Microfinance Institutions’ Successful Delivery Of Micronutrient Powders: A Randomized Trial In Rural Haiti

ABSTRACT Globally, two-thirds of child deaths could be prevented by increased provision of health interventions such as vaccines, micronutrient supplements, and water purification tablets. We report the results from a randomized controlled trial in Haiti during 2012 that tested whether microfinance institutions—which reach 200 million households worldwide—can effectively deliver health products. These institutions provide loans to underserved entrepreneurs, primarily poor women in rural areas. In the intervention group, micronutrient powders to improve the nutrition of young children were distributed at regularly occurring microfinance meetings by a trained borrower. In both the control and the intervention groups, nurses led seminars on nutrition and extended breastfeeding during microfinance meetings. At three-month follow-up, the mean difference in hemoglobin concentration between children in the intervention group and those in the control group was 0.28 grams per deciliter (g/dL)—with a subsample of younger children (under two years of age) showing greater relative improvement (0.46 g/dL)—and the odds ratio for children in the intervention group meeting the diagnostic criteria for anemia was 0.64. The results are similar to those of previous studies that evaluated micronutrient powder distribution through dedicated health institutions. Our findings suggest that microfinance institutions are a promising platform for the large-scale delivery of health products in low-income countries.
ficiaries. Accessing these supply networks can dramatically reduce distribution costs for suppliers. For beneficiaries, using community-based infrastructure may reduce prices, transport costs, and opportunity costs of accessing services, which could increase demand and uptake. Furthermore, while many health interventions require trained professionals, there is a growing consensus that delivering a set of basic health products and services can be shifted to lay community members who receive rapid, skills-based training with close supervision.

Background On Microfinance Institutions
We investigated whether microfinance institutions offered an effective platform for the delivery of a basic health product. Microfinance is an approach used to develop functioning credit markets in low-income countries, where the widespread lack of access to capital among poor households poses a fundamental constraint to economic development. Microfinance institutions provide loans to underserved entrepreneurs—primarily poor women who reside in rural areas. A growing body of research is evaluating the institutions’ impact on poverty reduction, and previous research has shown that microcredit group meetings promote social capital and thereby reduce defaults on loans. To supply financial services in remote regions, microfinance institutions typically organize borrowers into peer-led credit centers that regularly meet at the village level. The centers are serviced by traveling credit agents from a bank branch, which functions as a regional hub and offers financial services as well as secure storage space with electricity and Internet access.

The canonical microfinance model, termed joint liability lending, provides loans to self-formed groups of entrepreneurs rather than individuals. Theoretically, joint liability for loan repayment reduces default rates and thus lending risk. If an individual borrower does not repay a loan, joint liability requires her or his group to either repay the borrower’s share or collectively default on the loan. Despite lacking traditional collateral, defaulting diminishes a borrower’s social capital, which is an economically important asset among poor rural households that rely on long-standing informal insurance arrangements. Additionally, though individual credit histories remain unknown to the lender, entrepreneurs choose group members using their own knowledge of their peers’ likelihood of repayment, improving the creditworthiness of microfinance institutions’ pool of borrowers.

Integration Of Microfinance Institutions And Health Care
The reciprocal relationship between poor health and poverty—illness increases the likelihood of being poor, and poverty increases the risk of illness—argues for integrating health and anti-poverty initiatives. However, despite microfinance institutions’ having invested in reliable networks of community-based infrastructure to extend financial services to approximately 200 million rural households, little research has rigorously addressed whether they offer a scalable platform for the delivery of proven health interventions. In practice, the vast majority of the large institutions do not provide health services. Of those that do, most provide only education or promotion, not products.

Although there is a substantial body of documentation and reporting on existing programs that link health and microfinance, to our knowledge this article provides the first rigorous causal evidence as to whether the delivery of health products by microfinance institutions improves health status. Previous randomized trials have evaluated microfinance-based health education and promotion, microinsurance, and health-related loans. Most similar to our study is a cluster-randomized trial in Ethiopia that evaluated the provision of family planning services delivered by a health institution, in conjunction with the provision of microloans in the same geographic areas. The trial did not find positive effects on its primary outcome, contraceptive use. In contrast, evidence from six pilot programs across India and Cambodia suggest that delivery of water filters by microfinance institutions may lead to increased uptake of health products and improve water quality. However, a rigorous randomized controlled trial design was not feasible in those contexts.

Community-Based Health Intervention Trial
This article reports the results of a cluster-randomized, community-based intervention trial that estimated the health impact of a microfinance institution’s distribution of a proven health product: micronutrient powders. These powders are a form of micronutrient supplementation designed for ease of distribution and compliance that are recommended by the World Health Organization (WHO) and UNICEF to reduce malnutrition in young children. Micro-nutrient powders were previously proved to be acceptable and effective in rural Haiti when delivered through an integrated health and nutrition program. An important advantage of the powders over other supplements to improve...
Global Health Policy

Our study provides experimental evidence of beneficial health impacts from integrating microfinance and health care services.

Study Data And Methods

Study Participants
Participants were recruited during February and March 2012. The enrollees were 521 children from thirty-four Fonkoze credit centers. Participation was limited to children ages 6–59 months who lived in a household whose head was a member of one of the credit centers. Children were excluded and referred to partnering health centers if they tested as severely anemic (having a blood hemoglobin concentration of less than 7 g/dL) or severely malnourished.

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Networks organized by microfinance institutions offer a readily accessible bridge from formal to informal institutions.

ished (having a mid-upper-arm circumference of less than 110 mm) at baseline. Project staff members led sensitization sessions in all study credit centers, using informed consent procedures appropriate with low-literacy populations. Each enrolled participant’s parent or caregiver provided written consent via a signature or thumbprint, as well as spoken consent. For a flowchart of the stages of the trial, see online Appendix Exhibit A2.35

RANDOMIZATION AND MASKING A computer-generated list of random numbers was used to assign seventeen credit centers randomly to the intervention and seventeen to the control group. Participants in the control group received micronutrient powders after three-month follow-up at the conclusion of the study. A cluster design was chosen because individual-level randomization within credit centers had a greater likelihood of contamination across groups, would make it harder for the research team to monitor whether units were treated according to the initial random assignment, and could have created resentment toward the institution.

PROCEDURES During regularly scheduled credit center meetings, nurses hired specifically for the study enrolled participants and led education seminars covering nutrition, extended breast-feeding, detection of fever, and risks of malaria. A peer-elected client, the center chief from each of the seventeen treated credit centers, attended monthly training sessions that covered how to promote the use of, educate people about, and support the distribution of micronutrient powders. Two-week supplies of the powders were delivered to treated credit centers during biweekly credit center meetings, at which the center chiefs distributed the powders to clients with enrolled children. We recorded the volume of distribution of powders to each participant, collected empty powder sachets to monitor compliance, and conducted ad hoc surveys on borrowers’ knowledge, attitudes, and practices. A team of physicians, nurses, and technical experts developed training and educational materials, which were delivered by nurses.

The primary outcome was hemoglobin (Hb) concentration, a biomarker for anemia that is responsive to micronutrient powders within a two-month window and is operationally simple to measure at low cost with high fidelity. It was measured by nurses using a portable battery-run device (HemoCue Hb 201 + Analyzers) at baseline and during follow-up three months later. Nurses were trained to use the device and required to pass a certification exam before working in the field. The only secondary outcome was the percentage of children with anemia (as explained above, those with Hb less than 11 g/dL).

A demographic survey was administered at baseline to the heads of enrolled children’s households, eliciting information on age, breast-feeding practices, household size, literacy, and other variables. To screen for malnutrition, mid-upper-arm circumference was measured, as were height and weight for children younger than age twenty-four months. During follow-up, any children presenting with illness, including symptoms of or self-reported fever, or with severe anemia or malnutrition were referred to partnering clinics.

STATISTICAL ANALYSIS The analysis was done by intention-to-treat. All participants for whom there were hemoglobin data at the three-month follow-up were included in the primary analysis. We based statistical analyses on a random-effects linear regression model for the primary outcome, blood hemoglobin concentration (which is continuous), and on a random-effects logistic regression model for the secondary outcome, the percentage of children with anemia (which is binary). Both models included covariates for baseline blood hemoglobin concentration, age, and sex, and random effects for credit center to adjust for clustering effects (for the main regression model and alternative specifications, see the Appendix).35 with standard errors adjusted for thirty-four clusters.36 Statistical analyses were performed using Stata, version 13.

ETHICAL APPROVAL Ethical approval for the study was obtained from Haiti’s Ministère de la Santé Publique et de la Population and Columbia University’s Institutional Review Board. The study was registered online with clinicaltrials.gov (Identifier NCT02808117).

LIMITATIONS This study had several limitations. One was its generalizability. The sample was representative of young children residing in the household of a rural microfinance institution’s client, rather than the general population of children younger than age five in a low-income
country. When we compared participants' baseline distribution of anemia to nationally representative data from Haiti, we found that study participants were more likely to be anemic (79 percent) in comparison to the national average (59 percent) among children under age five.

A second limitation was that participants and field staff members were not blinded to their credit centers' group assignment, which posed a risk of post-randomization selection bias that is common in cluster-randomized designs. We implemented robustness checks that accounted for potential selection bias, and the results were unchanged from those of our main analysis.

A third limitation was imperfect compliance. For example, because micronutrient powders are added to one meal per day in the home, sharing the product with other household members is easy to do. We explored the issue of dilution by estimating the model separately for the subgroup of children with eligible siblings in their household and for the subgroup without eligible siblings, and we found similar effects for each subgroup.

### Study Results

For hemoglobin concentration, the primary outcome variable, the mean value was balanced across treatment groups at baseline (Exhibit 1). The intervention and control groups differed meaningfully on two of the sixteen demographic variables, sex (males accounted for 58 percent of the intervention group but only 47 percent of the control group) and weight (9.9 kg versus 8.7 kg). Means of mid-upper-arm circumference, age started on liquid foods, age started on semisolid food, and respondent literacy also differed across intervention and controls groups, but the differences had trivial magnitudes.

Thirty-nine of the 521 enrolled participants were lost to follow-up. There was no evidence of differential attrition between the intervention and control groups (for a table showing differences in attrition across groups, see Appendix Exhibit A3). Furthermore, baseline observable characteristics were very similar among participants who were and those who were not lost to follow-up (for a table showing differences in attrition between these groups of participants, see Appendix Exhibit A4).

Exhibits 2 and 3 show the mean hemoglobin concentration of participants at baseline and three-month follow-up in the intervention and control groups. At three-month follow-up, the mean difference in hemoglobin concentration between children in the intervention group and those in the control group was 0.28 g/dL. A subsample of younger children (ages 6–24 months) showed greater improvement (0.46 g/dL). The cluster-adjusted mean difference in hemoglobin concentration of children in the treated clusters compared with those in the control clusters was significant (Exhibit 2) and remained unchanged after we adjusted for covariates (Appendix Exhibit A5).

Exhibit 3 focuses on the change in hemoglobin concentration, showing that the change among children in the intervention group (0.74 g/dL) was greater than that among children in the control group (0.49 g/dL). The intervention group experienced a greater reduction in the percentage of children with anemia (19.1 percent) than the control group did (11.2 percent) (data not shown). The cluster-adjusted odds ratio for anemia for children in the treated clusters compared with those in the control clusters (0.64) was also significant (Exhibit 2).

The literature shows that the effects of micronutrient powders differ in children younger than 2 years and those ages 2–5. We found that children ages 6–24 months benefited more from the powders (with the reductions in the rates of anemia 22.6 percent in the intervention group and 8 percent in the control group), compared

### Exhibit 1

**Average baseline characteristics of children ages 6–59 months in Haiti, in treated and control groups**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Treated</th>
<th>Control</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemoglobin concentration (g/dL)</td>
<td>9.7</td>
<td>9.8</td>
<td>−0.09</td>
</tr>
<tr>
<td>Age (months)</td>
<td>29.7</td>
<td>27.6</td>
<td>2.1</td>
</tr>
<tr>
<td>Male (%)</td>
<td>58</td>
<td>47</td>
<td>11**</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>83.5</td>
<td>82.5</td>
<td>0.98</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>9.9</td>
<td>8.7</td>
<td>1.2**</td>
</tr>
<tr>
<td>Mid-upper-arm circumference (mm)</td>
<td>149.4</td>
<td>146.6</td>
<td>2.8**</td>
</tr>
<tr>
<td>Months breastfed</td>
<td>15.3</td>
<td>15.5</td>
<td>−0.25</td>
</tr>
<tr>
<td>Child is currently breastfed</td>
<td>0.28</td>
<td>0.28</td>
<td>0.00</td>
</tr>
<tr>
<td>Age started on liquid foods (months)</td>
<td>4.9</td>
<td>4.5</td>
<td>0.45**</td>
</tr>
<tr>
<td>Age started on semisolid foods (months)</td>
<td>7.7</td>
<td>7.1</td>
<td>0.57**</td>
</tr>
<tr>
<td>Household size</td>
<td>7.3</td>
<td>7.3</td>
<td>−0.01</td>
</tr>
<tr>
<td>Number of siblings younger than age 5</td>
<td>0.47</td>
<td>0.58</td>
<td>−0.11</td>
</tr>
<tr>
<td>Number of siblings age 5 or older</td>
<td>2.8</td>
<td>2.3</td>
<td>0.42*</td>
</tr>
<tr>
<td>Respondent age (years)</td>
<td>37.1</td>
<td>36.9</td>
<td>0.13</td>
</tr>
<tr>
<td>Respondent literacy</td>
<td>2.0</td>
<td>2.2</td>
<td>−0.22**</td>
</tr>
<tr>
<td>Respondent income source</td>
<td>4.3</td>
<td>4.1</td>
<td>0.21</td>
</tr>
<tr>
<td>Respondent years as a member of Fonkoze</td>
<td>3.2</td>
<td>3.4</td>
<td>−0.21</td>
</tr>
<tr>
<td>Number of observations</td>
<td>262</td>
<td>259</td>
<td>3</td>
</tr>
</tbody>
</table>

**Source:** Authors’ analysis of trial data. **Notes:** Differences may not match data for the control group minus data for the treated group because of rounding. Fonkoze, the largest microfinance institution in Haiti, was the authors’ implementing partner. ‘No = 0; yes = 1.’ 1 = cannot read at all; 2 = able to read part of sentence on card; 3 = able to read whole sentence on card; 4 = agriculture; 2 = livestock; 3 = wage labor; 4 = remittance; 5 = small business; 6 = service in other organizations; 99 = other. ‘p < 0.10 **p < 0.05 ***p < 0.001’
to children ages 25–59 months (with reductions of 17.1 percent versus 13.7 percent) (data not shown). In an exploratory analysis, we assessed heterogeneous effects by sex by adding an interaction term to the main specification (the results are reported in Appendix Exhibit A5). We found that female children benefited more than male children in both the full sample and the subsample of children younger than age two years. As robustness checks, we estimated alternative specifications using augmented inverse propensity score weighting and difference-in-differences regression models, with standard errors estimated using the cluster-robust sandwich estimator, wild bootstrap-t, and randomization inference. These additional specifications accounted for selection into the treatment group based on observable characteristics, relaxed the assumption of covariate balance, and tested significance using alternative approaches. When we used these specifications, the results were unchanged from those estimated by the main specification (for results from the robustness checks, see Appendix Exhibit A6).

Discussion

Our findings suggest that microfinance institutions can deliver a basic health product effectively to vulnerable rural populations. Based on a number of randomized trials, micronutrient powders are recommended by the WHO for children younger than age two. The magnitude of the effect found in this study of a microfinance institution’s delivery of the powders is similar to that in trials of delivery through health institutions. The most appropriate comparison to this study is a cluster-randomized trial conducted by P. Menon and coauthors in 2003 in central Haiti, which assessed the effect of delivery of micronutrient powders through an integrated health and nutrition program on hemoglobin concentration of children ages 9–24 months. Exhibit 4 compares our study’s results for children ages 6–24 months to the results of Menon and coauthors. In addition, with age and sex controlled for, at two-month follow-up Purnima Menon and coauthors found a treatment effect of 0.53 g/dL ($p < 0.05$), which is similar to our 0.46 g/dL ($p < 0.05$) effect we found at three-month follow-up for children ages 6–24 months (Exhibit 2).

Our study provides experimental evidence of beneficial health impacts from integrating microfinance and health care services. The results are consistent with previous observational research that documented improvements in health knowledge, product adoption, and behaviors from integrated microfinance and health programs. In contrast to our findings, a previous cluster-randomized trial, which is most similar to our study in terms of design, did not find a positive effect of combining family planning education and microloans on contraceptive uptake. However, that study reported no effect of family planning education alone on contraceptive uptake, which the authors attributed to the time-consuming distance participants had to travel to purchase their preferred form of contraception. The importance of reducing transport and opportunity costs to increase demand

### Exhibit 2

Hemoglobin concentration among children at three-month follow-up, and odds of having anemia in the intervention versus control group, by age

<table>
<thead>
<tr>
<th>Children</th>
<th>Treatment effect</th>
<th>SE</th>
<th>Odds ratio</th>
<th>SE</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ages 6–59 months</td>
<td>0.28**</td>
<td>(0.14)</td>
<td>0.64**</td>
<td>(0.16)</td>
<td>482</td>
</tr>
<tr>
<td>Ages 6–24 months</td>
<td>0.46**</td>
<td>(0.23)</td>
<td>0.41**</td>
<td>(0.18)</td>
<td>194</td>
</tr>
</tbody>
</table>

**Source**: Authors’ analysis of trial data. **Note**: The exhibit shows the results of a random-effects linear regression model for the primary outcome, hemoglobin concentration in grams per deciliter (g/dL), which is continuous, and the results of a random-effects logistic regression model for the secondary outcome, percentage of children with anemia (those with a concentration of less than 11 g/dL), which is binary. Both models included covariates for baseline value of blood hemoglobin concentration, age, and sex, and random effects for credit center. Cluster-robust standard errors (SEs) adjusted for thirty-four clusters. **$p < 0.05$**

### Exhibit 3

Average hemoglobin concentration in treated and control groups of children ages 6–59 months in Haiti in 2012, at baseline and three-month follow-up

**Source**: Authors’ analysis of trial data. **Note**: The error bars show 95% confidence intervals.
for health products among poor rural beneficiaries is consistent with our study’s positive findings about delivering health products directly during the microfinance institution’s credit center meetings.

This community-based pilot program had a high follow-up rate. The primary outcome was measured by trained nurses who had passed a certification exam and used a portable, battery-run device. Since the program was a cluster-randomized pilot program, with clusters geographically distant from one another, it is not likely that there was contamination and sharing across groups.

Because of the larger-than-anticipated improvement in the control group, we mapped the GPS coordinates of the credit centers and regressed outcomes among control participants against distance to the nearest treated center, as well as average distance to all treated centers. We found no effect of proximity to treated centers on outcomes in control centers. More likely, the observed improvement in the control group was driven in part by secular factors that affected blood iron levels across both treated and control groups (such as seasonal variation that influences what people eat) and by education on appropriate breast-feeding practices and nutrition, which covered the health risks of micronutrient deficiency and encouraged greater uptake of otherwise available nutrition interventions.

Exploratory analyses also revealed that the positive treatment effect was driven by improvement among girls. While a variety of factors may have contributed to this heterogeneity, mechanically it was driven by larger differential improvement across sexes within the control group (where boys improved more than girls) than within the treatment group (where girls improved more than boys). The substantially greater improvement within the control group among boys is consistent with a large literature in development economics concerned with parental preferences for boys, as well as the results of a previous study on community-based models of micronutrient powder distribution. It is unclear why girls in the intervention group improved more than boys. If girls had poorer health status than boys (or differed along other observable characteristics) at baseline, this could have caused the treatment to have greater effects on girls than boys. However, mean baseline hemoglobin levels and baseline covariates were similar across the sexes.

Conducting cluster-randomized controlled trials in low-income countries, particularly among young children, requires significant consideration of ethical issues. In this case, the rigorous study design allowed for a pragmatic evaluation of the program’s effectiveness in a limited number of credit centers, thereby functioning as a first step in the rollout of a much larger initiative that has the potential to improve public health in Haiti. The amount of micronutrient powder available at the beginning of the trial determined how many children could be in the study, given that participants in the control group would receive the powders after the three-month follow-up. As a continuation to this pilot program, with support from the US Agency for International Development and Grand Challenges Canada, the microfinance institution is pursuing delivery of a larger set of health products and services on a national scale using a nurse-supervised, community health entrepreneur model.

**Policy Implications**

In this section we highlight three implications of the study findings that are relevant to policy makers in Haiti and other low-income countries seeking to expand coverage of health products. First, having microfinance institutions deliver basic health products may be a promising way to reach poor rural beneficiaries in a coordinated fashion on a national scale. Globally, these in-
institutions reach 200 million households, with the number rising by about 20 million per year. Second, supply chains from urban centers to hundreds of thousands of rural villages are already established, maintained, and funded by the institutions, which gives distributors of basic health products a way to avoid having to make otherwise large, fixed, and arguably duplicative up-front investments in delivery infrastructure. Indeed, published cost estimates indicate that using existing supply chains could cut the total cost of mass delivery of micronutrient powders in low-income countries by 25 percent. Moreover, for borrowers who are already attending the regular credit meetings of microfinance institutions, time and travel costs of accessing services are already paid.

Finally, policy makers seeking to rapidly scale up lay health worker programs should consider incorporating microfinance institutions into their deployment strategy. In particular, microfinance center chiefs constitute a network of socially central, local, female leaders. Delivering interventions via well-connected peers may improve the interventions’ spread and targeting. Networks organized by microfinance institutions offer a readily accessible bridge from formal institutions, such as health care systems, to informal institutions and markets in remote communities.

**Conclusion**

To our knowledge, our study provides the first rigorous causal evidence that a microfinance institution’s delivery of health products improves health status. Our findings suggest that these institutions are a promising way to deliver health products on a large scale in low-income countries. Delivering health products through microfinance networks offers the possibility of using existing supply chains to provide the products to vulnerable populations in rural areas of low-income countries on a national scale and with reduced cost.

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**NOTES**
