence against civilians resulted in 34% of total fatalities during the same period.

2.3. Humanitarian aid in Mali

Amidst these crises, the complex emergency combining drought throughout the country and the conflict in the north, was the focus of two projects by the U.N. World Food Programme (WFP) in Mali, including: (i) emergency operation (EMOP) 200389 "Assistance to drought-affected populations in Mali"; and (ii) regional EMOP 200438 "Assistance to Refugees and Internally Displaced Persons Affected by Insecurity in Mali". These two projects reached approximately 100,000 internally displaced and 200,000 vulnerable people in the targeted regions of the country. The EMOP was implemented alongside a country program (CP) and a protracted relief and recovery operation (PRRO) that delivered humanitarian aid to different areas of the country. The WFP activities including the EMOP were aligned with WFP's Strategic Objective 1, which is "to save lives and protect livelihoods in emergencies", and sought to contribute towards the Millennium Development Goals 1, 2, 4 and 5, respectively on eradicating extreme poverty and hunger, supporting universal education, reducing child mortality and improving maternal health. The EMOP started in late January 2013 and ended in 2014. A subsequent project was implemented to continue to provide assistance during 2015. The project activities were carefully planned to ensure complementarity with the WFP country program, which targets similar interventions to chronically food-insecure populations in the south of Mali, through food/cash for assets, nutrition and school feeding. The EMOP supported approximately 564,000 vulnerable and food-insecure people across the most affected areas of the country.

The specific objectives of the EMOP were to:

- Improve the food consumption of targeted food-insecure displaced and other conflict affected communities;
- Prevent acute malnutrition among children 6–59 months and pregnant and lactating women; and
- Treat moderate acute malnutrition among children 6–59 months and malnourished pregnant and lactating women.

The relevant WFP food assistance activities included in the response are summarized in Table 1. These included supplementary feeding to prevent and treat acute malnutrition, general food distribution and school feeding. The Government of Mali adopted a national school feeding policy in 2009 and in 2012, prior to the political crisis, there were about 2,000 schools with a canteen in the country, accounting for 37% of schools in food-insecure areas. Following the crisis, the school feeding program continued to operate in schools that were already covered, although in the northern part of the country, it transformed into an emergency relief program. Humanitarian aid was targeted to schools with canteens (WFP, 2014). In Mopti, which is not one of the northern regions, the school feeding program mostly continued as planned.

3. Data and methods

3.1. Data sources

This longitudinal study is based on two rounds of surveys in the Mopti region of Mali. The baseline survey was undertaken as part of cluster-randomized trial of home-grown school feeding that had to be abandoned due to the conflict onset (Masset & Gelli, 2013). Data was collected from 66 communities (villages) randomly selected among food-insecure districts in the region. Twenty-five households with children in the original target 5–15

[1] Unlike previous Tuareg rebel groups, the MNLA was clearly a separatist group (and not an autonomist one).

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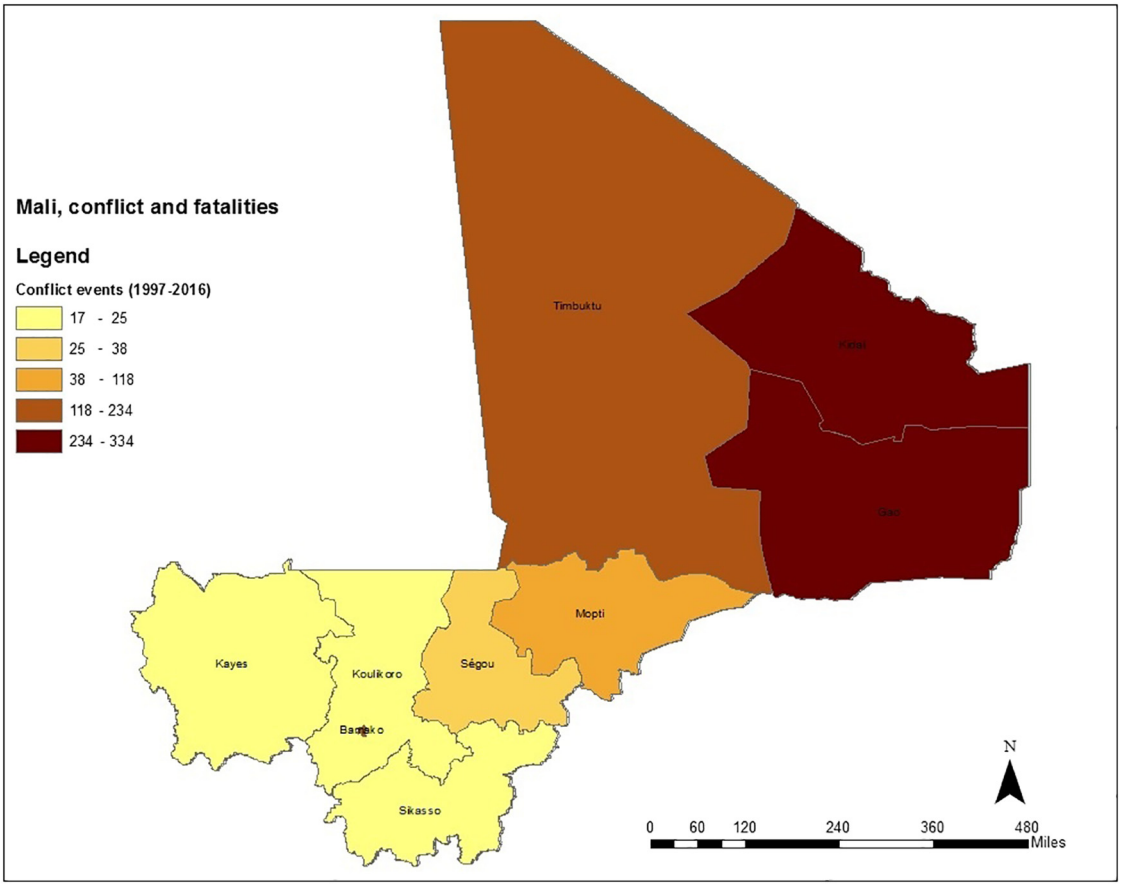

Fig. 1. Total conflict events in Mali between 1997 and 2016 by region. Source: ACLED.

Table 1
WFP's food assistance activities in northern Mali from January 2013 onwards.

Intervention	Targets	Objectives	Activities
Blanket supplementary feeding to prevent AM	Children 6–59 months and pregnant and lactating women	Implement blanket supplementary feeding to help prevent an increase in AM	Provide children half a sachet of Plumpy' Sup per day. Providing Super Cereal and vegetable oil to pregnant and lactating women. Nutrition and hygiene messages for mothers.
Targeted supplementary feeding aimed at treating AM	Children 6–59 months with MAM and malnourished pregnant and lactating women	Treat moderate acute malnutrition among children 6–59 months and malnourished PLW	Targeted supplementary feeding, providing 92 g of Plumpy'Sup per day
Targeted food assistance (GFD)	Food-insecure populations, IDPs. Women headed HHs, HHs who have lost income/ assets, and HHs with elderly or disabled people	Assist all accessible moderately and severely food-insecure households and non-displaced people, displaced people, and host communities	Provide 2,100 kcal per person per day, consisting of cereals, pulses, vegetable oil and salt, with Super Cereal to increase micronutrient intake
School feeding	Primary school children in areas with high food insecurity	Prevent hunger and provide incentives to arrive on time and attend school until lunchtime; school attendance will also reduce the exposure of children to other risks.	Two daily meals will be provided: a morning porridge of Super Cereal and a midday meal consisting of cereal, pulses, vegetable oil and salt

Note: AM refers to Acute Malnutrition. Source: WFP documentation and stakeholders interviews.

year age group were randomly selected for interviews within each community. The sampling of households was conducted through interviews with village chiefs and other community level stakeholders, building a list of enlarged households in the villages within the school catchment area. The listing also included an approximation of the size of the enlarged households. In addition, a number of farmer households was oversampled in each village. The community groups were asked to list which farmers they would contact if they were to purchase food within the village for the provision of school meals. This latter information was used

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to single out the surplus farmers in the area. Enlarged households were randomly selected (with inclusion probability proportional to size) from the list provided by the village chiefs, and listings of the restricted households within each selected enlarged households were then developed through interviews with household heads. A restricted household with children aged 5 to 15 was then randomly selected within each selected enlarged non-farmer household. A similar selection procedure was used for farmer households when these exceeded the numbers of 10 and 5 in the project and control villages, respectively. In farmer households though, no age criteria were used and the household was identified around the main agricultural holding unit of the enlarged household. At baseline, questionnaires collected data at household level and for each relevant household member separately. All children aged 2–15 within each restricted households in the survey sample were selected for anthropometry measures. In addition, all children aged 5–15 also underwent tests of literacy, numeracy and cognition. A follow-up survey was undertaken in January 2017 including all the 66 villages in the Mopti region in the baseline sample. New survey modules were added to explore conflict exposure, receipt of humanitarian aid, as well as a range of other potential health outcomes not covered at baseline.

3.2. Conceptual framework

To understand the program theory for the intervention we build on the 2013 Lancet Series framework on Maternal and Child Nutrition (Black et al., 2013). This framework describes how optimal nutrition depends on health, dietary, and behavioral determinants, and is influenced by the underlying food security, care-giving resources and environmental conditions.

The Lancet Series framework can also be used to identify pathways through which conflict events could affect populations both directly and indirectly. For example, effects on nutrition status could arise by changes in food access and availability (e.g. breakdown of food markets, loss of harvest or stocks due to conflict); or care-giving practices (e.g. death of caregivers, or decrease in women's mental health due to increased insecurity); or health status (e.g. no access to health facilities and medicines, or contamination or loss of water sources due to conflict). In addition, differential effects would be expected on displaced versus host families, in terms of exposure to new infectious diseases (e.g. malaria in the south of Mali), or on changes in food intake (e.g. different food customs) and care (e.g. no space in health centers and schools). In addition, closure of health centers and schools would not only affect health and education outcomes directly, but as these facilities are often used as distribution points for humanitarian aid these events could also have other negative spillovers on the community. Conflict may also have long-lasting consequences that affect long-term outcomes. For example, children can be affected at critical growth stages and become stunted or their cognitive ability can be severely impaired. Similarly, farmer households may suffer economic shocks from which they cannot recover and become destitute so that an impact on poverty can be visible even years after conflict has ended. In addition, emerging evidence suggests that conflict can severely undermine the most elaborate coping strategies used by households to face risk, and the ability to rely on informal networks for aid becomes critical. Conflict may also weaken the effectiveness of these networks (if people or cash cannot move anymore because of violence, for example). In addition, while being an ally or friend of people with access to key resources is always good in times of peace, this can be dangerous during conflict if the same powerful people are targeted for violence. In these contexts, whether humanitarian aid is a complement or a substitute to basic, informal solidarity remains an important question for research.

3.3. Study outcomes

We considered two levels of outcomes in the survey population based on the analysis of the program theory of the intervention. The first level included measures of household food security calculated from the consumption and expenditure modules of the household survey. The second level focuses on a proxy measure for the nutrition status of children. We calculated the value (in West African Francs, FCFA) of household food and non-food consumption, and household energy and nutrient availability[2] from data on the consumption of 52 foods over a seven-day recall period. Quantities were converted from local units to kilograms. Missing units were imputed from commodity-specific unit modes at different aggregation levels: household, village, community, commune, cercle, and region. Net quantities were obtained by multiplying reported quantities by food-specific edible fractions. Energy and nutrient consumption were calculated using a Mali food composition table (Barikmo, Ouattara, & Oshaug, 2004). All outcomes were calculated per capita and per adult equivalent (AE) to account for household size and composition differences. AE factors were assigned by dividing household members' age and sex specific recommended daily energy intake by a reference average recommended intake of 2636 kcal. The reference was calculated by taking the average energy needs of men and women aged 18 to 59.9 years. We used a weight of 56.2 kg for women aged 18–29.9, 58.6 kg for women aged 30–59.9, 66.2 kg for men aged 18.29.9, and 68.6 kg for men aged 30–59.9. A moderate physical activity level was assumed. Individual AE units were summed to yield the number of household AE units. We assessed energy and nutrient consumption from 12 food groups: cereals and grains, roots and tubers, legumes, nuts and pulses, fruits, vegetables, meat and poultry, fish and seafood, milk and dairy products, eggs, oils and fats, sweets, and spices, condiments and beverages (Swindale & Bilinsky, 2006). The value of food consumption was also calculated for these 12 groups. In addition, we examined the value of non-food expenditure from 8 non-food groups: energy, tobacco and cigarettes, transportation, hygiene, clothing, durable goods, housing, and social events. Anthropometry data included measurements of height and weight for all children from 24 months to 15 years of age. Height or length was measured to the nearest 0.1 cm using portable fixed base stadiometers and weight was measured to the nearest 0.1 kg using electronic scales. HAZ and WHZ scores were calculated using the 2006 WHO growth standard for children under 5 years (WHO, 2006). Stunting was defined as HAZ < −2 SD and wasting as WHZ < −2 SD. However, due to issues related to the measurement of dates of birth that are critical for the calculation of anthropometric indices we limited the analysis to measuring changes in height during the 5 year study period in a cohort of children aged 2–5 at baseline. Data was collected by trained enumerators using electronic tablets with computer-assisted personal interview (CAPI) software.

Tables 2 and 3 present summary statistics for these outcomes at baseline and endline, respectively. Table 2 also display information on key pre-intervention variables that we will use for the matching process that we describe in the next subsection. All the study outcome variables collected at baseline and endline have been trimmed to exclude extreme values.

[2] We measured consumption of vitamin A, iron and zinc, as deficiencies in each of these micro-nutrient are widespread and linked with well-known health and nutrition issues. We do not have recent information regarding zinc availability, but existing evidence suggests widespread prevalence of micro-nutrient deficiencies in Mali. 59% of pre-school children are estimated to suffer from vitamin A deficiency and 83% of them are anemic (caused by iron deficiency). The corresponding figures for pregnant women are 17% and 73%, respectively (WHO, 2008, 2009).

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Table 2
Summary statistics at baseline, January 2012.

Variable	Mean	Std. Dev.	Min.	Max.	N
Secondary school within 5 km	0.327	0.469	0	1	1717
Market within 5 km	0.24	0.427	0	1	1717
Past project	0.575	0.494	0	1	1717
Village considered unsafe	0.063	0.243	0	1	1592
Age head of household	48.85	13.591	20	101	1709
Expenditures per capita (FCFA)	161154.425	123832.612	16882.082	1598408	1717
Household size	7.037	2.988	1	19	1717
Depend ratio	1.575	0.858	0.1	6.5	1655
Food groups consumed	6.736	1.309	2	10	1715
Polygamous household	0.284	0.451	0	1	1709
Worker	0.045	0.207	0	1	1709
Land size	3.521	3.869	0	80	1717
Share of food in budget	0.746	0.136	0.044	0.987	1715
Assets value	11.441	1.487	7.313	15.299	1702
Monthly expenditures per AE (FCFA)*	16383.19	12101.37	3360.81	85559.7	1662
Monthly food expenditures per AE (FCFA)*	11137.02	9146.2	1795.937	63009.03	1659
Share of food in budget*	0.690	0.157	0.328	0.952	1574
Calories consumed daily per AE*	3342.089	2216.13	559.07	13606.47	1634
Protein consumed daily per AE*	97.5	61.73	16.98	377.47	1644
Iron consumed daily per AE*	23.204	14.753	3.756	86.005	1643
Zinc consumed daily per AE*	33.892	23.097	3.410	143.246	1636
Vitamin A consumed daily per AE*	496.70	697.176	0.000	3967.48	1693
Dietary Diversity Score	6.703	1.743	1	11	1715
Height (cm) of children under 5 in 2012	95.061	15.283	8.1	190.7	1379

Note: The * indicates that the variable has been trimmed to exclude values below the 2.5th percentile and above the 97.5th percentile of the distribution. AE refers to Adult Equivalent. 1 FCFA translates into 0.002 USD.

Table 3
Summary statistics at endline, January 2017.

Variable	Mean	Std. Dev.	Min.	Max.	N
Monthly expenditures per AE (FCFA)*	17498.43	13234.5	3358.762	86342.45	1319
Monthly food expenditures per AE (FCFA)*	11873.43	9763.785	1805.667	63908.97	1322
Share of food in budget*	0.703	0.159	0.328	0.951	1250
Calories (kcal) consumed daily per AE*	3260.855	2233.855	538.474	13705.97	1347
Protein (gram) consumed daily per AE*	87.323	61.425	16.511	378.413	1337
Iron (mg) consumed daily per AE*	20.433	14.183	3.814	86.717	1338
Zinc (mg) consumed daily per AE*	32.059	22.708	3.520	142.147	1345
Vitamin A (mcg) consumed daily per AE*	862.198	848.417	0.000	3949.502	1366
Dietary Diversity Score	6.093	2.121	0	11	1422
Height (cm) of children under 5 in 2012	123.208	13.1	12	189	1000
Any aid	0.326	0.469	0	1	1422
GFD	0.218	0.413	0	1	1408
TSF	0.023	0.151	0	1	1408
SF	0.143	0.351	0	1	1408
Number of types of aid	0.409	0.624	0	2	1422

Note: The * indicates that the variable has been trimmed to exclude values below the 2.5th percentile and above the 97.5th percentile of the distribution. AE refers to Adult Equivalent. 1 FCFA translates into 0.002 USD.
GFD: General Food Distribution; TSF: Targeted Supplementary Feeding; SF: School Feeding.

3.4. Identification strategy

We employ a matched difference-in-difference approach to estimate the impact of food assistance in conflict-affected areas. Using the classical notation of Dawid (1979), the change in outcome of interest Y between time t and t′ for household h receiving food assistance A is $\Delta Y_h^1 = Y_{ht'}^1 - Y_{ht}^1$ whereas the corresponding change for a household that did not receive food assistance A is $\Delta Y_h^0 = Y_{ht'}^0 - Y_{ht}^0$. Obviously, household h either receives aid or does not receive aid, so that only one outcome is observed: $\Delta Y_h = \Delta Y_h^1.P(A=1) + \Delta Y_h^0.P(A=0)$, where P indicates the probability of receiving aid. The effect of treatment at the household level remains therefore unknown but we can estimate the average effect of the treatment on the treated (ATT).

$$ATT = E[Y_{ht'}^1 - Y_{ht}^0 | A=1] - E[Y_{ht'}^0 - Y_{ht}^0 | A=0] \quad (1)$$

The matched difference-in-difference estimations will allow us to retrieve the ATT if the following identifying assumption is valid:

$$E[Y_{ht'}^0 - Y_{ht}^0 | A=1] = E[Y_{ht'}^0 - Y_{ht}^0 | A=0] \quad (2)$$

Eq. (2) requires that in the counterfactual situation in which aid recipients would have not received aid, there would be no difference in the evolution of Y between 'treated' and 'untreated' households. This assumption of parallel trend is weaker than the corresponding assumption for the matching estimator, which is that 'treated' and 'untreated' households would be characterized by a similar level of the outcome of interest at time t′. Such an assumption would likely not hold. On the one hand, the mission statement of WFP and the EMOP project documents highlight the need to deliver assistance to the most vulnerable. On the other hand, the conflict, remoteness and various financial and logistical challenges may have caused food aid to fail to reach the most vulnerable. Focusing on changes over time, which is enabled by the panel data at out disposal, contributes to alleviate this source of selection bias.

To further account for potential selection bias, we also resort to propensity score matching, exploiting our unique pre-crisis baseline. Specifically, we estimate the likelihood to receive aid

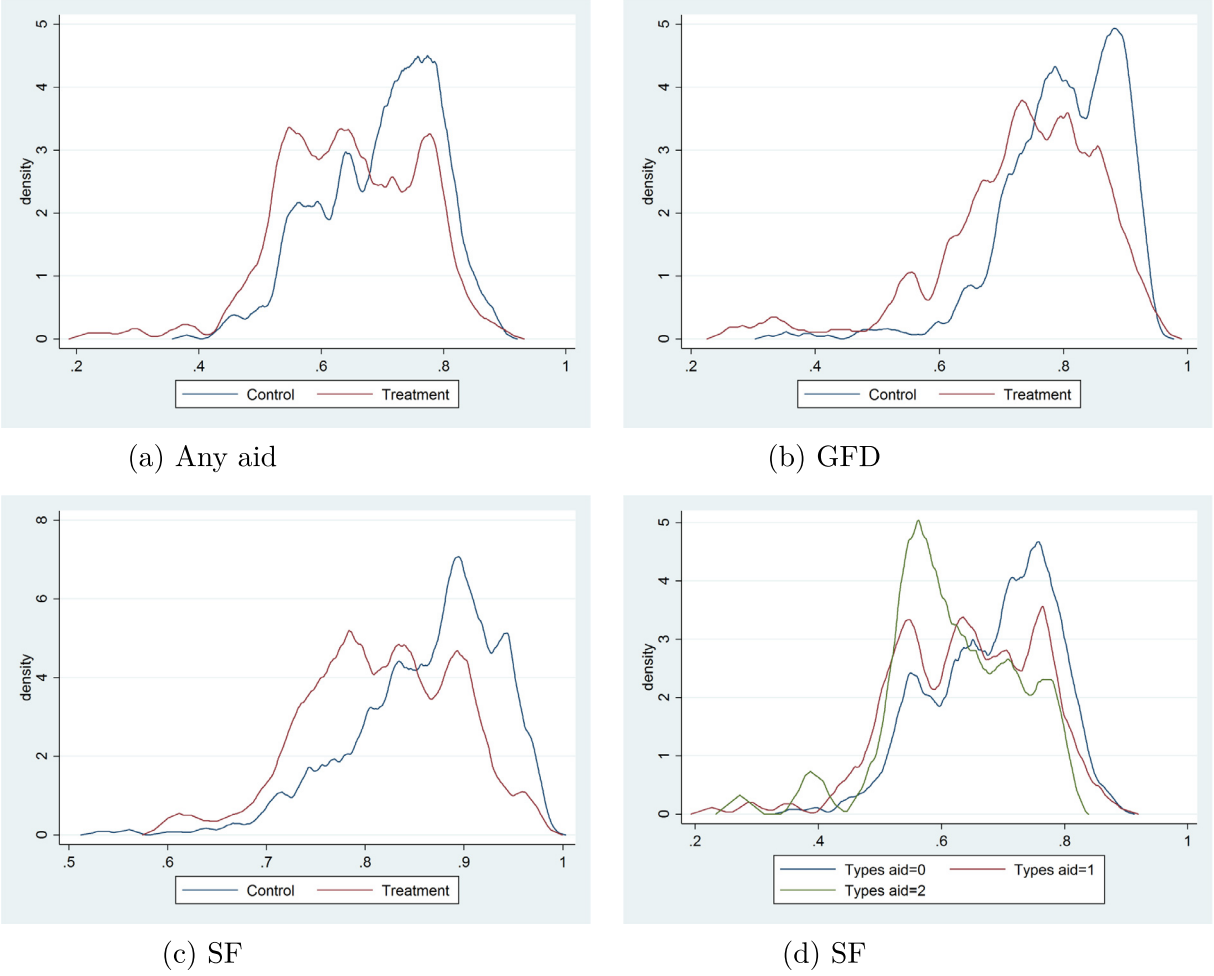

Fig. 2. Distribution of estimated propensity scores. Source: Authors' calculations.

conditional on a range of covariates $X : P(X) = P(A = 1|X)$. Following the logic of the matching estimator, the covariates included in X are measured before the intervention and are related to both the selection into treatment and the outcome of interest. In so doing, we are ensuring that treatment and control households are as similar as possible across the full range of confounding factors.

We include in the estimation of the propensity score a range of household and village characteristics measured at baseline. These are, at the village-level, the presence of a secondary school within 5 km, the presence of a market within 5 km, and conflict exposure (see below for definition of the latter variable). At the household-level, the variables we control for are whether children were involved in past projects, feelings of safety, age of the household head, expenditures per capita, household expenditures quintiles, the logarithm of value of assets, household size, dependency ratio, number of food groups consumed, whether the household is polygamous, whether the head of household identified as a worker, the amount of cultivated land, and the share of food expenditures in the household budget. The propensity score was estimated with a Logit estimator and the distributions of the estimated propensity in treatment and control groups score displayed a high degree of overlap across all variables of aid (see Fig. 2).

We use the propensity score to weight the treatment and control samples to conduct a kernel propensity score difference-in-difference (Heckman, Hichimura, & Todd, 1998; Hirano, Imbens, & Ridder, 2003) in the region of common support. The weight, w_h, is calculated as such: $w_h = 1/\hat{p}_h$ for treatment subjects and $w_h = 1/(1 - \hat{p}_h)$ for control subjects, where $\hat{p}_h$ is the estimated propensity score for household h. Applying these weights adjusts for the systematic imbalances in covariates between treatment and control subjects so that the kernel propensity score difference-in-difference estimator provides unbiased estimate of the ATT under the unconfoundness assumption.[3]

The key question of the paper is to evaluate the effect of aid in conflict-affected contexts. We use a twofold strategy to handle the interactions between conflict and aid. In a first set of estimations, we control for the exposure to conflict in the period immediately following the coup (2012–2014). In other words, we estimate the probability for households to receive aid over the period 2014–2016 based on baseline characteristics and exposure to conflict in the period 2012–2014. This provides a benchmark estimate of the average effect of food assistance for treated households in the Mopti area.

In a second set of estimations, we assess whether the impact of food assistance is heterogeneous with respect to exposure to conflict. The goal of these estimations is to ascertain whether food assistance is effective in situations of acute fragility. To do that, we estimate the propensity score separately for the subgroup of conflict-affected areas and the subgroup of non-affected areas.

3.5. Operationalization of food assistance

We previously described how the WFP operations in northern Mali combined (i) supplementary feeding for children below five

[3] We have used the user-written package *diff* in Stata 14 to perform the analysis.

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years of age and pregnant women to prevent (not targeted) and treat malnutrition (targeted), (ii) targeted general food assistance for vulnerable households, and (iii) school feeding in areas of food insecurity. The endline survey included questions on different forms of food assistance that WFP or other development partners may have provided to the study populations. Alongside general food distribution (GFD), targeted supplementary feeding (TSF), and school feeding (SF) we added the modality of food for work (FFW) that was also provided by WFP and partners as part of the Country Program running in parallel to the EMOP.

In our survey conducted in January 2017, we asked village and household respondents about their experience with food assistance. We begin by describing the operationalization of food assistance based on the availability of aid at village-level.

General food distribution (GFD) was the most common form of food assistance in the study population, with 51 out of 63 village respondents declaring that GFD occurred in their village since 2012. School feeding and TSF were reported to have been implemented in 26 and 24 villages, respectively.[4] It is interesting to note that targeted supplementary feeding and school feeding programs were mostly implemented in villages where general food distribution was also present. Hence, only three villages experienced TSF or SF without any GFD program.

In the household survey, detailed questions on aid were asked for the period covering the 24 month prior to the endline data collection to avoid measurement errors and recall bias. According to the household-level data, 66.6% of households did not receive any food assistance, 22.5% of households received GFD, 14.3% received school feeding, 2.4% received targeted school feeding and 1.9% participated in food for work programs. There is a limited overlap between these modalities of aid at household level as only 7.4% of households received two forms of aid or more. Once again, when overlap exists, it overwhelmingly involved GFD which has been reported by 94% of households who received at least two forms of aid.

In summary, we characterize aid provision and intensity of exposure to aid in the last 24 months (2014–16) through the following variables: a binary variable *Any aid* which takes the value 1 if the household received any form of aid, a binary variable *GFD* which takes the value 1 if the household received GFD, a binary variable *SF* which takes the value 1 if the household received school feeding and a categorical variable *Number of types of aid* which takes the value 0 if the household receives no aid, the value 1 if the household receives 1 form of aid, and the value 2 if the household received 2 forms of aid or more.[5]

3.6. Operationalization of conflict

The endline household and community surveys collected information on presence of armed groups and a wide range of violent events, some of which were directly linked with the armed conflict.

We capture exposure to the armed conflict through questions on the presence of armed groups that were asked in the village questionnaire. Indeed, it is important to note that the notions of violent conflict and control need to be distinguished. As Kalyvas (2006) argues, violent conflict is most likely to occur in contested areas between state and rebel forces and least likely to occur in areas firmly under the control of either factions. As a result, the absence of violent events in the household survey does not necessarily mean that respondents were sheltered from the effects of the armed conflict. In fact, households living in rebel-held territories may suffer from the range of indirect impacts of the conflict even in the absence of exposure to direct violence. Indirect consequences include the withdrawal of the state apparatus (not always replaced by rebel governance), absence of NGOs and aid system, fear and inability to travel to the market or towns. Tranchant et al. (2014) show that these indirect effects exert a very strong adverse effect of households' ability to cope with income shocks for households living in the shadow of the Naxal insurgency in India.

According to the village survey, 11 villages were still experiencing the presence of armed groups during the survey period, 55 villages did not report such a presence, and for 2 villages the information was not known. Out of the 11 villages experiencing the presence of armed groups, five villages reported the presence of unnamed "armed bandits", three reported the presence of the MUJAO, three reported the presence of Ansar Eddine, one reported the presence of the MNLA, and one reported the presence of AQMI. As is implicit from the above, two villages report multiple armed groups (one village reported four armed groups, and another one two).

There is a high degree of persistence in the presence of armed groups. Out of the 11 villages where armed groups were still present, nine villages reported the groups were already in the locality between January 2012 and the time of survey. Conversely, two villages were experiencing the presence of armed groups during the survey period though the armed groups were not present in the period following the coup. Out of the 55 villages without the presence of armed groups, only three had experienced their presence at some point since January 2012. A detailed look at the timing of first arrival of armed groups in the 13 villages which ever reported their presence shows that five of these villages were affected in 2012 (three in April, one in June, one in September) and five others were affected in 2013. The two remaining villages were affected much later, in August 2016 and February 2017, respectively.

The village questionnaire included questions on the behaviors of armed groups. These groups were depicted as violent (12 out 13 villages report the groups attack civilians) and a threat to individuals' livelihoods (in 11 of the 13 villages). However, the groups seemed unwilling or unable to insert themselves in the population and/or to impose order (none of the villages report that the groups relied on the population for food, enforced tax or payments, attempted to solve local conflicts, or offered services to the population). The only exception concerned the imposition of the Sharia law, which six villages reported that the groups aimed to enforce (whole or parts of it) at the local level.

Whereas 16% of the villages (11) reported experiencing the presence of armed groups in the locale itself, 77% of them (52) reported that armed groups were present in the region (six did not provide information). In 34 villages, armed groups arrived in 2012 and in 12 villages they arrived in 2013. Five villages reported the presence of armed groups before the conflict started, as early as 2009. Finally, and consistent with the notion that insecurity is appearing to spread in the Mopti region, 17 villages respondents declared that their regions were first affected only in 2016 or 2017.

The presence of armed groups will be operationalized through: (i) a binary variable *Armed groups in village* which takes the value 1 if the village has ever experienced the presence of an armed group since the beginning of the conflict, and (ii) a binary variable *Armed groups in region* which takes the value 1 if the region in which the village is located has ever experienced the presence of an armed group since the beginning of the conflict.

[4] In addition, two villages respondents declared the presence of food-for-work program. In each of these villages, GFD was also reported.

[5] Aid has been scaled-down after 2015, which is why we do not use current aid receipt as our variable of interest. We do not know whether people who received aid on the period 2014–2016 also received aid in the previous period. However, our understanding of the emergency operations in Mali is that aid operations after 2014 were a continuation of the previous emergency aid operations. It is then likely that people exposed to aid on the period 2014–16 were already beneficiaries in the period 2013–14 whereas people not receiving aid in the latter period did not benefit from previous aid.

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Table 4
Presence of armed groups and conflict-related violence.

% of households reporting the presence of:	No armed groups in region	Armed groups in region but not in village	Armed groups in village	Pearson Chi-squared Statistic
Banditry	13.3	13.0	38.9	76.45***
Terrorist attacks	6.2	4.6	22.2	69.12***
Political violence	1.0	3.5	6.8	9.5***
Destruction of infrastructures	0.0	0.8	1.5	2.71
Kidnappings	0.0	1.6	4.4	11.1***
Lynchings	0.0	0.9	1.5	2.55
Any conflict-related violence	15.9	15.7	46.4	95.3***

Stars represent the p-value associated with the Pearson Chi squared test.
***: p < .01; **: p < .05; *: p < .1.

Table 5
Presence of armed groups and mobility.

Respondent declared fear when traveling to:	No armed groups in region	Armed groups in region but not in village	Armed groups in village	Pearson Chi2
the market to buy food	42.6	42.0	66.7	41.16***
the market to sell food	40.5	41.3	66.2	42.9***
look for work	35.4	38.1	67.6	63.3***
the health center	29.2	21.2	52.7	79.1***
the aid center	25.6	19.8	44.0	50.0***
to buy/sell agricultural inputs	24.1	25.8	46.4	36.2***
anywhere outside village	47.2	49.3	78.3	59.4***
Respondents reduced trips of their children to school	11.8	16.7	34.3	40.4***

Stars represent the p-value associated with the Pearson Chi squared test.
***: p < .01; **: p < .05; *: p < .1.

3.7. Conflict, control and violence

The presence of armed groups was not innocuous. First, there is an overlap between presence of armed groups and conflict-related violence in our sample. As shown by Table 4, whereas 16% of households experienced conflict-related violence in villages free from the presence of armed groups (whether they are present in the region or not), 47.3% experienced conflict-related violence in villages where armed groups have been present. There was a strong discontinuity between villages where armed groups have been present and other villages on all types of conflict-related violence. However, there was a not a clear demarcation between villages located in areas where armed groups have been present and villages located in areas free from armed groups. Political violence, kidnappings and lynchings were more prevalent in the former, but the differences were not substantive, and there was no difference in terms of banditry or terrorist attacks.

Second, the presence of armed conflict negatively affected households through fear and reduced mobility. Table 5 shows the cross-tabulation between households' self-reported levels of fear of traveling and presence of armed groups. A similar pattern emerged to that shown in Table 4. Table 5 shows that households living in villages where armed groups have been present were much more likely to have reduced their travels than households living in villages where armed groups had been absent (irrespective of whether or not the presence of these armed groups are reported in the wider region). The table also highlights a widespread fear of traveling in conflict-affected villages, that affected over 78% of households. This translated into fewer trips to the market, health center, job fairs etc. as well as in reduced trips to school for children.

Finally, Table 6 explores the relationships between presence of armed groups, feelings of safety and social capital in villages. With regards to feelings of safety, the table shows that the presence of armed groups at the regional level was important. Whereas 63% of respondents in regions where no armed groups were present felt safe, only 47% of respondents in regions with armed groups felt similarly safe. Over the last 4 years, there was a monotonic relationship between proximity to armed groups and feelings of safety. 52% of households in regions without armed groups felt safe, 37% of households in regions with armed groups but in villages directly unaffected by armed groups felt safe, and only 20% of households in villages directly affected by armed groups felt safe. The relationship between responses related to social capital and proximity to armed groups was less strong, with the main difference arising between villages with direct presence of armed groups and others.

3.8. Food assistance and conflict

Does food assistance reach populations in conflict-affected areas? Table 7 shows that the relationships between availability of food assistance programs and presence of conflict were complex. Access to any food assistance program at village level decreased as proximity with armed groups increased. Whereas food assistance was potentially available for all households living in villages unaffected by armed groups, the proportion went down to 90% in villages indirectly affected (i.e. groups were present in the region but not in the village) and to 76% in villages directly affected by presence of armed groups. Availability of least two forms of food assistance program was, however, roughly similar at the extreme of the conflict spectrum (40%) and was highest in villages indirectly affected (59%).

Looking at the modalities of aid, increased proximity with armed groups reduced access to GFD. The likelihood to have access to GFD + TSF, however, was highest in villages indirectly affected (43%), lowest in villages directly affected (11.6%), and in between in unaffected villages (31%). Finally, the likelihood to have access to GFD and school feeding was twice as high in directly and indirectly affected villages (about 40%) than in unaffected villages (20%). This suggests that the school feeding program in Mopti has been used as an emergency platform for scaling-up aid provision in conflict-affected areas.

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Table 6
Presence of armed groups, safety and social capital.

	No armed groups in region	Armed groups in region but not in village	Armed groups in village	Pearson Chi2
Feel safe in community	63.1	47.6	46.9	15.8***
Felt safe in community over last 4 years	52.3	37.4	19.8	46.0***
Feel that people in community commonly discuss problems	93.8	92.2	88.2	4.6*
Feel that people in community commonly help each other out	91.7	85.9	78.6	14.0***

Stars represent the p-value associated with the Pearson Chi squared test.
***: p < .01; **: p < .05; *: p < .1.

Table 7
Availability of food assistance programs and presence of armed groups.

	No armed groups in region	Armed groups in region but not in village	Armed groups in village	Pearson Chi2
% Households living in villages with:				
Any type of food assistance	100.0	90.4	76.3	61.7***
No food assistance program	0.0	9.6	23.7	61.8***
1 food assistance program	60.0	31.4	35.3	54.3***
2 + food assistance programs	40.0	59.0	41.1	35.5***
GFD	91.3	83.9	76.3	16.6***
GFD + TSF	31.3	42.5	11.6	69.4***
GFD + SF	19.5	43.4	41.1	37.8***
% Households receiving:				
Any type of food assistance	40.0	28.1	32.9	10.7***
No food assistance	59.5	71.4	66.7	10.5***
1 food assistance program	30.3	22.0	29.0	8.2**
2 + food assistance programs	10.3	6.6	4.4	5.7*
GFD	31.4	17.1	26.2	22.7***
SF	15.5	13.4	8.7	4.5

Access to aid means that the corresponding aid program is present in the village.
Stars represent the p-value associated with the Pearson Chi squared test. ***: p < .01; **: p < .05; *: p < .1.
GFD: General Food Distribution; TSF: Targeted Supplementary Feeding; SF: School Feeding.

A similar picture emerged when examining access to aid from the household perspective. The likelihood for households to receive any aid decreased when armed groups were present in the region (from 40% in unaffected villages to 33% in affected villages). Similarly, households were highly less likely to receive two forms of aid or more as proximity with armed groups increased (4.4% versus 10%). There was, however, a much weaker relationship between the presence of armed groups and likelihood to receive one form of aid (and the likelihood was smallest in indirectly affected villages). Examining the modalities of aid revealed that households were most likely to receive GFD in unaffected villages (31%), followed by households in directly affected villages (26%) and households in indirectly affected villages (17%). Finally, the likelihood of receiving school feeding was twice as low in villages where armed groups were present than elsewhere (despite the above finding on availability of school feeding from the village-level data).

To summarize, in our study population, access to aid tended to decrease as proximity with armed groups increased, contrary to what a logic of prioritization of conflict-affected populations would imply, though perhaps reflecting the practicalities of operations during conflict. This manifested itself in a higher likelihood for conflict-affected households to live in villages without any access to aid, and a lower likelihood for conflict affected populations to live in villages with one form of food assistance. However, villages where armed groups were present were as likely to have access to two forms of aid than villages in peaceful environments. The relationship between proximity to armed groups and access to aid is not as marked at the household-level. The strongest effect of conflict was to reduce the chance to receive two forms of aid and a lower likelihood to obtain school feeding, in contradiction with village level information.

3.9. Change in study outcomes

Table 8 shows the mean change in study outcomes between 2012 and 2017 in the overall sample, and in the three subgroups defined by proximity of the respondents with the armed groups. The crisis situation in Mopti is manifest in that households only increased average expenditures per adult equivalent by less than FCFA 1220 over the whole period, corresponding to an increase of just 0.7% of the initial consumption level[6]. Furthermore, calories and micro-nutrient intake decreased between 2012 and 2017. The drop is particularly salient for protein and iron, for which the mean consumption is 10% lower in 2017 than it was in 2012. The corresponding decrease in calories and zinc intake per adult equivalent was more modest (less than 1% of the baseline values). In sharp contrast to this picture of deteriorating food security, consumption of vitamin A increased by 308 microgram over the study period, corresponding to a 73% increase of the baseline value.

Surprisingly, households located nearer to the armed groups have increased their (food) expenditures substantially more than households living in region free from their presence, perhaps due to higher prices. The rise in vitamin A consumption was also stronger when armed groups were present (in the village or in the region) than where they were not. The intake of calories decreased the most for households indirectly affected by the armed groups (-77 calories), and increased the most in villages directly affected by the conflict (+145 calories). Protein, iron and zinc intake decreased in a broadly uniform manner with respect to the conflict situation although zinc consumption only increased in villages where armed groups were present. This pattern could signal that

[6] It is worth noting that these are nominal consumption figures.

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Table 8
Mean change in study outcomes between 2012 and 2017, by exposure to armed groups.

Study outcome	Whole Sample	No armed groups	Armed groups in region	Armed groups in village
ΔMonthly exp. per AE (FCFA)*	1219.34	196.132	1839.191	3041.617
	[1213]	[417]	[584]	[128]
ΔMonthly food exp. per AE (FCFA)*	833.37	−21.23	1277.016	1929.277
	[1210]	[414]	[582]	[130]
ΔShare of food in budget*	0.033	0.015	0.039	0.067
	[1279]	[430]	[639]	[130]
ΔCalories consumed daily per AE*	−12.65	−17.46	−71.509	144.645
	[1216]	[404]	[604]	[130]
ΔProtein consumed daily per AE*	−9.62	−10.12	−10.751	−8.890
	[1213]	[405]	[599]	[132]
ΔIron consumed daily per AE*	−2.46	−2.75	−2.704	−1.799
	[1214]	[405]	[603]	[127]
ΔZinc consumed daily per AE*	−1.089	−2.57	−1.633	2.751
	[1216]	[402]	[613]	[125]
ΔVitamin A consumed daily per AE*	362.85	307.57	356.145	493.56
	[1282]	[429]	[646]	[128]
ΔDietary Diversity Score	−0.589	−0.45	−0.471	−1.723
	[1420]	[475]	[717]	[141]
ΔHeight (cm) of children under 5 in 2012	24.270	24.744	24.342	22.587
	[2449]	[807]	[1199]	[176]

Note: Sample size in square brackets.
The * indicates that the variable has been trimmed to exclude values below the 2.5th percentile and above the 97.5th percentile of the distribution. AE refers to Adult Equivalent.

Table 9
Mean change in study outcomes between 2012 and 2017, by household's food assistance status

Variable	Any Aid	Any aid	GFD	GFD	SF	SF	Number of types of aid		
	no	yes	no	yes	no	yes	0	1	2
ΔExpenditures per AE (FCFA)*	873.656	1879.208	1081.745	1615.23	966.498	2570.608	849.179	2224.369	741.805
	[796]	[417]	[918]	[282]	[1020]	[180]	[783]	[334]	[96]
ΔFood expenditures per AE (FCFA)*	626.839	1233.386	682.57	1269.865	712.613	1452.636	605.206	1478.814	497.27
	[798]	[417]	[914]	[283]	[1021]	[176]	[785]	[328]	[97]
ΔShare of food in budget*	0.034	0.029	0.034	0.026	0.031	0.042	0.035	0.029	0.027
	[858]	[421]	[984]	[281]	[1083]	[182]	[844]	[339]	[96]
ΔCalories consumed daily per AE*	29.22	−100.66	40.606	−183.806	−25.910	92.233	34.183	−85.159	−180.05
	[824]	[392]	[934]	[270]	[1039]	[165]	[812]	[312]	[92]
ΔProtein consumed daily per AE*	−8.83	−11.229	−8.338	−13.700	−9.843	−7.795	−8.728	−10.185	−15.426
	[815]	[398]	[927]	[273]	[1033]	[167]	[802]	[319]	[92]
ΔIron consumed daily per AE*	−2.07	−3.307	−1.979	−4.002	−2.378	−2.841	−2.011	−2.880	−5.142
	[818]	[396]	[928]	[273]	[1034]	[167]	[805]	[317]	[92]
ΔZinc consumed daily per AE*	−0.543	−2.225	−0.408	−3.042	−0.969	−1.236	−0.410	−1.841	−4.417
	[821]	[395]	[930]	[273]	[1037]	[166]	[808]	[314]	[94]
ΔVitamin A consumed daily per AE*	318.17	454.549	335.35	461.399	344.455	471.441	317.63	452.758	445.687
	[862]	[420]	[990]	[278]	[1083]	[185]	[848]	[338]	[96]
ΔDietary Diversity Score	−0.551	−0.667	−0.544	−0.694	−0.566	−0.637	−0.533	−0.631	−0.943
	[958]	[462]	[1099]	[307]	[1205]	[201]	[944]	[371]	[105]
ΔHeight (cm) of children under 5 in 2012	24.4	24.0	24.5	23.4	24.2	24.6	24.4	24.0	23.9
	[1634]	[815]	[1936]	[486]	[2021]	[401]	[1607]	[644]	[198]

Note: Sample size in parentheses. AE refers to Adult Equivalent.
* indicate that the variable has been trimmed to exclude values below the 2.5th percentile and above the 97.5th percentile of the distribution.
GFD: General Food Distribution; TSF: Targeted Supplementary Feeding; SF: School Feeding.

the presence of armed groups was rather innocuous and/or that food assistance was more effective in areas directly concerned by the conflict. Examining child growth, however, reveals that children in directly affected villages grew by about 2 cm less than their counterparts in villages indirectly or unaffected by the presence of armed groups.

Table 9 displays the evolution of the study outcomes across aid categories. Households who received any aid (and especially school feeding) increased their (food) expenditures more than household without access to aid. However, households who received two forms of aid have seen a smaller increase in expenditures than households who received either one form of aid or no aid at all. The share of food expenditures in the budget did not vary significantly with aid categories. Caloric intake, dietary diversity and micro-nutrient availability decreased the most for households that received aid (under any form), which may indicate that aid prioritized the most vulnerable. Consumption of vitamin A increased the most for recipients of aid (in any form). Finally, there is no obvious relationship between child growth and aid status.

4. Estimating the impact of food assistance in northern Mali

In the first set of estimations, we assume that the whole study population was affected by the conflict, whether directly or indirectly. Such a view is consistent with insights from Tables 5 and 6. In areas where armed groups were absent, almost half (47%) of households reported fearing to travel outside their village. Such a high proportion indicates widespread insecurity and fear, even in areas that are supposedly out of the reach of armed groups. In addition, the proportion of households that feared traveling outside their village was virtually the same in villages not directly affected by armed groups, but where armed groups are present

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Table 10
Determinants of food assistance at household level, Logit estimates.

				Number of types of aid	
	Any aid	GFD	SF	1	2
	(1)	(2)	(3)	(4)	(5)
Secondary school within 5 km	−0.056	0.019	−0.31	0.070	−0.49
	(0.17)	(0.20)	(0.24)	(0.18)	(0.32)
Market within 5 km	−0.85***	−0.95***	−0.64**	−0.68***	−1.92***
	(0.21)	(0.25)	(0.30)	(0.22)	(0.54)
Past project	0.74***	0.76***	0.73***	0.63***	1.16***
	(0.17)	(0.20)	(0.24)	(0.19)	(0.32)
Very unsafe	−0.62**	−0.91**	−0.16	−0.52	−1.10*
	(0.29)	(0.41)	(0.34)	(0.32)	(0.57)
Age household head	−0.0021	−0.00045	−0.0025	−0.0022	−0.0062
	(0.0061)	(0.0069)	(0.0084)	(0.0066)	(0.011)
Expenditures per capita	0.0000021	0.00000069	0.0000033	0.0000017	0.0000030
	(0.0000017)	(0.0000019)	(0.0000022)	(0.0000018)	(0.0000028)
Household size	0.040	−0.014	0.052	0.040	0.059
	(0.044)	(0.053)	(0.058)	(0.048)	(0.079)
Dependency ratio	0.033	0.0016	0.16	−0.016	0.0083
	(0.10)	(0.12)	(0.14)	(0.11)	(0.18)
Food groups consumed	−0.0018	0.034	−0.057	−0.0022	0.046
	(0.063)	(0.072)	(0.088)	(0.068)	(0.011)
Polygamous household	−0.18	−0.12	−0.17	−0.13	−0.45
	(0.19)	(0.23)	(0.27)	(0.21)	(0.37)
Worker	0.73*	1.06***	−0.12	0.71*	1.39**
	(0.38)	(0.39)	(0.65)	(0.41)	(0.58)
Land cultivated	−0.0059	−0.030	0.024	−0.0047	−0.015
	(0.024)	(0.030)	(0.030)	(0.026)	(0.045)
1st quintile expenditures	0.47	−0.19	1.14	0.42	0.69
	(0.59)	(0.67)	(0.82)	(0.63)	(1.06)
2nd quintile expenditures	0.68	0.19	1.00	0.62	0.71
	(0.50)	(0.57)	(0.70)	(0.54)	(0.91)
3rd quintile expenditures	0.15	0.062	−0.19	0.15	0.22
	(0.43)	(0.49)	(0.64)	(0.47)	(0.80)
4th quintile expenditures	0.33	0.18	0.31	0.27	0.56
	(0.38)	(0.42)	(0.54)	(0.41)	(0.68)
% of food in budget	0.043	0.90	−1.77**	0.013	−0.52
	(0.55)	(0.66)	(0.71)	(0.60)	(0.99)
Logarithm of assets value	0.042	−0.075	0.23***	0.014	0.067
	(0.053)	(0.060)	(0.076)	(0.058)	(0.095)
Armed groups in village	0.14	0.60**	−0.73**	0.28	−0.46
	(0.21)	(0.24)	(0.36)	(0.23)	(0.44)
Armed groups in region	−0.41**	−0.53**	−0.34	−0.45**	−0.25
	(0.21)	(0.23)	(0.27)	(0.23)	(0.35)
Observations	981	975	975	981	975

Notes: Standard errors in parentheses. * $p < .1$, ** $p < .05$, *** $p < .01$.
GFD: General Food Distribution; TSF: Targeted Supplementary Feeding; SF: School Feeding.

in the wider region. This shows that the demarcation between areas not affected and areas indirectly affected may not be very clear (unlike the distinction between indirectly and directly affected villages). Household respondents tended to feel more safe in areas supposedly out of reach of armed groups than in villages indirectly affected by armed groups (63% versus 48%) but the very high proportion of respondents who felt unsafe in either area further justified considering the whole study population as affected by insecurity.

Table 10 shows that few household-level covariates predict the likelihood to receive aid. Household heads who identified as workers were more likely to receive GFD (but marginally less likely to receive any form of aid) and households who dedicated a larger share of their budget to food were less likely to participate in school feeding programs. Households with higher value of assets were also more likely to participate in school feeding programs. Village-level covariates were more important in terms of allocation of aid. Aid was less likely to be received in villages with access to a nearby market (remote areas seem to have been prioritized), in villages perceived to be very unsafe at baseline (although this does not have an effect on school feeding) and in villages where armed groups were present (for GFD and school feeding). The likelihood of receiving any aid or GFD was also lower in villages located in regions where armed groups are present. Finally, the existence of past development projects before the baseline explains the access to food aid in subsequent years. Columns 4 and 5, which shows the results of a multinomial logit regression of the number of forms of aid received by the household, broadly confirms these findings.

Tables 11 and 12 show how balanced the covariates are before and after weighting the treatment and control samples with the estimated propensity score. Austin (2009) recognizes that standardized differences below 10% do not signal problematic imbalances in the distribution of covariates. With this threshold in mind, no less than seven covariates are imbalanced in the raw sample for *Any aid* (column 1). In the weighted sample, however, standardized differences are below 10% for all covariates. Similarly, for GFD, SF and Number of types of aid (when equal to 1), the imbalances in the raw sample are eliminated in the weighted sample (although the standardized difference for past safety is just 10% for GFD). When number of types of aid equal 2, however, two covariates remain imbalanced after the weighting. Specifically, treated households are less likely to have access to a market within

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Table 11
Standardized differences in raw and weighted samples.

Sample:	(1) Raw	(2) Weighted	(3) Raw	(4) Weighted	(5) Raw	(6) Weighted
Treatment:	Any aid	Any aid	GFD	GFD	SF	SF
Secondary school within 5 km	−0.013	−0.042	−0.029	0.056	−0.080	−0.007
Market within 5 km	**−0.248**	−0.003	**−0.284**	0.013	**−0.209**	−0.012
Past project	**0.268**	−0.034	**0.210**	0.034	**0.349**	−0.011
Very unsafe	**−0.127**	0.030	**−0.230**	**−0.10**	**0.100**	−0.004
Age household head	−0.007	−0.006	−0.014	−0.018	−0.022	0.015
Expenditures per capita	0.073	0.007	**0.160**	−0.022	−0.073	0.017
Household size	−0.009	−0.029	**−0.128**	0.036	0.068	−0.013
Dependency ratio	0.053	−0.002	0.010	0.014	**0.121**	−0.029
food groups	0.002	−0.0004	0.030	0.003	−0.089	−0.024
Polygamous	−0.081	−0.0098	**−0.126**	0.023	−0.044	−0.0001
Worker	**0.147**	−0.01	**0.242**	−0.005	−0.067	−0.007
Land cultivated	0.018	−0.026	**−0.119**	−0.003	**0.197**	−0.022
1st quintile expenditures	−0.084	0.011	**−0.123**	−0.008	0.076	0.017
2nd quintile expenditures	**0.125**	−0.011	0.075	0.018	**0.160**	−0.010
3rd quintile expenditures	**−0.104**	−0.015	−0.016	−0.002	**−0.291**	−0.005
4th quintile expenditures	0.060	0.014	0.066	−0.012	−0.008	−0.010
Food % in budget	0.029	0.002	**0.182**	−0.029	**−0.269**	0.019
Logarithm of assets value	0.059	−0.022	−0.092	−0.004	**0.261**	−0.001
Armed groups in village	0.010	0.012	**0.171**	0.0002	**−0.293**	−0.004
Armed groups in region	**−0.181**	0.001	**−0.221**	−0.012	**−0.172**	0.002
Observations	1024	1024	1012	1012	1012	1012

Note: Numbers in bold indicate standardized difference above 10%.
GFD: General Food Distribution; TSF: Targeted Supplementary Feeding; SF: School Feeding.

Table 12
Standardized differences in raw and weighted samples for *Types aid*

Sample	(1) Raw	(2) Weighted	(3) Raw	(4) Weighted
Number of types of aid	1	1	2	2
Secondary school within 5 km	0.074	0.024	−0.040	−0.067
Market within 5 km	**−0.181**	−0.005	**−0.472**	**−0.193**
Past project	**0.147**	0.027	**0.356**	−0.023
Very unsafe	**−0.107**	−0.013	**−0.100**	0.038
Age household head	−0.049	−0.001	0.035	0.001
Expenditures per capita	0.074	−0.020	0.091	0.099
Household size	0.059	0.028	−0.096	−0.080
Dependency ratio	0.059	0.014	0.022	0.013
Food groups consumed	−0.032	−0.014	**0.135**	−0.003
Polygamous household	−0.058	0.009	**−0.188**	**−0.126**
Worker	**0.149**	0.026	**0.221**	0.030
Land cultivated	−0.012	0.018	−0.088	−0.030
1st quintile expenditures	−0.137	0.003	**−0.148**	0.029
2nd quintile expenditures	**0.133**	0.016	0.078	−0.019
3rd quintile expenditures	−0.032	−0.006	0.043	0.011
4th quintile expenditures	0.040	−0.025	0.087	−0.051
Food % in budget	−0.002	0.011	0.014	0.043
Logarithm of assets value	0.029	0.014	0.017	0.063
Armed groups in village	0.087	0.019	−0.088	0.059
Armed groups in region	0.081	0.005	**−0.107**	0.055
Observations	1024	1024	1024	1024

Note: Numbers in bold indicate standardized difference above 10%.

5 km and they are less likely to be polygamous. Still, we have a strong degree of confidence that the matched DID estimations are able to eliminate observable sources of selection bias for each treatment variable, at least for four out of five aid categories.

The impact estimates of the food assistance are summarized in Table 13 for the full sample, showing evidence of some positive impact of the food transfers during the study period on household total expenditures and food expenditures. GFD was found to increase total expenditures whereas school feeding and the combination of two forms of aid were found to increase food expenditures. These effects are statistically significant at the 10% level. In terms of total expenditures, the effect of the GFD was estimated at 3208 CFA/month per AE, corresponding to an increase of 20% from baseline. For food expenditures, the impact of school feeding was 2364 CFA/month per AE, equivalent to an increase of 21% from baseline values.

There were also positive effects on micro-nutrient availability from household food consumption during the seven-day recall period. Households who received two forms of aid have seen a statistically significant increase in their availability of calories, protein, iron and vitamin A at the 5% or 10% levels. The magnitude of these effects is very substantial, as it ranges from 29% of the baseline value for calories to 50% of the baseline value for vitamin A. Consumption of vitamin A also strongly increased for recipients of

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Table 13
Estimations of the impact of food assistance on household food expenditures, food consumption and on children's height.

Sample	Full sample				
Estimator	Propensity score (kernel) matching difference-in-difference.				
Food assistance	Any aid (1)	GFD (2)	SF (3)	1 Type of aid (4)	2 types of aid (5)
ΔMonthly expenditures (FCFA)	2332.37	3208.77*	2228.95	2159.05	2804.18
	(1522.6)	(1947.04)	(1480.4)	(1995.67)	(2028.2)
	[1970]	[1973]	[1962]	[1968]	[1649]
ΔMonthly food expenditures (FCFA)	1873.02	2680.5	2364.1*	1468.1	3108.3**
	(1567.08)	(1915.8)	(1393.5)	(2152.0)	(1434.3)
	[1971]	[1974]	[1963]	[1969]	[1646]
ΔFood expenditure as % of budget	−0.001	0.000	0.008	−0.001	−0.015
	(0.016)	(0.021)	(0.021)	(0.017)	(0.026)
	[1969]	[1972]	[1961]	[1968]	[1645]
ΔCalories (kcal) consumed daily	−2979.5	−4463.1	1390.9	−4057.4	970.95*
	(3515.6)	(6211.8)	(1285.1)	(4633.7)	(502.4)
	[1996]	[1998]	[1987]	[1994]	[1674]
ΔProtein (gram) consumed daily	−62.1	−95.4	36.5	−91.3	36.7**
	(73.3)	(108.3)	(30.3)	(112.15)	(17.4)
	[1979]	[1982]	[1971]	[1978]	[1650]
ΔIron (mg) consumed daily	−16.7	−25.9	9.0	−23.4	7.73**
	(21.5)	(36.1)	(8.0)	(23.0)	(3.67)
	[1982]	[1984]	[1973]	[1980]	[1653]
ΔZinc (mg) consumed daily	−40.6	−59.2	13.57	−53.3	7.08
	(45.6)	(91.2)	(16.6)	(53.3)	(5.8)
	[1992]	[1994]	[1983]	[1990]	[1664]
ΔVitamin A (mcg) consumed daily	128.4	168.4	270.3***	88.3	247.04*
	(84.5)	(113.4)	(82.9)	(95.8)	(147.7)
	[1978]	[1981]	[1970]	[1975]	[1651]
ΔDietary diversity score	0.026	0.291	−0.231	0.051	−0.251
	(0.157)	(0.195)	(0.252)	(0.189)	(0.274)
	[2290]	[2294]	[2282]	[2288]	[1920]
ΔHeight (cm)	−0.107	−0.652	0.045	−0.305	0.818
	(1.444)	(1.784)	(1.529)	(1.445)	(3.201)
	[1947]	[1953]	[1960]	[1956]	[1866]

Notes: Bootstrapped standard errors in parentheses. Number of observations in square brackets.
All expenses are scaled per adult equivalent (AE).
The variables "1 form" and "2 forms" refer to the number of forms of aid received by the household, as indicated by the *Types of aid* variables.
Estimations for Height restricted to children under 5 years of age at baseline.
Estimations exclude observations for which the change in the outcome variable is lower than the 2.5th percentile and above the 97.5th percentile of the distribution.
GFD: General Food Distribution; TSF: Targeted Supplementary Feeding; SF: School Feeding.

school feeding, and the effect is significant at the 1% level. However, we found no effect of any forms of food assistance (when received in isolation) on micro-nutrient availability. Finally, there is no discernible impact of food assistance on children's growth.

5. Estimating the impact of food aid allowing for heterogeneity

The treatment effects reported in Section 4 are estimated under the assumption that the whole sample was affected by insecurity. In what follows, we investigate whether stronger, or more direct, exposure to armed conflict influences the impact of food assistance. Specifically, we will estimate the impact on aid on three subgroups: (i) villages unaffected by the presence of armed groups, (ii) villages indirectly affected by the presence of armed groups (they were present in the region but not in the village), and (iii) villages directly affected by the presence of armed groups.

The number of observations is small for estimations on the subsample of directly affected villages. We have dropped from the table of results all the estimations that were based on fewer than 30 observations in either the treatment or control group at baseline and/or endline. This condition is always met on the subsamples of unaffected and indirectly affected villages. For directly affected villages, however, the condition is systematically violated for school feeding and when the number of types of aid equal 2. There were also an insufficient number of observations to estimate the impact of any treatment variable on children's height.

To ensure that the covariates are balanced in these subsamples, we re-ran the estimation of the propensity score at the level of the subgroups. Even within the three subgroups, the kernel propensity score DID estimator is remarkably effective at balancing covariates between treatment and control groups.[7]

Table 14 summarizes the impact estimates in the sub-sample of the study population living in villages with no armed groups in the region. Humanitarian aid in the form of SF had a positive impact on food expenditures whereas GFD was found to increase total food expenditures. These results are comparable in magnitude and statistical precision to those of Table 13. However, the positive effects of aid on food consumption that we found for the full sample are not present for the subsample of 'conflict-free' villages, with the exception of vitamin A. Iron consumption was even slightly lower for households receiving two forms of aid than for others ($p < 0.1$). It is worth stressing that the coefficients associated with food expenditures, calories and iron are all negative in Table 14. The fact that receiving two forms of aid is no longer positively associated with these variables in the villages not affected by armed groups thus cannot be explained by the lower sample size and statistical power. Other variables of aid continued to be unrelated with micro-nutrient availability (other than vitamin A) and height.

[7] Results not shown to save space but are available upon request.

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Table 14
Estimations of the impact of food assistance on households' food expenditures, food consumption and children's height in villages not affected by the conflict.

Sample	No armed groups in the region				
Estimator	Propensity score (kernel) matching difference-in-difference.				
Food assistance	Any aid (1)	GFD (2)	SF (3)	1 type of aid (4)	2 types of aid (5)
ΔMonthly expenditures (FCFA)	1716.8	3296.6*	2439.1	1372.7	−999.0
	(1538.4)	(1957.6)	(1806.03)	(2013.4)	(2682.2)
	[718]	[704]	[721]	[712]	[658]
ΔMonthly food expenditures (FCFA)	916.9	1684.4	2375.4*	336.1	−409.1
	(1265.7)	(1658.8)	(1274.6)	(1682.9)	(2156.5)
	[717]	[699]	[718]	[708]	[657]
ΔFood expenditure as % of budget	−0.021	−0.036	−0.002	−0.018	−0.049
	(0.026)	(0.031)	(0.038)	(0.035)	(0.045)
	[711]	[694]	[714]	[701]	[653]
ΔCalories (kcal) consumed daily	−9000.6	−1300	26.1	−1300	−362.1
	(7605.1)	(1600)	(368.0)	(1200)	(648.8)
	[750]	[684]	[703]	[692]	[644]
ΔProtein (gram) consumed daily	−205.3	−289.1	−2.6	−288.5	−19.3
	(220.8)	(297.9)	(11.2)	(321.8)	(18.6)
	[694]	[676]	[694]	[684]	[635]
ΔIron (mg) consumed daily	−57.2	−78.8	−2.8	−79.0	−7.0*
	(61.3)	(76.7)	(2.7)	(79.1)	(3.9)
	[690]	[674]	[692]	[680]	[635]
ΔZinc (mg) consumed daily	−120.7	−167.8	−5.75	−168.06	−8.7
	(113.5)	(166.4)	(6.05)	(148.8)	(9.12)
	[682]	[665]	[685]	[672]	[628]
ΔVitamin A (mcg) consumed daily	153.7	256.4*	275.8**	20.4	307.35***
	(102.3)	(148.9)	(126.67)	(89.13)	(114.9)
	[705]	[689]	[704]	[698]	[643]
ΔDietary diversity score	−0.03	0.386	−0.236	−0.171	0.14
	(0.247)	(0.330)	(0.413)	(0.338)	(0.466)
	[806]	[790]	[810]	[798]	[744]
ΔHeight (cm)	−2.222	−3.813	−1.302	−0.837	−5.609
	(2.817)	(2.798)	(3.204)	(2.215)	(4.450)
	[745]	[669]	[699]	[706]	[725]

Notes: Bootstrapped standard errors in parentheses. Number of observations in square brackets.
All expenses are scaled per adult equivalent (AE).
The variables "1 form" and "2 forms" refer to the number of forms of aid received by the household, as indicated by the *Types of aid* variables.
Estimations for Height restricted to children under 5 years of age at baseline.
Estimations exclude observations for which the change in the outcome variable is lower than the 2.5th percentile and above the 97.5th percentile of the distribution.
GFD: General Food Distribution; TSF: Targeted Supplementary Feeding; SF: School Feeding.

Table 15 summarizes the impact estimates in the sub-sample of the study population living in villages that were not directly affected by the conflict but where armed groups were present in the wider region. Total and food expenditures tended to be higher for aid recipients than for other households, but the standard errors of the estimates were quite large so that none of these effects are statistically distinguishable from zero. Aid was however responsible for a strong increase in food consumption. Households receiving two forms of aid have seen their availability of calories, protein, iron and zinc go up by 47%, 74%, 68% and 35% respectively. These effects are statistically significant at the 1% level for protein, at the 5% level for iron and at the 10% level for calories and zinc. Furthermore, GFD was found to significantly increase caloric intake by 52% ($p < 0.05$) and zinc consumption by 64% ($p < 0.1$) while school feeding was found to increase vitamin A availability by 48% ($p < 0.05$).

Interestingly, the provision of two forms of aid increased the height of children aged 2–5 years at baseline by approximately 7 cm in the intervention households compared to controls, equivalent to an increase of about 8% from baseline.

Table 16 displays the impact estimates in the sub-sample of the study population living in villages with armed groups present. A significant positive impact was identified on food expenditures in households receiving any aid, GFD, or one form of aid, with effects sizes of substantively larger magnitude compared to those observed in the full sample. Consumption of zinc was also significantly increased for recipients of any food aid (or one form of aid). No statistically significant results were found for the other outcomes, including availability of vitamin A.[8]

6. Discussion and conclusions

In this study we examined new survey data to assess the impact of humanitarian aid on food security and nutrition outcomes during conflict in Northern Mali. The survey data showed that during the five years since the conflict escalated, households experienced continued food insecurity, as evidenced by the modest increases in average expenditures per adult equivalent (less than FCFA 1220 over the whole period, corresponding to less than a 1% increase), as well as decreases in overall food consumption and micronutrient availability.

The survey data also highlighted the extent and intensity of conflict exposure in the study population. Over one in five households in our study were exposed to violence linked to the presence of armed groups, including episodes of banditry, terrorist/armed attacks, political violence, kidnappings, and destruction of

[8] It is plausible that the smaller sample size in Table 16 explains the lack of significant effects of food aid on vitamin A, iron and calories as the coefficients associated with each of these variables are positive and similar in magnitude to the corresponding coefficients in previous tables, where some of which were found to be significantly different from zero number.

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Table 15
Estimations of the impact of food assistance on households' food expenditures, food consumption and children anthropometry in villages indirectly affected by the conflict.

Sample	Armed groups in the region but not in the village.				
Estimator	Propensity score (kernel) matching difference-in-difference.				
Food assistance	Any aid (1)	GFD (2)	SF (3)	1 type of aid (4)	2 types of aid (5)
ΔMonthly expenditures (FCFA)	1253.4	2762.5	229.6	1139.75	3100.8
	(2733.7)	(4181.1)	(2528.7)	(3938.15)	(2361.9)
	[1036]	[1021]	[981]	[1032]	[764]
ΔMonthly food expenditures (FCFA)	654.5	1498.2	714.8	226.9	2839.28
	(2847.8)	(3872.12)	(2810.4)	(3713.4)	(1767.8)
	[1036]	[1019]	[980]	[1032]	[763]
ΔFood expenditure as % of budget	0.001	−0.002	0.025	0.009	−0.016
	(0.024)	(0.030)	(0.027)	(0.029)	(0.039)
	[1043]	[1028]	[981]	[1038]	[770]
ΔCalories (kcal) consumed daily	554.13	1737.4**	51.17	378.5	1572.5*
	(704.6)	(699.44)	(800.12)	(848.7)	(875.1)
	[1066]	[1050]	[1004]	[1061]	[795]
ΔProtein (gram) consumed daily	15.1	35.9	11.86	3.2	72.04***
	(25.1)	(32.04)	(27.3)	(28.09)	(27.5)
	[1062]	[1046]	[998]	[1057]	[785]
ΔIron (mg) consumed daily	6.42	11.76*	3.23	4.25	15.76**
	(6.06)	(1.74)	(5.3)	(5.39)	(6.4)
	[1064]	[1049]	[1003]	[1059]	[791]
ΔZinc (mg) consumed daily	6.09	20.78*	−3.33	4.94	12.03*
	(9.2)	(10.74)	(11.9)	(8.73)	(7.23)
	[1083]	[1064]	[1014]	[1077]	[805]
ΔVitamin A (mcg) consumed daily	1.115	−184.7	240.4**	13.35	38.0
	(117.93)	(180.4)	(114.7)	(158.3)	(196.38)
	[1066]	[1049]	[1005]	[1059]	[801]
ΔDietary diversity score	−0.179	−0.004	−0.326	−0.04	−0.904*
	(0.230)	(0.355)	(0.357)	(0.28)	(0.498)
	[1238]	[1218]	[1164]	[1230]	[924]
ΔHeight (cm)	2.265	3.273	−0.070	0.829	7.244***
	(1.791)	(2.286)	(1.842)	(1.645)	(2.661)
	[1002]	[979]	[965]	[1006]	[961]

Notes: Bootstrapped standard errors in parentheses. Number of observations in square brackets.
All expenses are scaled per adult equivalent (AE).
The variables "1 form" and "2 forms" refer to the number of forms of aid received by the household, as indicated by the *Types of aid* variables.
Estimations for Height restricted to children under 5 years of age at baseline.
Estimations exclude observations for which the change in the outcome variable is lower than the 2.5th percentile and above the 97.5th percentile of the distribution.
GFD: General Food Distribution; TSF: Targeted Supplementary Feeding; SF: School Feeding.

infrastructure, amongst others. Out of the 68 villages included in the survey, 11 (16%) were still experiencing the presence of armed groups at the time of the follow-up survey, with most these reporting that the presence of armed groups had persisted following the coup in 2012. Only three of the 55 villages without presence of armed groups during the follow-up survey had experienced their presence since 2012. These groups were violent and were perceived as threatening by the population. The data also indicated that the presence of armed groups overlapped with conflict-related violence, as well as with fear and reduced mobility in the communities, including visits to farms, markets, health centers and schools. These findings confirm the potential for conflict to indirectly affect household's food security through a range of different channels.

The household and village surveys suggested that a range of humanitarian aid had been scaled-up in the study areas during the five-year period following the 2012 coup, including food assistance in the form of GFD, SF, and other modalities. Of the different forms of aid, GFD was more common, followed by SF. The coverage of TSF (targeted supplementary feeding), a key intervention to prevent and treat acute malnutrition, was extremely low in the study population. However, survey data also indicates that access to aid tended to decrease as proximity with armed groups increased, as highlighted by the higher likelihood for conflict-affected households to live in villages without any access to aid, and a lower likelihood to live in villages with one form of food assistance, though this relationship was not as marked at the household level. These findings suggest that the logistics of safely scaling-up aid in conflict areas may override the necessity to reach most vulnerable populations.

The analysis of treatment effects suggests that the scaling-up of humanitarian aid by WFP and development partners in Mali had important positive impacts on the food security targeted population. We find evidence of protective effects on household total expenditures and food expenditures, as well as on micro-nutrient availability, food consumption and on changes in height in children aged to 2–5 years at baseline. The effects on food consumption are comparable with those in the literature on social assistance. A recent meta-analysis of social assistance programs including 48 studies of 39 social protection programs found that transfers increase monthly food expenditure by 17% on average, compared to the 21% estimate found in our study (Hidrobo et al., 2018).

Our analysis identified a large protective effect of aid on food consumption and on the height of children in the cohort aged 2–5 at baseline (of the order of 0.5 SDs), where armed groups were present near the targeted communities, though not present in the communities themselves. The effect was concentrated on households receiving at least two forms of aid (usually GFD with school feeding). This finding suggests that food assistance may provide a platform to improve children's growth outside the priority age group for nutrition interventions during the first 1000 days. This finding is also consistent with the idea that the provision of household food transfers, or GFD alone without specific complementary foods targeting young children, generally does not result in

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Table 16
Estimations of the impact of food assistance on households' food expenditures, food consumption and children anthropometry in villages directly affected by the conflict.

Sample	Armed groups in the village.				
Estimator	Propensity score (kernel) matching difference-in-difference.				
Food assistance	Any aid (1)	GFD (2)	SF (3)	1 type of aid (4)	2 types of aid (5)
ΔMonthly expenditures (FCFA)	7478.9	7191.2	.	5946.3	.
	(4887.3)	(4590.3)	.	(3742.8)	.
	[220]	[216]	[43]	[208]	[45]
ΔMonthly food expenditures (FCFA)	8639.6***	7907.1**	.	6197.5**	.
	(3312.7)	(3616.6)	.	(3217.2)	.
	[223]	[219]	[42]	[210]	[46]
ΔFood expenditure as % of budget	0.022	0.013	.	0.003	.
	(0.06)	(0.073)	.	(0.061)	.
	[214]	[211]	[41]	[200]	[49]
ΔCalories (kcal) consumed daily	2474.7	2387.5	.	1758.0	.
	(1848.8)	(1725.2)	.	(1194.2)	.
	[223]	[218]	[41]	[209]	[46]
ΔProtein (gram) consumed daily	135.7	140.3	.	102.7	.
	(93.8)	(97.5)	.	(66.65)	.
	[224]	[219]	[42]	[209]	[48]
ΔIron (mg) consumed daily	35.02	35.27	.	26.05	.
	(24.86)	(26.94)	.	(17.8)	.
	[223]	[218]	[41]	[210]	[47]
ΔZinc (mg) consumed daily	34.15*	32.15	.	26.71*	.
	(17.9)	(19.6)	.	(13.84)	.
	[223]	[218]	[42]	[209]	[46]
ΔVitamin A (mcg) consumed daily	522.2	230.5	.	349.6	.
	(471.8)	(311.17)	.	(280.9)	.
	[205]	[202]	[38]	[194]	[44]
ΔDietary diversity score	0.203	0.226	.	0.122	.
	(0.621)	(0.549)	.	(0.605)	.
	[242]	[238]	[44]	[226]	[54]

Notes: Bootstrapped standard errors in parentheses. Number of observations in square brackets.
All expenses are scaled per adult equivalent (AE).
The variables "1 form" and "2 forms" refer to the number of forms of aid received by the household, as indicated by the *Types of aid* variables.
Estimations for Height restricted to children under 5 years of age at baseline.
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GFD: General Food Distribution; TSF: Targeted Supplementary Feeding; SF: School Feeding.

improvements on nutrition outcomes of young children (Ruel et al., 2013).

In conclusion, in settings characterized by chronic food insecurity and conflict, food transfers may have a protective effect on food security of vulnerable populations. Evidence from this study suggests that there is scope to improve the design and scale-up of humanitarian aid interventions during conflict, including providing increased coverage of nutrition specific interventions, or of the provision of specialized complementary foods alongside foods provided to households as part of general food distribution, for example. However, humanitarian operations during conflict face important trade-offs involving on the one hand program scale and effectiveness, and on the other the practicalities of operating in areas under the control of armed groups, including security, governance and transparency.

Conflict of interest

None.

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References

Akresh, R., Bhalotra, S., Leone, M., & Osili, U. O. (2012). War and stature: Growing up during the nigerian civil war. *American Economic Review, 102*(3), 273–277.
Alderman, H., Hoddinott, J., & Kinsey, B. (2006). Long term consequences of early childhood malnutrition. *Oxford Economic Papers, 58*(3), 450–474.
Altare, C., & Guha Sapir, D. (2013). The burden of armed conflict: A public health approach. In T. Bruck & P. Verwimp (Eds.), *A micro-level perspective on the dynamics of conflict, violence, and development*. Oxford University Press.
Austin, P. (2009). Balance diagnostics for comparing the distribution of baseline covariates between treatment groups in propensity-score matched samples. *Statistics in Medicine, 28*(25), 3083–3107.

Barikmo, I., Ouattara, F., & Oshaug, A. (2004). *Food composition table for mali*. Oslo: Akershus University College.

Black, R., Victora, C., Walker, S., Bhutta, Z., Christian, P., & de Onis, M. (2013). Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet, 382*, 427–451.

Boas, M., & Torheim, L. E. (2013). The trouble in Mali: Corruption, collusion, resistance. *Third World Quarterly, 34*(7), 1279–1292.

Bozzoli, C., Bruck, T., & Wald, N. (2013). Evaluating programmes in conflict-affected areas. In P. Justino, T. Bruck, & P. Verwimp (Eds.), *A micro-level perspective on the dynamics of conflict, violence, and development*. .

Camacho, A. (2008). Stress and birth outcomes: Evidence from terrorist attacks in colombia. *American Economic Review: Papers and Proceedings, 98*(2), 511–515.

Casey, K., Glennerster, R., & Miguel, E. (2012). *Healing the wounds: Learning from sierra leone's post-war institutional reforms*. NBER Working Paper 18368.

Dawid, A. (1979). Conditional independence in statistical theory. *Journal of the Royal Statistical Society, Series B, 41*, 1–31.

Domingues, P., & Barre, T. (2013). The health consequences of the mozambican civil war: An anthropometric approach. *Economic Development and Cultural Change, 61*(4), 755–788.

FAO IFAD & WFP (2015). *The state of food insecurity in the world 2015. meeting the 2015 international hunger targets: taking stock of uneven progress*. Rome: FAO.

Fearon, J. D., Humphreys, M., & Weinstein, J. M. (2009). Can development aid contribute to social cohesion after civil war? evidence from a field experiment in post-conflict liberia. *American Economic Review: Papers & Proceedings, 99*(2), 287–291.

Haider, H. (2011). *Helpdesk research report: Cash transfers in fragile/conflict-affected environments*. Governance and Social Development Resource Centre.

Harvey, P., Proudlock, K., Clay, E., Riley, B., & Jaspars, S. (2010). *Food aid and food assistance in emergency and transitional contexts: A review of current thinking*. Synthesis Paper, Humanitarian Policy Group.

Heckman, J. J., Hichimura, H., & Todd, P. (1998). Matching as an econometric evaluation estimator. *Review of Economic Studies, 65*, 261–294.

Hidrobo, M., Hoddinott, J., Kumar, N., & Olivier, M. (2018). Social protection, food security and asset formation. *World Development, 101*, 88–103.

Hirano, K., Imbens, G. W., & Ridder, G. (2003). Efficient estimation of average treatment effects using the estimated propensity score. *Econometrica, 71*(4), 1161–1189.

Honorati, M., Gentilini, U., & Yemtsov, R. (2015). *The state of social safety nets*. Washington D.C: World Bank Group.

Justino, P. (2012). War and poverty. In M. Garfinkel & S. Skaperdas (Eds.), *Handbook of the economics of peace and conflict*. Oxford University Press.

Kalyvas, S. N. (2006). *The logic of violence in civil war*. New York, NY: Cambridge University Press.

Lecoq, B. (2010). *Disputed desert: Decolonisation, competing nationalisms and tuareg rebellions in northern mali*. Brill Academic Publishers.

Masset, E., & Gelli, A. (2013). Community participation and the links between agriculture, nutrition and education: design of a randomised field experiment of "home-grown" school feeding in Mali. *Trials, 14*, 55.

Minoiu, C., & Shemyakina, O. N. (2014). Armed conflict, household victimization, and child health in côte d'ivoire. *Journal of Development Economics, 118*, 237–255.

Rossi, L., Hoerz, T., Thouvenot, V., Pastore, G., & Michael, M. (2006). Evaluation of health, nutrition and food security programmes in a complex emergency: the case of congo as an example of a chronic post-conflict situation. *Public Health Nutrition, 9*(5), 551–556.

Ruel, M. T., Alderman, H., & Maternal & Child Nutrition Study Group (2013). The Nutrition-sensitive interventions and programs: How can they help to accelerate progress in improving maternal and child nutrition? *The Lancet, 382*(9891), 536–551.

Schraeder, P. (2011). Traditional conflict medicine? lessons for putting mali and other african countries on the road to peace. *Nordic Journal of African Studies, 20*(2), 177–202.

Swindale, A., & Bilinsky, P. (2006). *Household dietary diversity score (hdds) for measurement of household food access: Indicator guide (v.2)*. Washington, DC: FHI 360/FANTA.

Tranchant, J.-P., Justino, P., & Mueller, C. (2014). *Political violence, drought and child malnutrition: Empirical evidence from andhra pradesh, india.*. HiCN Working Paper 173.

USDA (2009). *Assessment of local production for school feeding in Mali*. Washington, DC: United States Department of Agriculture, Foreign Agricultural Service.

Webb, P., Boyd, E., de Pee, S., Lenters, L., Bloem, M., & Schultink, W. (2014). Nutrition in emergencies: Do we know what works? *Food Policy, 49*, 33–40.

WFP (2014). *Standard project report: Mali country programme*. Rome: World Food Programme.

WFP Mali (2016). *Enquete nationale sur la securite alimentaire et nutritionnelle (ensan mali)*. ENSAN MALI.

WHO (2006). *The who child growth standards*. World Health Organization.

WHO (2008). *Worldwide prevalence of anaemia 1993–2005: Who global database on anaemia*. Geneva: World Health Organization.

WHO (2009). *Global prevalence of vitamin a deficiency in populations at risk 1995–2005: Who global database on vitamin a deficiency*. Geneva: World Health Organization.

Willibald, S. (2006). Does money work? cash transfers to ex-combatants in disarmament, demobilisation and reintegration processes. *Disasters, 30*(3).

World Bank (2016). *World development report 2016: Digital dividends*. Washington, D.C.: World Bank Group.

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