



HAL
open science

Conditional cash transfer and/or lipid-based nutrient supplement targeting the first 1000 d of life increased attendance at preventive care services but did not improve linear growth in young children in rural Mali: results of a cluster-randomized controlled trial

Laura Adubra, Agnes Le Port, Yves Kameli, Sonia Fortin, Tanimoune Mahamadou, Marie Ruel, Yves Martin-Prevel, Mathilde Savy

► **To cite this version:**

Laura Adubra, Agnes Le Port, Yves Kameli, Sonia Fortin, Tanimoune Mahamadou, et al.. Conditional cash transfer and/or lipid-based nutrient supplement targeting the first 1000 d of life increased attendance at preventive care services but did not improve linear growth in young children in rural Mali: results of a cluster-randomized controlled trial. *The American Journal of Clinical Nutrition*, 2019, 110 (6), pp.1476-1490. 10.1093/ajcn/nqz238 . hal-03740589

HAL Id: hal-03740589

<https://hal.science/hal-03740589>

Submitted on 19 Mar 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Title:

Conditional cash transfer and/or lipid-based nutrient supplement targeting the first 1000 days of life increased attendance at preventive care services but did not improve linear growth in young children in rural Mali: results of a cluster-randomized controlled trial

Laura Adubra^{1,2}, Agnes Le Port³, Yves Kameli¹, Sonia Fortin¹, Tanimoune Mahamadou⁴, Marie T Ruel⁵, Yves Martin-Prevel¹, Mathilde Savy¹

¹ NUTRIPASS, University of Montpellier, French National Research Institute for Sustainable Development (IRD), Montpellier SupAgro, Montpellier, France. (LA, YK, SF, YMP, MS)

² Sorbonne University, Pierre and Marie Curie University Paris 06, Paris, France. (LA)

³ International Food Policy Research Institute (IFPRI), Poverty, Health and Nutrition Division, BP 24063, Dakar, Senegal. (ALP)

⁴ World Food Programme (WFP), Bamako, Mali. (TM)

⁵ International Food Policy Research Institute (IFPRI), Poverty, Health and Nutrition Division, 2033 K Street, NW Washington, DC, 20006, USA. (MTR)

Corresponding author:

Mathilde SAVY

Institut de Recherche pour le Développement (IRD)

Délégation régionale Occitanie - UMR NUTRIPASS

911 avenue Agropolis – BP 64501

34394 Montpellier cedex 05 – FRANCE

Tel: +33 (0)4 67 41 63 49

Fax: +33 (0)4 67 41 61 57

E-mail : mathilde.savy@ird.fr

Data sharing: Data described in the manuscript, code book, and analytic code will be made available upon request pending approval from all co-authors.

Sources of support: The program implementation was funded by the Global Affairs Canada (GAC) through WFP, with support from UNICEF. The research was funded by the European Union (EU) through the International Fund for Agricultural Development, UNICEF, WFP, IRD, and with additional support from the CGIAR Research Programs on Agriculture for Nutrition and Health (A4NH) hosted by IFPRI.

LA received a research allowance from the French Ministry of Higher Education and Research through the Pierre and Marie Curie University (Sorbonne University) doctoral school 393.

Short running head: Impact of cash transfer and/or LNS on linear growth

Abbreviations used: ANC, antenatal care; BCC, behavior change communication; CCT, conditional cash transfer; CHC, community health center; CNA, cash for nutrition awareness; EA, enumeration area; ENA, Emergency Nutrition Assessment; FLW, frontline worker; GM, growth monitoring; HAZ, height-for-age z score; IYCF, infant and young child feeding; LNS, lipid-based nutrient supplement; MAD, minimum acceptable diet; MDD, minimum dietary diversity; MMF, minimum meal frequency; PP, percentage point; SNACK, *santé nutritionnelle à assise communautaire dans la région de Kayes*; WFP, world food programme.

Clinical Trial Registry: The trial is registered with ISRCTN, number ISRCTN 08435964

1 **Abstract**

2 **Background:** In 2014, the World Food Programme added to an ongoing health and nutrition
3 program named '*Santé Nutritionnelle à Assise Communautaire dans la région de Kayes*'
4 (SNACK), the distribution of cash to mothers and/or lipid-based nutrient supplement (LNS) to
5 children aged 6-23 months, conditional upon attendance at community health centers (CHCs)
6 during the first 1000 days of life.

7 **Objective:** We evaluated the additional impact of the distribution of cash and/or LNS on
8 linear growth and on intermediate outcomes along the theoretical program impact pathways.

9 **Design:** In a cluster randomized controlled trial using a 2×2 factorial design, 76 CHCs were
10 randomly assigned to deliver either SNACK, SNACK+Cash, SNACK+LNS or
11 SNACK+Cash+LNS. A cross-sectional survey among 12-42 month old children and their
12 mothers was conducted at baseline (2013, n=5046) and again at endline (2016, n=5098).

13 **Results:** Factorial analysis for stunting revealed an antagonistic interaction between cash and
14 LNS treatments (Odds ratio 1.55, 95% CI (1.05, 2.31), $P=0.03$). At endline, mean height-for-
15 age Z-scores (primary outcome) was higher in the SNACK+Cash (-1.46 z-scores compared
16 with -1.57 z-scores at baseline) and SNACK+LNS (-1.38 z-scores compared with -1.54 z-
17 scores at baseline) arms but remained unchanged in the SNACK+Cash+LNS arm (-1.48 z-
18 scores). Compared to the SNACK arm, however, the differences in changes over time
19 (treatment \times time interaction) were not significant. The findings were similar for stunting and
20 none of the differences between treatment and SNACK groups were statistically significant.
21 More children in the SNACK+LNS and SNACK+Cash+LNS arms attended at least one
22 growth monitoring session (difference in differences of +28.0 and +28.7 percentage point
23 (PP), respectively) and more completed at least half the expected sessions (+33.1 and +35.8
24 PP, respectively).

25 **Conclusion:** Implementation constraints, and overloaded health services may explain the lack
26 of impact of the program on child linear growth in this region of rural Mali.

27 **Keywords:** conditional cash transfer, Lipid-based nutrient supplement, community health
28 center, linear growth, children, Mali.

29 **Introduction**

30 In 2017, 151 million children under five were stunted worldwide (1). In West Africa, 35% of
31 children in rural areas were estimated to be stunted in the period 2010-2015 (2). Stunting in
32 childhood is associated with increased risk of morbidity and mortality, poor cognitive and
33 motor development in early childhood and poor health and loss of economic productivity later
34 in life (3,4). The ‘Cost of Hunger’ study in Mali estimated that 21% of school grade repetition
35 was associated with stunting, and 34% of infant mortality was associated with stunting or
36 other forms of undernutrition. The estimated impact of undernutrition on the Malian economy
37 is also substantial with a loss of more than 4% of annual GDP in 2013 (5). These figures
38 underline the extent to which undernutrition in early childhood, if not addressed, may prevent
39 Mali from achieving sustainable development.

40 High levels of both acute and chronic malnutrition have been reported in the region of Kayes
41 in western Mali (6). In 2011, in collaboration with the Malian government and with support
42 from UNICEF, the World Food Programme (WFP) implemented a 5-year program named
43 SNACK (*Santé Nutritionnelle à Assise Communautaire dans la région de Kayes*) in this
44 region. The aim of the program, based on a set of preventive and curative activities, was to
45 improve nutrition during the first 1000 days of life, a ‘window of opportunity’ for action,
46 when mothers and young children have the highest potential to benefit from nutrition
47 interventions both in the short and the long-term (7,8). In 2014, to incentivize the uptake of
48 maternal and child health services, the distribution of cash and LNS conditional upon
49 attendance at community health centers (CHCs), was added to the SNACK activities.

50 Conditional Cash Transfers (CCTs) were initially introduced in Latin America and the
51 Caribbean as central elements of their poverty reduction strategies, and later extended to Sub-
52 Saharan Africa in the 2000s (9). In these programs, a financial assistance is provided to poor
53 and vulnerable populations conditional upon compliance with a set of requirements such as

54 healthcare utilization or school enrollment. Evidence from Latin America, Asia and to a lesser
55 extent Africa showed that CCTs have the potential to increase utilization of maternal and
56 child health services (10,11). Eventually, CCTs are hypothesized, through better birth and
57 child health outcomes, to improve child nutritional status (12). However, to date, the evidence
58 on whether CCTs ultimately promote linear growth is inconclusive (11-14). Given the context
59 of high food-insecurity and poorly diversified diets in the region of Kayes, nutritional
60 supplementation strategies can also play an important role (15). Some studies have shown that
61 long-term supplementation with LNS had an impact on linear growth - for example in
62 Burkina Faso where children received the supplement along with malaria and diarrhea
63 treatment (16) but others have shown no effect (17,18).

64 In this paper, we present the results of a 2×2 factorial-design cluster-randomized controlled
65 trial that evaluated the impact on the linear growth of young children of conditional cash
66 transfers to mothers or LNS distribution to children or a combination of the two, added to the
67 on-going SNACK program. We also discuss the impact on intermediate outcomes along some
68 theoretical impact pathways.

69 **Methods**

70 **Study Site**

71 The region of Kayes, located in the western part of Mali, is the country's largest
72 administrative region; the vast majority of its population resides in rural areas. In terms of
73 monetary poverty, between 50 and 60% of the population was living below the poverty line in
74 2014 (19). Agriculture is the predominant occupation (cereals, groundnuts and cotton-based
75 farming) and livestock is also a significant source of income. Despite the high agro-pastoral
76 potential of the region, a combination of factors - small-scale farmers' low income and
77 indebtedness, collapse of the groundnut sector, fall in cotton prices, high cost of agricultural
78 assets, climate and rainfall patterns- makes the region of Kayes one of the areas where food
79 insecurity and vulnerability are the highest in the country. The 2012-2013 Mali Demographic
80 and Health Survey indicated for the region of Kayes, a proportion of pregnant women
81 receiving antenatal care of 69%, a proportion of institutional delivery of 47% and a proportion
82 of mothers attending the postnatal visit of 36%. Among children under 5 years, the proportion
83 of chronic undernutrition was estimated at 34% (20).

84 **Interventions**

85 The SNACK program launched in 2011 was implemented in three districts (Bafoulabé,
86 Diéma, and Yélimané) of the rural region of Kayes. SNACK activities, delivered by frontline
87 workers (FLWs) through CHCs, included screening and treating children with acute
88 malnutrition, delivering blanket feeding with fortified blended flour for 6 to 23-month-old
89 children during the lean season, community gardens, and behavior change communication
90 (BCC) on health, nutrition and hygiene.

91 In 2014, a new intervention was added to the SNACK program to incentivize attendance at
92 CHCs throughout the first 1000 days, and increase the uptake of the SNACK activities. This
93 intervention was named Cash for Nutrition Awareness (CNA) and was in fact comprised of

94 two components: cash was distributed to mothers and LNS (Plumpy Doz™) was provided to
95 children aged 6-23 months, conditional on attendance at CHCs. The size of the cash transfer
96 was calculated to subsidize transportation costs to CHCs and help cover minor expenses
97 related to health care. The ration of LNS (4 pots monthly, 325 g/pot) was calculated to ensure
98 daily consumption of ~46 g (3 tablespoons, ~250 kcal) as recommended, to provide adequate
99 energy, micronutrients, and essential fatty acids to 6 to 23-month-old children. The theoretical
100 impact pathways of the SNACK-CNA program were i) the ‘Maternal and child preventive
101 care’ pathway that involved higher prenatal care attendance rates for better pregnancy
102 outcomes, and higher attendance at child preventive health care attendance rates for reduced
103 child morbidity and growth faltering; and ii) the ‘Maternal knowledge’ pathway, which
104 hypothesized that increasing women’s contacts with health centers would increase exposure
105 to the SNACK BCC activities, thus improving maternal knowledge on health, nutrition and
106 hygiene, and infant and young child feeding practices (**Figure 1**).

107 Eligible women for inclusion in the SNACK-CNA program were all pregnant women of the
108 three districts enrolled, attending antenatal care (ANC) and mothers of children aged less than
109 12 months. Once included, women remained in the program until their child reached the age
110 of two. The schedule for cash distribution was as follows: women received 2,500 West
111 African Financial Community of Africa francs (XOF) (~US\$4) at each ANC session (for a
112 total of 3 sessions), 6,000 XOF (~US\$11) at delivery, 2,500 XOF (~US\$4) at each of the
113 child’s vaccinations (total of 3 before the age of 6 months), and 1,500 XOF (~US\$3) at
114 monthly GM sessions when the child was 6 to 23 months old. A mother with a complete
115 follow up (from the first ANC session to the child’s second birthday) thus received a total
116 amount equivalent to ~US\$96. For LNS distribution, women received a ration of LNS for
117 their child aged 6 to 23 months at monthly GM sessions. A child with a complete follow up
118 would receive 18 rations of LNS. While the program was ongoing, the distribution of LNS in

119 the villages was authorized by WFP in order to reach mothers and children living in the most
120 remote areas.

121 **Study design**

122 We conducted a four-arm cluster-randomized controlled trial using a 2×2 factorial design.
123 Clusters were the CHCs and their catchment area. A total of 76 CHCs were randomly
124 assigned to deliver either: 1) SNACK activities or 2) SNACK activities plus Cash or 3)
125 SNACK activities plus LNS or 4) SNACK activities plus Cash and LNS. We compared
126 independent cross-sectional samples of 12 to 42-month-old children and their mother from the
127 four arms 3 years apart. The rationale behind the choice of the age range was to ensure
128 program exposure that was early enough in infancy (no later than 6 months of age) and long
129 enough (18 months minimum, which could include the *in utero* stage) to be able to expect an
130 impact on child growth. The baseline and endline surveys were conducted in Nov-Dec 2013
131 and Nov-Dec 2016, respectively. The baseline survey was conducted after the randomization
132 was performed but before the first distribution of cash and LNS occurred. A mixed-method
133 process evaluation (PE) was conducted in 2015 and extensively analyzed the implementation
134 and uptake of the CCT component of the program (21).

135 The trial was approved by the Ethical Committee of the Faculties of Medicine and
136 Odontostomatology, of the Faculty of Pharmacy and of the University of Sciences,
137 Techniques and Technologies of Bamako/Mali and was registered on December 9th 2013
138 under N° ISRCTN08435964. The trial protocol was approved by the Institutional Review
139 Board of the International Food Policy Research Institute. The trial protocol is available upon
140 request from the principal investigator. Before randomization, consent to participate to the
141 SNACK-CNA trial was sought by WFP from representatives of each CHC. Participants gave
142 their informed and written consent to take part to the impact evaluation surveys (baseline and
143 endline).

144 **Randomization and masking**

145 Randomization was performed at the CHC level for reasons of feasibility, acceptability and to
146 avoid contamination between arms. The CHCs were randomly allocated to one of the four
147 arms of the study, after stratification according to district. To minimize disparities between
148 CHCs, they were matched to make blocks of four in each district. Matching variables
149 included distance from the Referral Health Center, size of the population covered, medical
150 staff and equipment available, attendance and immunization rates. During a public event
151 involving local authorities and community members, the representatives of the CHCs in each
152 block of four were asked to draw blindly and successively a ball from a bag containing four
153 different colored balls. Each color was then assigned a treatment using a table of random
154 numbers with Emergency Nutrition Assessment (ENA) software. The CHC of the main city
155 of each district (i.e. the city where the Referral Health Center is located) was excluded from
156 the randomization. Program participants and individuals delivering the interventions were not
157 masked to cluster assignment. Enumerators were not told the allocation of the participants
158 they were interviewing, however, at endline questions were included at the end of the
159 questionnaire about whether mothers and their child received cash and/or LNS. Enumerators
160 performing anthropometric measurements were masked. LA and SF were not masked when
161 doing the analysis.

162 **Sampling**

163 The sample size was calculated to detect a meaningful difference of 0.20 z-score in the mean
164 height-for-age Z-scores (HAZ) between two groups from two distinct arms. The calculation
165 was based on a HAZ variance of 1.40 z-score reported from a previous study conducted in the
166 same area, a 5% Type I error, a statistical power of 90%, an inter-cluster within-pair
167 coefficient of variation of 0.10 (with the minimum number of paired cluster set at 19 CHCs
168 per arm) and a non-response rate of 10%. A total of 1 254 mother-child pairs (66 mother-child
169 pairs x 19 CHCs) per study arm was required. The sample size ensured adequate power for

170 pairwise comparisons among the four study arms if an interaction between the cash and LNS
171 treatments was detected.

172 The flow chart of the study and numbers of participants is described in **Figure 2**. For each
173 survey, mother-child pairs were randomly selected using a multistage cluster selection
174 process: during the first stage, six enumeration areas (EAs) were randomly selected in each of
175 the 76 CHCs with a probability proportional to the population size. During the second stage,
176 within each EA, an exhaustive list of households with eligible mother-infant pairs was drawn
177 up, i.e. mothers living permanently in the area who had a child aged 12–42 months. A total of
178 11 households/EA was randomly selected among the list of eligible households. If a
179 household had several eligible mother-infant pairs, all were surveyed. If a mother had several
180 eligible children, only one was surveyed after random selection by the enumerator. For CHCs
181 covering less than six EAs, the number of households selected per EA was adjusted so that at
182 least 66 mother-child pairs were included.

183 **Data collection and Measures**

184 Each survey was preceded by a ten-day training course for enumerators, and by additional
185 specific training including standardization for enumerators who had been selected to perform
186 anthropometric measurements. A one-day pilot survey was conducted in the outskirts of
187 Bamako to test the questionnaire and to check the quality of anthropometric measurements.

188 The questionnaire included information on the socio-demographic and economic
189 characteristics of households and mother-child pairs, use of health services throughout the
190 first 1 000 day period, maternal and child health status, maternal knowledge and child feeding
191 practices. Information was also collected at endline on mothers' uptake of the cash and LNS
192 components.

193 Anthropometric measurements were performed twice by trained team members. Children's
194 length (for those less than 2 years old) or height (for those 2 years old and above) was

195 measured to the nearest millimeter with portable wooden devices equipped with height
196 gauges. The exact age of children was reported from health cards or birth certificates
197 whenever possible. Otherwise, the birth date was recalled by the mother or a family member
198 using a calendar of local events when necessary.

199 Data were entered directly into tablet devices using the SurveyCTO Collect application which
200 ensured real-time quality checks. Field supervision was performed by an experienced
201 coordinator.

202 **Outcomes**

203 The primary outcome was the mean HAZ. We also analyzed the prevalence of stunting (HAZ
204 below $-2SD$) and intermediate outcome variables along the SNACK-CNA theoretical impact
205 pathways. Those included measures on i) antenatal follow up (for biological mothers only), ii)
206 delivery and post-partum follow up (for biological mothers only), iii) child vaccination, iv)
207 child growth monitoring, v) child health in the 15 days prior to the survey (fever, diarrhea,
208 respiratory infections, cough, and vomiting), vi) maternal knowledge on nutrition, health,
209 hygiene, and vii) WHO Infant and Young Child Feeding (IYCF) indicators (22) - Minimum
210 Dietary Diversity (MDD), Minimum Meal Frequency (MMF), Minimum Acceptable Diet
211 (MAD) - computed from a qualitative multiple-pass 24-h dietary recall.

212 **Statistical analysis**

213 Data management and analysis were performed with R software version 3.4.3. All analyses
214 accounted for the sampling design (stratification, clustering, sampling weights) using the
215 Survey package in R. Using a multiple correspondence analysis (23), we constructed a
216 household wealth index based on the household's ownership of selected assets, housing
217 quality and facilities; we used the index categorized into tertiles in subsequent analyses. The
218 WHO 2006 Child Growth Standards *igrowup* macro package for R (24) was used to calculate
219 HAZ. The baseline characteristics of our sample are presented per study arm, continuous
220 variables are expressed as means \pm SDs and categorical variables as proportions. The type I

221 error risk was set at 0.05. Comparability between trial arms on baseline characteristics was
222 tested using linear regression models for continuous variables and logistic regression models
223 for categorical variables.

224 All effect analysis are intention-to-treat. Treatment effects are reported as regression
225 coefficients (β) for continuous outcomes and odds ratios (ORs) for categorical outcomes for
226 the interaction term *treatment* \times *time*. In regression analyses for linear growth and stunting
227 outcomes, we controlled for the age and sex of children. Children with missing or extreme
228 values of HAZ (< -6 or > 6) were excluded (baseline, n=76; endline, n=5).

229 We investigated the main effects of cash and LNS on linear growth and stunting outcomes
230 using methods recommended for factorial trials (25,26). This included testing the interaction
231 between the two treatments (*LNS* \times *Cash* \times *Time*) and in the case of a significant interaction,
232 presenting ‘inside-the-table’ analysis (i.e. the study arms ‘SNACK+Cash’, ‘SNACK+LNS’,
233 ‘SNACK+Cash+LNS’ are compared with the ‘SNACK’ comparison arm). When testing this
234 3-way interaction, we raised the Type I error rate to 0.10 (27). For intermediate outcomes, we
235 only performed ‘inside-the-table’ analysis and we only report confidence intervals around
236 estimated treatment effects. The treatment effects in the ‘SNACK+LNS’ arm were estimated
237 for mother and child outcomes beginning with GM attendance since the LNS intervention
238 started at these sessions. No adjustments were made for multiplicity of testing.

239 **Results**

240 **Baseline characteristics**

241 Baseline characteristics at the household, mother and child levels were comparable in the four
242 arms (**Table 1**). Households had an average of seven members and were mostly headed by
243 men. The predominant religion was Islam. The mean age of women was 29, and that of the
244 children was 26 months. Most women were homemakers and very few had received any
245 formal education. About 51% of the children were boys. Approximately one third of children
246 were stunted (including 11% who were severely stunted) and there were no statistically
247 significant differences between the study arms at baseline.

248 **Impact on linear growth outcomes**

249 In the factorial analysis, we found no significant interaction between cash and LNS treatments
250 for the mean HAZ ($\beta = -0.19$, $P = 0.12$) (**Table 2**) but we found a significant interaction
251 between the two treatments for the prevalence of stunting ($OR = 1.55$, $P = 0.03$) (**Table 3**).
252 Consequently, here we describe the ‘inside-the-table’ analysis comparing the treatment arms
253 ‘SNACK+Cash’, ‘SNACK+LNS’, and ‘SNACK+Cash+LNS’ to the ‘SNACK’ arm.
254 At endline, the mean HAZ was higher in the ‘SNACK’ arm (-1.33 z-scores compared with -
255 1.40 z-scores at baseline), ‘SNACK+Cash’ arm (-1.46 z-scores compared with -1.57 z-scores
256 at baseline) and ‘SNACK+LNS’ arm (-1.38 z-scores compared with -1.54 z-scores at
257 baseline) but did not change in the ‘SNACK+Cash+LNS’ arm (-1.48 z-scores). Compared to
258 the ‘SNACK’ arm, the difference in differences in mean HAZ were not statistically
259 significant (‘SNACK+Cash’ $\beta = 0.03$, $P = 0.75$; ‘SNACK+LNS’ $\beta = 0.09$, $P = 0.34$;
260 ‘SNACK+Cash+LNS’ $\beta = -0.07$, $P = 0.36$) (**Table 2**). Similarly, at endline, the prevalence of
261 stunting was lower in the ‘SNACK’ arm (28.8% compared with 29.5% at baseline),
262 ‘SNACK+Cash’ arm (31.8% compared with 35.6% at baseline), and ‘SNACK+LNS’ arm
263 (29.5% compared with 34.6% at baseline), but higher in the ‘SNACK+Cash+LNS’ arm
264 (33.0% compared with 31.5% at baseline). Compared to the ‘SNACK’ arm, the above

265 changes over time were not statistically significant ('SNACK+Cash' OR=0.87, P=0.32;
266 'SNACK+LNS' OR=0.82, P=0.21; 'SNACK+Cash+LNS' OR=1.11, P=0.44) (**Table 3**).

267 **Impact on intermediate outcomes along the 'Maternal and child preventive care'** 268 **pathway**

269 Antenatal follow up and maternal health

270 There were no effects of the treatments on ANC attendance (at least one session) or on the
271 administration of iron (at least one tablet) or on the antimalarial intermittent preventive
272 treatment (at least one dose) (**Table 4**); the levels of these indicators were high at baseline in
273 all arms (>75%). At endline, we found a lower proportion of mothers who experienced fever
274 during pregnancy in all treatment arms ('SNACK+Cash', 'SNACK+LNS',
275 'SNACK+Cash+LNS') and a lower proportion of mothers who had edema during pregnancy
276 in all four arms.

277 Delivery and post-partum follow up

278 At endline, we found a higher proportion of institutional deliveries as well as a higher
279 proportion of mothers who attended the postnatal check-up in all four arms. We measured a
280 lower proportion of low birth weight at endline, in all four arms.

281 Child vaccination

282 There were no effects of the treatments on attendance at vaccination sessions (at least one) or
283 on the full immunization rates; the levels of these indicators were already quite high at
284 baseline in all four arms (>80%).

285 Child growth monitoring

286 All GM-related outcomes significantly improved in the 'SNACK+LNS' and in the
287 'SNACK+Cash+LNS' arm, compared with the 'SNACK' arm: children attended at least one
288 GM session ('SNACK+LNS' arm: difference in differences of +28.0 percentage points (PP)
289 and 'SNACK+Cash+LNS' arm: +28.7 PP); children completed at least half the GM sessions
290 ('SNACK+LNS' arm: +33.1 PP and 'SNACK+Cash+LNS' arm: +35.8 PP); mean age at

291 which mothers stopped taking their child to health monitoring ('SNACK+LNS' arm: +5.18
292 months and 'SNACK+Cash+LNS' arm: +5.38 months).

293 Child health

294 At endline, we found a lower proportion of children who were ill in the last 15 days, in all
295 four arms.

296 **Impact on intermediate outcomes along the 'Maternal knowledge' pathway**

297 Maternal knowledge

298 Overall, mothers had good knowledge of GM and colostrum feeding practices, fair knowledge
299 of complementary feeding and hygiene, and poor knowledge of children's illnesses (**Table 5**).

300 Treatment effects were significant for GM knowledge in the 'SNACK+LNS' and
301 'SNACK+Cash+LNS' arms, and for complementary feeding knowledge in the
302 'SNACK+LNS' arm.

303 Feeding practices

304 At endline, we found a higher proportion of children who met the MMF and MAD in all four
305 arms. At baseline, less than 25% of children reached the MAD, whereas at endline, more than
306 40% reached MAD in all four arms.

307 **Mothers' uptake of the cash and LNS components**

308 Conditional Cash transfer

309 About 66% and 61% of women received at least one cash transfer in the 'SNACK+Cash' and
310 'SNACK+Cash+LNS' arms, respectively (**Table 6**). About 43% and 40% of women received
311 the cash transfers on the occasion of the three ANC sessions, as intended by the program, in
312 the 'SNACK+Cash' and 'SNACK+Cash+LNS' arms, respectively. Approximately 70% of
313 women who received money for delivering at the health facility received it before returning
314 home. Nearly half of women reported having to wait between one and three hours at the
315 collection point to receive the cash. The cash received was preferably used to buy food

316 ('SNACK+Cash' arm: 79%, 'SNACK+Cash+LNS' arm: 88%), clothes ('SNACK+Cash'
317 arm: 40%, 'SNACK+Cash+LNS' arm: 41%), as well as for health expenses for the child
318 ('SNACK+Cash' arm: 27%, 'SNACK+Cash+LNS' arm: 24%). Approximately 40% of
319 women in both arms with cash would have preferred other types of intervention, notably free-
320 of-charge health consultations. Overall, the main reasons for not participating to the
321 intervention, i.e. not going to the health centers whatever the occasion (pregnancy follow-up,
322 delivery, vaccination, growth monitoring) were long distances and lack of time.

323 Lipid-based nutrient supplement

324 About 88% of the women in the 'SNACK+LNS' arm and 87% in the 'SNACK+Cash+LNS'
325 arm received the LNS for their child at least once (**Table 6**). From 6 to 23 months of age, the
326 mean number of times mothers received the LNS for their children was 10. Nearly half the
327 women reported that they would not have attended child growth monitoring sessions without
328 the LNS distribution. Some women reported giving less than the recommended amount of
329 LNS to their child ('SNACK+LNS' arm: 19.6%, 'SNACK+Cash+LNS' arm: 15.7%). About
330 19% of women in the 'SNACK+LNS' arm and 13% of women in the 'SNACK+Cash+LNS'
331 arm reported that the LNS was occasionally shared with other members of the household,
332 most often with siblings. More than 40% of women reported the occurrence of LNS shortage.
333 When unavailable, 10.1% of women in the 'SNACK+LNS' arm and 15.2% in the
334 'SNACK+Cash+LNS' arm reported that the LNS was not replaced by other supplements.

335 Discussion

336 This study assessed the additional impact on children's linear growth of delivering
337 CCTs provided to mothers, or LNS to children aged 6-23 months, or the combination of the
338 two, in addition to the SNACK health and nutrition activities during the first 1000 days of life
339 in the rural region of Kayes in Mali. In a context of difficult implementation which impeded
340 an adequate delivery of the treatments, we found no significant improvement in mean HAZ
341 and no significant decrease in stunting prevalence among children in groups that received the
342 cash or LNS added to the SNACK program, in comparison with children in the group that
343 received the SNACK program alone. In factorial analysis, we detected an antagonistic
344 interaction suggesting that the combined effect of cash and LNS was less than the additive
345 effect of each of the two treatments effects alone. The LNS component, with or without the
346 cash component, substantially improved all GM-related outcomes and the LNS alone
347 improved knowledge on complementary feeding. The absence of evidence of the impact on
348 linear growth and stunting outcomes, although disappointing, is consistent with results
349 reported in the literature.

350 A study which summarized the results from 6 reviews on cash transfers impact on
351 child nutritional status (mostly CCT programs from LA) found that none of them showed
352 conclusive evidence of a positive impact on child nutritional status (12). More recently, a
353 review covering Sub-Saharan Africa cash transfer programs -most of which were
354 unconditional- (11) found only one study, in Burkina Faso, that reported a transitory positive
355 impact of a CCT on linear growth among under 5 years children. There was mixed evidence
356 about effect on maternal services uptake (ANC and access to skilled delivery), but the studies
357 reviewed showed that CCTs successfully increased the use of child health care services in
358 Ghana, Tanzania and Burkina Faso. As for the LNS, the most recent systematic review,
359 covering Asia and Africa, on the effects of preventive LNS given to 6-23 months old children,

360 showed that LNS is effective at improving growth outcomes and reducing the occurrence of
361 stunting (28). However, the authors found from a subgroup analysis that for a shorter duration
362 of intervention (6 to 12 months) there was no significant impact. We do believe that our
363 results are comparable to the shorter-duration case scenario since less than recommended
364 distribution of LNS occurred in the context of the SNACK-CNA program. Our results add to
365 this literature by showing that the combination of Cash and LNS did not provide any
366 additional benefit in a rural context such as the region of Kayes.

367 Despite corrective actions adopted by WFP following the process evaluation and the
368 recommendations to strengthen implementation (21), we recorded at endline persistent
369 problems that may partially explain the modest impacts. First, sub-optimal coverage of
370 activities. This was particularly marked for the cash component (>34% of women received no
371 cash transfer) and despite much higher coverage for the LNS component, children received
372 the supplement only 10 times on average instead of the intended 18 times. The process
373 evaluation highlighted that supplying cash and LNS to CHCs was extremely complex and
374 resulted in shortages of cash/supplement, as well as in the discouragement of mothers who
375 travelled long distances without receiving their due. The regularity of transfers has indeed
376 been reported to be an important factor influencing the effectiveness of cash transfer programs
377 in sub-Saharan Africa (11). Second, there were some weaknesses in the intervention design.
378 The amount of the cash transfer, for example, appeared to be insufficient to encourage
379 mothers or at least to maintain their motivation to attend CHCs over time. Around 20% to
380 30% of women reported being not satisfied with the amount of cash distributed at ANC,
381 vaccination and GM and even more at delivery. We found no added value of the cash
382 component alone added to the SNACK activities in the intermediate outcomes. Some of those
383 indicators, including ANC coverage and immunization rates, however, were already high at
384 baseline, which might have reduced the potential for further improvements, as suggested in

385 another study in Zimbabwe (29). However, the process evaluation highlighted the fact that
386 mothers perceived the cash as a benefit of the program and not as an incentive to participate in
387 it. The apparent small incentive value of the cash transfers is supported by our results that
388 showed no difference in the impacts on GM-related outcomes between the LNS only
389 compared to the LNS plus cash group. An additional design aspect reported in the process
390 evaluation refers to the added workload for FLWs in particular for the ‘SNACK+Cash+LNS’
391 arm. This may have affected the quality of services provided to mothers and infants and
392 reduced the effectiveness of the CNA components. Third, the LNS and/or the cash were
393 sometimes misused, or at least used for other purposes than planned. For example, an
394 appreciable share of mothers reported giving smaller doses of LNS than recommended to their
395 child. This was most likely due to sharing the supplement, also reported by mothers, with
396 other members of the households especially with other children. This practice is not easily
397 preventable in such a context where sharing is a fundamental cultural value, as also seen in
398 Mozambique and Malawi for example (30). The cash, which was meant to be used to attend
399 preventive health services was reported to be used to buy food (>75%), clothes (~40%) and to
400 a lesser extent, to cover the children’s health expenses (~25%). Considering the small size of
401 the transfer, we hypothesize that women had to choose between expenses, rather than being
402 able to cumulate them.

403 There were improvements from baseline to endline across all arms, including in the
404 SNACK arm, in several indicators. Thus, although there was no comparison with a pure
405 control group, there are reasons to believe that overall the program improved use of health
406 services, may have reduced child morbidity, and improved feeding practices. The success of
407 the CNA intervention partly relied on the optimal implementation of the SNACK package of
408 activities. In particular, the “Maternal knowledge” pathway could only work if BCC activities
409 were adequately delivered. Yet, only half the mothers reported that BCC sessions were taking

410 place at the CHCs. A study conducted in Kenya suggested that BCC interventions with more
411 than monthly contacts with beneficiaries were necessary to induce behavior change in child
412 feeding practices (31).

413 One major strength of our study was the use of a large and well-designed controlled-
414 trial, in which we were able to document a wide range of relevant outcomes other than linear
415 growth and stunting that are no less important for child health and well-being (32), as well as
416 information on the uptake and perception of beneficiaries of the program. This information
417 coupled with those from the process evaluation greatly helped understand why the SNACK-
418 CNA program did not have an impact on child linear growth and stunting, hence providing
419 guidance for future programs. The positive impact of the LNS component on GM-related
420 outcomes and complementary feeding knowledge, is a result that merits further investigation
421 and should be taken into account in future interventional programs. Nevertheless, our study
422 has also some limitations. The WFP confirmed that the SNACK activities were equally
423 implemented across all four arms. However, we could not verify, based on the data we
424 collected in our study, whether the addition of cash or LNS hindered or on the contrary
425 facilitated the implementation of the SNACK activities and potentially led to variability of
426 quality and extent of implementation. Some intermediate outcomes were based on the
427 mothers' recall, and given that there was a BCC intervention, their responses may have been
428 influenced by the social desirability bias. In addition, we did not collect data on CHC
429 functioning or on the quality of the services provided throughout the program. The SNACK-
430 CNA program was designed to increase the contacts the beneficiaries have with health
431 services; it partly did, but we acknowledge that the translation into better linear growth
432 outcomes was unlikely if CHCs were unable to provide good quality care or to respond to
433 increased demand (33,34). One last limit that could be raised, which however is not of our
434 making, relates to the CCT targeting strategy. In the context of the region of Kayes where

435 almost all the population faces poverty, the WFP chose to implement a universal CCT.
436 However, targeting the ultra-poor individuals may have required less resources, decreased
437 difficulties regarding some implementation aspects, and potentially led to better results.
438 In conclusion, we found that the distribution of cash, LNS or a combination of both in the
439 context of an ongoing health and nutrition program during the first 1000 days of life did not
440 improve young children's linear growth in the rural region of Kayes in Mali. However, we did
441 observe a positive impact of the LNS distribution on the participation in growth monitoring
442 sessions and on knowledge of complementary feeding. These encouraging results suggest that
443 such strategies can incentivize poor rural communities for a higher uptake of preventive
444 health services. The next steps will be to ensure that constraints to implementation are
445 addressed, especially when intervention components are added to ongoing programs.

446 **Acknowledgments and statement of authors' contributions to manuscript**

447 Our acknowledgments go to our colleagues from the WFP: Niamké Ezoua Kodjo and
448 Kamayera Fainke, responsible for the implementation of the SNACK-CNA program, who
449 provided insights that greatly assisted the research. We thank our colleagues Saidou Magagi
450 from WFP and Ampa Dogui Diatta from IFPRI for assistance with the training of the
451 interviewers. We are also very grateful to the field coordinators and enumerators for their
452 dedicated work in difficult conditions, and to the household members who participated in the
453 study for their patience and kindness.

454 LA is grateful for the support of the Public Health Doctoral Network of the EHESP French
455 School of Public Health.

456 The authors' responsibilities were as follows—YMP, TM, MTR, MS, and ALP conceived and
457 designed the study; YK, MS, ALP, SF, and LA conducted the field research; LA and SF:
458 performed statistical analysis; LA, MS, ALP and YMP drafted the manuscript; MTR critically
459 revised the manuscript for important content; MS had primary responsibility for final content;
460 all authors read and approved the final manuscript.

461 LA, ALP, YK, SF, TM, MTR, YMP and MS, have no conflicts of interest

References

1. FAO, IFAD, UNICEF, WFP and WHO. The State of Food Security and Nutrition in the World 2018. Building climate resilience for food security and nutrition. Rome: FAO; 2018.
2. Van Wesebeeck C. Disentangling urban and rural food security in West Africa. *West African Papers*, n° 15. Paris: OECD; 2018. Internet: <https://doi.org/10.1787/e0c75266-en> (accessed 18 May 2019).
3. Victora C, Adair L, Fall C, Hallal P, Martorell R, Richter L, Sachdev H. Maternal and child undernutrition: consequences for adult health and human capital. *The Lancet*. 2008;371(9609):340-357.
4. Dewey K, Begum K. Long-term consequences of stunting in early life. *Matern Child Nutr*. 2011;7:5-18.
5. COHA | Le coût de la faim en Afrique: l'incidence sociale et économique de la Malnutrition chez l'enfant au Mali. Internet: https://reliefweb.int/sites/reliefweb.int/files/resources/le_cout_de_la_faim_en_afrique_coha_mali.pdf (accessed 18 May 2019).
6. Institut national de la statistique du Mali (INSTAT). Nutrition et mortalité rétrospectives sondage SMART. Bamako (Mali); 2012. Internet: <https://reliefweb.int/sites/reliefweb.int/files/resources/Enquete%20Nutritionnelle%20Anthropometrique%20et%20de%20Mortalite.pdf> (accessed 18 May 2019).
7. Bryce J, Coitinho D, Darnton-Hill I, Pelletier D, Pinstrup-Andersen P. Maternal and child undernutrition: effective action at national level. *The Lancet*. 2008;371(9611):510-526.
8. Wrottesley SV, Lamper C, Pisa PT. Review of the importance of nutrition during the first 1000 days: maternal nutritional status and its associations with fetal growth and birth, neonatal and infant outcomes among African women. *J Dev Orig Health Dis*. 2016;7:144–62
9. Garcia M, Moore CMT. The Cash Dividend: The Rise of Cash Transfer Programs in Sub-Saharan Africa. Washington,DC: World Bank, 2012.
10. Glassman A, Duran D, Fleisher L, Singer D, Sturke R, Angeles G, et al. Impact of conditional cash transfers on maternal and newborn health. *J Health Popul Nutr*. 2013;31(Suppl 2):48–66.
11. Owusu-Addo E, Renzaho AMN, Smith BJ. The impact of cash transfers on social determinants of health and health inequalities in sub-Saharan Africa: a systematic review. *Health Policy Plan*. 2018;33:675–96.
12. Groot R de, Palermo T, Handa S, Ragno LP, Peterman A. Cash Transfers and Child Nutrition: Pathways and Impacts. *Dev Policy Rev*. 2017;35:621–43.
13. Leroy JL, Ruel M, Verhofstadt E. The impact of conditional cash transfer programmes on child nutrition: a review of evidence using a programme theory framework. *J Dev Effect*. 2009;1:103–29.
14. Manley J, Gitter S, Slavchevska V. How Effective are Cash Transfers at Improving Nutritional Status? *World Development*. 2013;48:133–55.17.
15. Adubra L, Savy M, Fortin S, Kameli Y, Kodjo NE, Fainke K, Mahamadou T, Le Port A, Martin-Prevel Y. The Minimum Dietary Diversity for Women of Reproductive Age (MDD-W) Indicator Is Related to Household Food Insecurity and Farm Production Diversity: Evidence from Rural Mali. *Curr Dev Nutr*. 2019;3(3):nzz002. doi:10.1093/cdn/nzz002.
16. Hess SY, Abbeddou S, Jimenez EY, Somé JW, Vosti SA, Ouédraogo ZP, Guissou RM, Ouédraogo J-B, Brown KH. Small-Quantity Lipid-Based Nutrient Supplements, Regardless of Their Zinc Content, Increase Growth and Reduce the Prevalence of Stunting and Wasting in Young Burkinabe Children: A Cluster-Randomized Trial. *PLoS One*. 2015;10:e0122242.

17. Matsungo TM, Kruger HS, Smuts CM, Faber M. Lipid-based nutrient supplements and linear growth in children under 2 years: a review. *Proc Nutr Soc.* 2017;76:580–8.
18. Adu-Afarwuah S, Lartey A, Dewey KG. Meeting nutritional needs in the first 1000 days: a place for small-quantity lipid-based nutrient supplements: Nutrient needs during first 1000 days. *Ann N Y Acad Sci.* 2017;1392:18–29.
19. OCDE/CSAO. Un atlas du Sahara-Sahel : Géographie, économie et insécurité, Cahiers de l'Afrique de l'Ouest. Paris: OCDE; 2014. Internet: <https://doi.org/10.1787/9789264222335-fr>. (accessed 18 July 2019).
20. Cellule de Planification et de Statistique - CPS/SSDSPF/Mali, Institut National de la Statistique - INSTAT/Mali, Centre d'Études et d'Information Statistiques - INFO-STAT/Mali and ICF International. Enquête Démographique et de Santé au Mali 2012-2013. Rockville, Maryland, USA: CPS, INSTAT, INFO-STAT and ICF International; 2014. Internet: <https://dhsprogram.com/pubs/pdf/FR286/FR286.pdf> (accessed 18 July 2019).
21. **Le Port et al**
22. World Health Organization. Indicators for assessing infant and young child feeding practices - Part I: Definitions. Geneva: WHO; 2008.
23. Traissac P, Martin-Prevel Y. Alternatives to principal components analysis to derive asset-based indices to measure socio-economic position in low- and middle-income countries: the case for multiple correspondence analysis. *Int J Epidemiol.* 2012;41:1207–8.
24. WHO Child Growth Standards R igrowup package. Geneva: WHO; 2006. Internet: http://www.who.int/childgrowth/software/readme_r.pdf (accessed 18 May 2019).
25. McAlister FA, Straus SE, Sackett DL, Altman DG. Analysis and Reporting of Factorial Trials: A Systematic Review. *JAMA.* 2003;289:2545.
26. Montgomery AA, Peters TJ, Little P. Design, analysis and presentation of factorial randomised controlled trials. *BMC Med Res Methodol.* 2003;3:26.
27. Greenland S. Tests for interaction in epidemiologic studies: a review and a study of power. *Stat Med.* 1983;2:243–251. doi: 10.1002/sim.4780020219.
28. Das JK, Salam RA, Hadi YB, Sadiq Sheikh S, Bhutta AZ, Weise Prinzo Z, Bhutta ZA. Preventive lipid-based nutrient supplements given with complementary foods to infants and young children 6 to 23 months of age for health, nutrition, and developmental outcomes. *Cochrane Database Syst Rev.* 2019 May 2;5:CD012611.
29. Robertson L, Mushati P, Eaton JW, Dumba L, Mavise G, Makoni J, Schumacher C, Crea T, Monasch R, Sherr L, et al. Effects of unconditional and conditional cash transfers on child health and development in Zimbabwe: a cluster-randomised trial. *The Lancet.* 2013;381:1283–92.
30. Kodish S, J Aburto N, Nseluke Hambayi M, Dibari F, Gittelsohn J. Patterns and determinants of small-quantity LNS utilization in rural Malawi and Mozambique: Considerations for interventions with specialized nutritious foods. *Matern Child Nutr.* 2017; 13:e12234.
31. Byrd K, Dentz HN, Williams A, Kiprotich M, Pickering AJ, Omondi R, Kwena O, Rao G, Arnold CD, Arnold BF, et al. A behavior change intervention with lipid-based nutrient supplements had little impact on young child feeding indicators in rural Kenya. *Matern Child Nutr.* 2018:e12660.
32. Leroy JL, Frongillo EA. Perspective: What Does Stunting Really Mean? A Critical Review of the Evidence. *Adv Nutr.* 2019;10:196–204.
33. Gaarder MM, Glassman A, Todd JE. Conditional cash transfers and health: unpacking the causal chain. *J Dev Effect.* 2010;2:6–50.

34. Cruz RC de S, Moura LBA de, Soares Neto JJ. Conditional cash transfers and the creation of equal opportunities of health for children in low and middle-income countries: a literature review. *Int J Equity Health*. 2017;16:161.

Table 1: Baseline characteristics of households and mother-infant pairs per assigned study arm¹

	All	SNACK	SNACK+Cash	SNACK+LNS	SNACK+Cash+LNS	P ²
Household characteristics	n=4790	n=1210	n=1166	n=1230	n=1184	
Average household size, n° of people	6.9 ± 3.2	6.7 ± 3.4	6.7 ± 3.3	6.9 ± 3.3	7.2 ± 3.7	0.34
Head of household religion, % Muslim	99.1	99.3	98.9	99.0	99.3	0.99
Head of household gender, % men	81.0	78.5	81.9	79.2	84.6	0.40
Head of household education, %						0.65
No education at all	74.1	74.6	72.9	75.2	73.7	
No formal education	13.1	13.4	12.1	13.1	13.8	
Primary school	10.4	9.6	11.8	9.8	10.6	
Secondary school or higher level	2.4	2.4	3.2	1.9	1.9	
Household wealth (tertiles), %						0.98
Low	34.2	33.0	33.0	35.6	35.2	
Middle	33.1	34.2	33.1	30.9	34.3	
High	32.7	32.8	33.9	33.5	30.5	
Maternal characteristics	n=5046	n=1278	n=1223	n=1289	n=1256	
Biological mother, %	97.7	97.7	97.2	97.1	96.9	0.78
Age, y	28.6 ± 7.2	28.2 ± 7.1	28.4 ± 7.2	28.8 ± 7.4	28.8 ± 7.2	0.33
Education, %						0.79
No education at all	93.6	95.0	93.2	91.6	94.6	
No formal education	1.4	1.0	1.7	1.6	1.3	
Primary school	4.5	3.7	4.4	6.2	3.7	
Secondary school or higher level	0.5	0.3	0.7	0.6	0.4	
Occupational status, %						0.87
Housewife	68.2	68.5	66.3	69.5	68.3	
Employed	26.3	26.8	27.7	25.5	25.5	
Other (student/retired/seeking employment)	5.5	4.7	6.0	5.0	6.3	
Child characteristics	n=5046	n=1278	n=1223	n=1289	n=1256	
Age, mo	26.0 ± 8.9	26.1 ± 8.8	26.6 ± 8.9	26.0 ± 8.8	25.6 ± 9.0	0.29
Age categories, %						0.34
12 – 23 mo	41.8	40.2	40.3	42.2	44.3	
24 – 42 mo	58.2	59.8	59.7	57.8	55.7	0.16
Sex, % female	49.0	48.8	49.6	48.7	48.9	
Child's anthropometric measurements	n=4970	n=1260	n=1202	n=1269	n=1239	
Height-for-age Z-scores	-1.50 ± 1.22	-1.40 ± 1.23	-1.57 ± 1.23	-1.54 ± 1.22	-1.48 ± 1.21	0.24
Stunting (HAZ below -2 SD), %	33.1	29.6	35.8	34.6	31.4	0.16
Severe stunting (HAZ below -3 SD), %	10.9	10.6	10.7	11.1	10.8	0.99

¹Abbreviations: HAZ, height-for-age Z-score. LNS, lipid-based nutrient supplement. SNACK, santé nutritionnelle à assise communautaire dans la région de Kayes. Values are % or means ± SDs.

²Estimated from linear and logistic regression analysis for continuous and categorical variables, respectively.

Table 2: Impact of the Cash and LNS components on child linear growth (mean HAZ)¹

	Baseline		Endline		β (95% CI)	P
	n	Mean ± SD	n	Mean ± SD		
Mean HAZ						
Main effect comparison (factorial analysis)						
No cash ²	2529	-1.48 ± 1.22	2544	-1.36 ± 1.16	reference	-
Cash ³	2441	-1.53 ± 1.22	2549	-1.47 ± 1.21	0.03 (-0.15, 0.20)	0.75
No LNS ⁴	2462	-1.49 ± 1.21	2554	-1.40 ± 1.18	reference	-
LNS ⁵	2508	-1.52 ± 1.23	2539	-1.43 ± 1.18	0.09 (-0.10, 0.28)	0.34
Interaction (LNS×Cash×Time)	-	-	-	-	-0.19 (-0.43, 0.04)	0.12
Individual group comparison ('inside-the-table' analysis)						
SNACK (comparison arm)	1260	-1.40 ± 1.23	1278	-1.33 ± 1.23	reference	-
SNACK+Cash	1202	-1.57 ± 1.23	1276	-1.46 ± 1.14	0.03 (-0.15, 0.20)	0.75
SNACK+LNS	1269	-1.54 ± 1.22	1266	-1.38 ± 1.19	0.09 (-0.10, 0.28)	0.34
SNACK+Cash+LNS	1239	-1.48 ± 1.21	1273	-1.48 ± 1.18	-0.07 (-0.23, 0.08)	0.36

¹Abbreviations: HAZ, height-for-age Z-score; LNS, lipid-based nutrient supplement. SNACK, santé nutritionnelle à assise communautaire dans la région de Kayes. Analysis: Treatment effects are estimated by regression coefficients (β), with 95%CI, for the interaction term *treatment* × *time* in linear regression models that account for the sampling design and were adjusted for the child's age and sex. In factorial analysis, the two main effects (cash vs no cash, and LNS vs no LNS) and their interaction are investigated, and in the 'inside-the-table' analysis, treatment arms 'SNACK+Cash', 'SNACK+LNS', 'SNACK+Cash+LNS' are compared with the 'SNACK' arm.

²SNACK and SNACK plus LNS arms.³SNACK plus Cash and SNACK plus Cash plus LNS arms.⁴SNACK and SNACK plus Cash arms.⁵SNACK plus LNS and SNACK plus Cash plus LNS arms.

Table 3: Impact of the Cash and LNS components on child stunting prevalence¹

	Baseline		Endline		OR (95% CI)	P
	n	%	n	%		
Stunting (HAZ <-2SD)						
Main effect comparison (factorial analysis)						
No cash ²	2529	32.17	2544	29.16	reference	-
Cash ³	2441	33.59	2549	32.39	0.87 (0.66, 1.14)	0.32
No LNS ⁴	2462	32.61	2554	30.33	reference	-
LNS ⁵	2508	33.11	2539	31.22	0.82 (0.60, 1.12)	0.21
Interaction (LNS×Cash×Time)	-	-	-	-	1.55 (1.05, 2.31)	0.03
Individual group comparison ('inside-the-table' analysis)						
SNACK (comparison arm)	1260	29.5	1278	28.8	reference	-
SNACK+Cash	1202	35.6	1276	31.8	0.87 (0.66, 1.14)	0.32
SNACK+LNS	1269	34.6	1266	29.5	0.82 (0.60, 1.12)	0.21
SNACK+Cash+LNS	1239	31.5	1273	33.0	1.11 (0.85, 1.44)	0.44

¹Abbreviations: HAZ, height-for-age Z-score; LNS, lipid-based nutrient supplement. SNACK, santé nutritionnelle à assise communautaire dans la région de Kayes. Analysis: Treatment effects are estimated by odds ratios (ORs), with 95%CI, for the interaction term *treatment* × *time* in logistic regression models that account for the sampling design and were adjusted for the child's age and sex. In factorial analysis, the two main effects (cash vs no cash, and LNS vs no LNS) and their interaction are investigated, and in the 'inside-the-table' analysis, treatment arms 'SNACK+Cash', 'SNACK+LNS', 'SNACK+Cash+LNS' are compared with the 'SNACK' arm.

²SNACK and SNACK plus LNS arms.³SNACK plus Cash and SNACK plus Cash plus LNS arms.⁴SNACK and SNACK plus Cash arms.⁵SNACK plus LNS and SNACK plus Cash plus LNS arms.

Table 4: Impact of the Cash and LNS components on intermediate outcomes along the ‘Maternal and child preventive care’ pathway¹

	SNACK (comparison arm)		SNACK+Cash		SNACK+LNS ²		SNACK+Cash+LNS	
	n	% or mean ± SD	n	% or mean ± SD	n	% or mean ± SD	n	% or mean ± SD
Antenatal follow up: ANC check-ups, preventive care and maternal health								
Mothers attended at least 1 ANC check-up, %								
Baseline	1251	81.7	1190	84.1	1253	84.4	1216	81.4
Endline	1246	86.5	1250	83.9	1238	87.1	1240	84.5
Treatment effect, OR		<i>Reference</i>		0.68(0.44,1.06)		–		0.87(0.56,1.33)
Mothers attended at least 3 ANC check-ups, %								
Baseline	1025	86.6	1004	86.6	1061	88.2	1003	86.2
Endline	1090	86.9	1043	82.9	1083	85.9	1053	82.0
Treatment effect, OR		<i>Reference</i>		0.73(0.48,1.12)		–		0.71(0.46,1.09)
Mothers received iron, %								
Baseline	1251	80.4	1190	82.7	1253	83.3	1216	80.6
Endline	1246	84.2	1250	81.8	1238	85.0	1240	84.2
Treatment effect, OR		<i>Reference</i>		0.72(0.47,1.09)		–		0.98(0.68,1.43)
Mothers received intermittent preventive antimalarial treatment, %								
Baseline	1251	78.3	1190	79.0	1253	81.7	1216	77.7
Endline	1246	82.2	1250	80.0	1238	82.2	1240	81.2
Treatment effect, OR		<i>Reference</i>		0.84(0.54,1.31)		–		1.00(0.67,1.49)
Mothers experienced fever, %								
Baseline	1251	73.5	1190	79.0	1253	76.3	1216	78.0
Endline	1246	75.5	1250	72.5	1238	61.7	1240	68.9
Treatment effect, OR		<i>Reference</i>		0.63(0.43,0.92)		–		0.56(0.41,0.76)
Mothers had edema, %								
Baseline	1251	47.1	1190	50.8	1253	47.6	1216	45.8
Endline	1246	40.6	1250	41.0	1238	34.4	1240	38.1
Treatment effect, OR		<i>Reference</i>		0.88(0.66,1.17)		–		0.95(0.72,1.26)
Delivery, post-natal care and newborn health								
Institutional delivery, %								
Baseline	1251	59.9	1190	58.9	1253	57.4	1216	57.9
Endline	1246	63.9	1250	64.5	1238	61.5	1240	64.0
Treatment effect, OR		<i>Reference</i>		1.07(0.76,1.52)		–		1.09(0.80,1.50)
Mothers attended the post-natal check-up, %								
Baseline	1251	56.6	1190	57.8	1253	60.7	1216	62.5
Endline	1246	67.1	1250	71.8	1238	75.9	1240	71.6
Treatment effect, OR		<i>Reference</i>		1.19(0.76,1.87)		–		0.97(0.58,1.63)
Birth weight, g (checked on health card)								
Baseline	77	3409.8 ± 765.1	95	3238.7 ± 740.6	162	3287.7 ± 729.9	136	3408.0 ± 709.1
Endline	88	3584.4 ± 817.4	100	3233.2 ± 810.0	64	3352.9 ± 604.7	115	3304.8 ± 723.5
Treatment effect, β		<i>Reference</i>		-180.1 (-559,199)		–		-277.8 (-624,69)
Low birth weight, %								
Baseline	77	9.5	95	11.8	162	12.8	136	8.3
Endline	88	4.4	100	8.5	64	9.7	115	4.3
Treatment effect, OR		<i>Reference</i>		1.58(0.29,8.50)		–		0.97(0.58,1.63)
Child vaccination								
Children attended at least 1 vaccination session, %								
Baseline	1278	95.2	1223	94.3	1289	95.3	1256	94.9
Endline	1279	94.9	1273	93.1	1265	96.0	1276	96.2
Treatment effect, OR		<i>Reference</i>		0.89(0.42,1.88)		–		1.47(0.59,3.65)
Full immunization of children ³ (checked on card), %								
Baseline	1002	82.6	982	80.1	1094	86.8	1021	80.3
Endline	933	82.0	996	83.7	1004	80.5	1080	81.2
Treatment effect, OR		<i>Reference</i>		1.32(0.71,2.48)		–		1.10(0.66,1.83)
Child growth monitoring								
Children attended at least one GM clinic, %								
Baseline	1278	44.2	1223	43.6	1289	40.6	1256	38.0
Endline	1279	58.3	1273	65.0	1265	82.7	1276	80.8
Treatment effect, OR		<i>Reference</i>		1.36(0.69,2.70)		3.95(1.69,9.24)		3.90(1.73,8.81)
Children had at least half of their GM check-ups according to their age (GM check-ups checked on card), %								
Baseline	189	36.5	208	29.0	275	27.9	197	28.3
Endline	294	20.4	466	35.8	604	44.9	717	48.0
Treatment effect, OR		<i>Reference</i>		3.07(0.93,10.17)		4.72(1.47,15.17)		5.25(1.82,15.11)
Child’s age when health monitoring stopped, mo								
Baseline	744	9.5 ± 2.8	735	10.0 ± 3.8	804	9.8 ± 2.8	691	10.0 ± 3.4
Endline	857	12.0 ± 6.1	681	13.5 ± 6.7	674	17.5 ± 7.3	644	17.9 ± 7.2
Treatment effect, β		<i>Reference</i>		0.96 (-0.75,2.67)		5.18 (3.34,7.02)		5.38 (3.80,6.96)
Child health								

Children who were ill in the preceding 15 days ⁴ , %									
Baseline	1278	23.0	1223	19.9	1289	23.7	1256	24.9	
Endline	1279	18.4	1273	16.2	1265	14.6	1276	16.2	
Treatment effect, OR		<i>Reference</i>		1.02(0.58,1.80)		0.72(0.40,1.30)		0.77(0.46,1.29)	

¹Abbreviations: ANC, antenatal care; GM, growth monitoring; LNS, lipid-based nutrient supplement; SNACK, santé nutritionnelle à assise communautaire dans la région de Kayes. Analysis: Treatment effects are estimated by regression coefficients, with 95%CI, (β) for continuous outcomes and odds ratios (ORs) for categorical outcomes for the interaction term *treatment* \times *time* in models that account for the sampling design. In 'inside-the-table' analysis, treatment arms 'SNACK+Cash', 'SNACK+LNS', 'SNACK+Cash+LNS' are compared with the 'SNACK' arm.

²Treatment effects for 'SNACK+LNS' arm are not estimated for outcomes outside of the intervention theoretical impact pathways.

³BCG, Polio 1, 2 and 3, DPT-1, 2 and 3, hepatitis B, yellow fever and measles received (as recommended by the expanded program on immunization in Mali)

⁴Symptoms include fever, diarrhea, respiratory infections, cough, and vomiting.

Table 5: Impact of the Cash and LNS components on intermediate outcomes along the ‘Maternal knowledge’ pathway¹

	SNACK (comparison arm)		SNACK+Cash		SNACK+LNS		SNACK+Cash+LNS	
	n	%	n	%	n	%	n	%
Knowledge								
On child growth								
Bringing child to GM sessions is important, %								
Baseline	1278	86.9	1223	88.08	1289	86.1	1256	85.7
Endline	1279	87.7	1277	92.3	1266	92.9	1276	95.3
Treatment effect, OR		<i>Reference</i>		1.51(0.85,2.70)		1.98(1.16,3.39)		3.12(1.60,6.09)
On infant and child feeding practices								
Feeding colostrum is important, %								
Baseline	1278	83.9	1223	88.2	1289	86.9	1256	88.3
Endline	1279	84.8	1277	90.9	1266	88.5	1276	92.5
Treatment effect, OR		<i>Reference</i>		1.24(0.79,1.95)		1.08(0.64,1.83)		1.53(0.86,2.72)
WHO recommended age to start complementary feeding is 6 months, %								
Baseline	1278	43.8	1223	42.6	1289	41.7	1256	47.0
Endline	1279	49.9	1277	52.5	1266	59.7	1276	59.2
Treatment effect, OR		<i>Reference</i>		1.16(0.79,1.70)		1.62(1.09,2.41)		1.28 (0.85,1.94)
Feeding child slowly & patiently (responsive feeding technique), %								
Baseline	1278	55.7	1223	59.6	1289	60.5	1256	53.9
Endline	1279	57.2	1277	56.3	1266	65.3	1276	51.3
Treatment effect, OR		<i>Reference</i>		0.82(0.48,1.41)		1.15(0.65,2.05)		0.85(0.43,1.66)
On child illness								
Keeping sick child hydrated (increase fluid intake), %								
Baseline	1278	26.2	1223	24.6	1289	27.7	1256	25.6
Endline	1279	29.7	1277	35.7	1266	38.8	1276	32.5
Treatment effect, OR		<i>Reference</i>		1.42(0.89,2.27)		1.38(0.83,2.30)		1.17(0.75,1.82)
On hygiene								
Right time for handwashing ² , %								
Baseline	1278	50.8	1223	46.3	1289	50.5	1256	49.7
Endline	1279	54.9	1277	55.3	1266	56.1	1276	58.8
Treatment effect, OR		<i>Reference</i>		1.21(0.80,1.85)		1.06(0.68,1.64)		1.22(0.81,1.85)
Feeding Practices								
Minimum Dietary Diversity, %								
Baseline	513	33.8	501	31.4	565	35.1	559	35.8
Endline	508	32.5	536	33.2	554	42.4	530	34.6
Treatment effect, OR		<i>Reference</i>		1.15(0.72,1.85)		1.45(0.85,2.47)		1.01(0.59,1.70)
Minimum Meal Frequency, %								
Baseline	513	59.3	501	68.8	565	65.4	559	61.2
Endline	508	78.3	536	77.4	554	79.0	530	79.2
Treatment effect, OR		<i>Reference</i>		0.62(0.27,1.43)		0.80(0.39,1.67)		0.97(0.42,2.21)
Minimum Acceptable Diet, %								
Baseline	513	18.7	501	24.1	565	20.7	559	23.7
Endline	508	40.4	536	46.6	554	53.0	530	45.6
Treatment effect, OR		<i>Reference</i>		0.93(0.34,2.50)		1.47(0.43,4.97)		0.91(0.33,2.51)

¹Abbreviations: ANC, antenatal care; GM, growth monitoring; LNS, lipid-based nutrient supplement; SNACK, *santé nutritionnelle à assise communautaire dans la région de Kayes*. Analysis: Treatment effects are estimated by odds ratios (ORs), with 95%CI, for the interaction term *treatment*×*time* in logistic regression models that account for the sampling design. In ‘inside-the-table’ analysis, treatment arms ‘SNACK+Cash’, ‘SNACK+LNS’, ‘SNACK+Cash+LNS’ are compared with the ‘SNACK’ comparison arm.

²Hand washing with soap at two critical times: before eating or ‘cooking, and after using the toilet.

Table 6: Mothers' uptake of the Cash and LNS components¹

	SNACK+Cash	SNACK+LNS	SNACK+Cash+LNS
CCT			
	n=998		n=1109
Cash received at least once, %	65.7	-	61.2
	n=622		n=650
Cash received for 3 ANC sessions, %	43.1	-	40.1
Cash received for delivery, %	67.6	-	66.5
	n=660		n=695
Cash received for 3 vaccinations, %	68.1	-	71.0
Cash received for GM check-up (at least one), %	62.6	-	75.8
Waiting time at the collection point: 1 to 3 hours (last distribution attended), %	49.1	-	47.0
Mothers attended collection point but did not receive the cash, %	43.6	-	38.3
Mothers would have attended CHCs in the same way without the cash, %			
ANC sessions	70.0	-	76.8
Delivery	89.2	-	93.7
Child vaccination	87.8	-	91.4
GM check-ups	33.9	-	71.9
Mothers would have preferred another type of incentive, %	39.1	-	39.9
Mothers were satisfied with the amount of cash distributed, %			
ANC sessions	67.7	-	78.3
Delivery	55.3	-	62.0
Vaccinations	73.9	-	76.9
GM check-ups	68.5	-	72.4
LNS			
		n=1275	n=1276
LNS received at least once, %	-	87.7	87.4
Mean number of times the LNS was received ²	-	10 ± 5	10 ± 4
Mean number of times the LNS was received ³	-	9 ± 5	9 ± 4
		n=1108	n=1114
Waiting time at the collection point: 1 to 3 hours (last distribution attended), %	-	45.0	48.3
Mothers attended collection point but did not receive the LNS, %	-	29.4	21.1
Mothers would have attended child GM in the same way without the LNS, %	-	52.1	53.4
Mothers gave 3 tablespoons/d of LNS to the child, %			
Yes, as recommended	-	78.6	82.5
More than recommended	-	1.8	1.8
Less than recommended	-	19.6	15.7
Mothers sometimes shared the LNS with other members of the household, %	-	19.0	13.4
Mothers reported LNS shortage, %	-	43.9	42.5
In the event of shortage, the LNS was, %			
replaced with EezeCup™	-	37.9	38.2
replaced with Nutributter®	-	61.8	67.6
replaced with Plumpy Sup™	-	15.5	17.9
not replaced	-	10.1	15.2

¹Abbreviations: ANC, antenatal care; CCT, conditional cash transfer; CHC, community health center; GM, growth monitoring; LNS, lipid-based nutrient supplement; SNACK, *santé nutritionnelle à assise communautaire dans la région de Kayes*. Values are % or means ± SDs.

²calculated for children exposed to the LNS from 6 to 23 months of age; information was checked on the beneficiary's card

³calculated for children exposed to the LNS from 6-11 months to 23 months of age; information was checked on the beneficiary's card

Figure legends**Figure 1: Program theory of change**

CHC, community health center; SNACK, *santé nutritionnelle à assise communautaire dans la region de Kayes*.

Figure 2: Trial design

Two repeated cross-sectional surveys were carried out on independent representative samples of 12 to 42-month-old children and their mothers prior to the start of the Cash and LNS components (Baseline, n=5046 mother-child pairs) and three years later (Endline, n=5098 mother-child pairs).