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Microcredit Programme Participation and Household Food Security in Rural Bangladesh

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Abstract

Lack of access to credit prevents poor households in developing countries from diversifying into income-generating activities that could safeguard them against unforeseen shocks and seasonality, leaving them susceptible to food deprivation, even when aggregate food supplies are adequate. Microcredit programmes help these households to access financial capital that could help improve their food security situation. We examine how microcredit affects different measures of food security; namely, household calorie availability, dietary diversity indicators and anthropometric status of women of reproductive age (15–49 years) and children under the age of 5 years. We find that microcredit programme participation increases calorie availability both at the intensive and extensive margins, but does not improve dietary diversity and only has mixed effects on the anthropometric measures. We also find that the effect of microcredit participation on food security may be non-linear in which participation initially has either no effect on food security or may actually worsen it, before improving it in the longer run. Our results help to explain why existing short-term evaluations of microcredit sometimes do not show any positive effects.

Keywords: *Calorie availability*; *dietary diversity*; *food security*; *malnutrition*; *microcredit*.

JEL classifications: *G21, I3, I14, Q18*.

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1. Introduction

Smallholder agricultural production, coupled with output shocks such as drought, flood and disease, has raised concern about food security in many parts of the developing world (see e.g. Arslan *et al.*, 2015; Kassie *et al.*, 2015). Bangladesh has witnessed significant reduction in poverty over the last two decades; however, widespread food insecurity persists (Rahman, 2010; Rahman and Salim, 2013). Out of a total population of 165 million people in Bangladesh, 33 million were classified as lacking food security in 2010 and by 2020 it is estimated that this number will increase to 37 million (USDA, 2010). A 2012 survey by the Economist Intelligence Unit of 105 countries ranked Bangladesh 81st in terms of the Global Food Security Index (*Economist*, 2012). In rural Bangladesh, most of the income of a poor household is derived from the agricultural sector, which exposes households to seasonality in agricultural employment, poverty and consumption (Rahman and Salim, 2013). Income from non-agricultural sources could safeguard households against seasonal food insecurity; however, they may lack the resources to diversify into more productive employment opportunities that could improve food security, particularly during lean seasons. Low income levels, and lack of access to credit, prevents households from accessing food, leaving them susceptible to food deprivation, even when aggregate food supplies are adequate.

Microcredit was developed in order to meet an important need not addressed by formal institutions; namely, providing financial capital to landless and assetless rural households, who would otherwise be either ineligible to access credit or be locked into the informal credit system. From the beginning, one of the major forces motivating the development of microcredit was to improve the food security of the rural poor. This objective, for example, is clearly enunciated in Grameen Bank documents (see e.g. Yunus, 1994) and is accepted in the extant literature on microcredit. We suggest that there are at least three channels linking microcredit to improved food security. One channel is through generating investment-led benefits, which result in greater levels of income, consumption and wealth. A second channel is through insurance-led benefits, through which participation in microcredit institutions (MCI) protects households against unforeseen risk and seasonality. The third channel is via improved financial education and information flows about health and nutrition associated with interventions that often accompany microfinance programme participation.[2]

A number of related studies find that microcredit programme participation results in consumption smoothing and asset building (Kaboski and Townsend, 2005), reduces household vulnerability to health and income shocks (Islam and Maitra, 2012), and improves health and nutrition (Pitt *et al.*, 2003). Higher benefits have also been found to accrue from long-term participation in such programmes (Islam, 2011). A few studies have examined the effect of microcredit on poverty. Proxies for poverty used in the literature include female body mass index (BMI), food consumption, a composite index based ranking, household expenditure and household income. The findings have been mixed. Some studies have found that microcredit reduces household poverty (see e.g. Pitt and Khandker, 1998; Imai and Azam, 2012), but others have found that microcredit has no poverty-reducing effect or no effect on consumption (see e.g. Cull *et al.*, 2009; Banerjee *et al.*, 2015).

[2]These channels, which are complementary and reinforcing, are discussed in more detail in the next section.

In this study, for the first time, we seek to measure the effect of microcredit on several different dimensions of food security. Our contribution is important because food security is a broader concept than food consumption. In addition to food consumption *per se*, there is widespread recognition that dietary diversity forms an important component of food security. More generally, the FAO (1996) states that food security exists 'when all people, at all times, have physical, social and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life'. This definition recognises availability, access and utilisation as the three principal components in the concept of food security. More recently, vulnerability, which captures the extent to which households that are currently food secure may be at risk of future food insecurity, has also become important as a fourth dimension to the measurement of food security. Since, no single indicator can capture all of the above aspects of food security, the use of multiple measures is appropriate.

We use a large household level panel dataset to examine the effect of microcredit on household food insecurity in rural Bangladesh. Our data include a rich set of information on item-wise food consumption. To measure food security we use absolute level of calorie availability and shortfall from standard cut-offs of calorie norms, dietary diversity of the household and anthropometric indicators for children below 5 years of age (incidence of stunting, wasting and underweight) and for women of reproductive age (15–49 years), focusing on BMI and mid-upper arm circumference (MUAC).

The paper is structured as follows. The next section presents a simple conceptual framework of the pathways through which microcredit affects food security. The microcredit programme in Bangladesh, the data and the measurement of food security we use are discussed in section 3. Section 4 discusses the alternative estimation methodologies that we use to assess the impact of MCI participation on the food security situation of the household. Section 5 presents the results and discussion and the final section concludes.

2. The Conceptual Framework

We consider a simple analytical framework to understand the pathways through which microcredit programme participation affects household calorie consumption and food insecurity. Demand for calories can be estimated within the framework of consumer demand theory, which incorporates the demand for characteristics (Lancaster, 1966) with household production theory (Becker, 1965). Drawing on Rose *et al.* (1998), one can consider a utility function that has vectors of taste components, S, and nutrients, N, found in meals, as well as a vector of other goods, X_0 and leisure, represented by L:

$$U = U(S, N, X_0, L). \tag{1}$$

A representative household maximises its utility, subject to a home production function and constraints on its income and time, given food and other goods' prices. The reduced-form nutrient demand equation for this optimisation problem then takes the following form:

$$N = y(P_f, P_0, w, Nw, K, H), \tag{2}$$

where, P_f is a vector of food prices, P_0 is a vector of prices of other goods, w is the wage rate, Nw is non-wage income, K is a vector of capital goods, including human capital, physical assets and land, and H is a vector of demographic characteristics, such as household size and composition. Demand functions for other meal characteristics as well as other goods and leisure could be similarly depicted. For the purposes of this exposition, we focus on the case of one nutrient – food energy or calorie availability. Let C_a represent the household's absolute level of calorie availability, an important component of the nutrient vector, which is a function of prices, wages, non-labour income, capital and socio-economic and demographic characteristics of the household. Food insufficiency occurs when the household's calorie (energy) availability falls below some minimum threshold level, set at some pre-determined level, $C_{\min}$, referred to as the minimum energy requirement.

Incidence of food insecurity can be then be represented by an indicator (A_h), where:

$$\begin{aligned} A_h &= 1 \text{ if } C_a < C_{\min} \\ &= 0 \text{ otherwise.} \end{aligned} \tag{3}$$

Two alternative models of household food insecurity can then be estimated – one based on the absolute level of calorie availability, C_a and the other using the indicator function, A_h. Next, we sketch a model of the nutritional status of the most vulnerable in the household (women and children), following Garrett and Ruel (1999). Since we address the issue of food security at the household level only, the nutritional status of children under the age of 5 years and that of women of reproductive age are considered as proxy indicators for the level of food utilisation within the household. Nutrition for an individual i is conceived of as the output of a production function in which a specific technology translates inputs into nutritional outcomes, which are represented by some standardised anthropometric measure, such as height-for-age or BMI. Nutrition can be represented by the function:

$$W_i = z(DI_i; R_i; E_i), \tag{4}$$

produced by a set of inputs which include dietary intake (DI_i), resources available to the household (R_i) and household environment (E_i). Individual i suffers from acute malnutrition if his/her nutritional status falls below a specified cut-off level, as set by the WHO (2006).

There are at least three channels through which microcredit is expected to have a positive effect on food security, reflected in calorie availability and dietary diversity. The first channel is through generating investment-led benefits. Access to microcredit provided by MCIs increases available resources and relaxes the budget constraint faced by households. Resulting investment-led benefits are of two broad types. One set of benefits results from productive uses of microcredit. Increased access to credit provided by microcredit programmes opens up opportunities to diversify into more profitable self-employment based activities which improve household income (McKernan, 2002; Islam and Maitra, 2012). One would expect microcredit to increase calories available in a household because of a rise in income from such activities. Reinforcing the positive effect of productive investment from microcredit on the food security of women and their children, if microcredit results in greater female empowerment, women and their children will be less likely to be underweight if they are participating in a microcredit programme because it potentially improves the status of the women in their household (and their share of the food) (Pitt *et al.*, 2003). Offsetting this, it might be argued that microcredit may potentially have a negative effect on the nutritional status of women if productive investment also means more work for them, and therefore greater nutritional needs that are not fully compensated by the increase in calories available.

The other set of investment-led benefits results from non-productive use of microcredit. While microcredit is supposed to be used for investing in income-generating activities, in practice, particularly among very low-income households, it is used to directly increase food consumption (Zeller and Sharma, 2000).[3] Thus, microcredit can have a direct positive effect on food security. Imai and Azam (2012) found that microcredit contributed to reducing poverty in Bangladesh through both productive and non-productive uses of loans.

The second channel through which microcredit potentially increases food security is through insurance-led benefits that can protect households against unforeseen risk and seasonality. It is recognised that participation in MCIs and access to microcredit provides a safety net that prevents income from falling to such low levels that households are unable to satisfy their basic consumption needs. Insurance-led benefits from microfinance can operate in two ways. One is that it reduces household vulnerability to income and health shocks, thus improving food security (Islam and Maitra, 2012). The other is that microcredit participation allows poor households to diversify into activities that generate income streams that are not correlated with income from agricultural production (Pitt and Khandker, 2002), that smooths food consumption and insures against not having food, particularly during lean seasons.

A third channel through which microcredit potentially increases food security is through education or information. Financial education can improve the success of projects funded by microfinance by increasing participants' knowledge of financial planning (Gray *et al.*, 2009). In some cases, microfinance programmes have been coupled with supplemental health interventions to improve information flows about health and nutrition (Reinsch *et al.*, 2011). Hence, conceptually through an information or education channel, women are potentially better able to convert cash into calories or food diversity if they are in a microcredit programme. In Bangladesh, MCIs have not provided comprehensive financial education to clients. BRAC, and other non-government organisations have provided complementary financial education, but these have been targeted at the very poor (Yuge, 2011).

For the most part, we expect these three channels to be reinforcing. In terms of timeframe, we expect non-productive investment-led lending and insurance-led benefits that smooth out health and income shocks to improve food security in the short run. Both involve spending loans from MCIs directly on increasing food consumption and hence have an immediate short-run positive effect on food security. Productive investment of loans that generate an increase in income-earning activities and, hence, indirectly an increase in food consumption, are likely to only improve food security in the medium-to-long term. Similarly improvement in female empowerment, stemming from an increase in female income-generating activities, as well as education and information flows, are only likely to have an positive effect on food security in the medium-to-long term.

Increases in calorie (energy) availability of the households depend on the shape of their calorie-income curve. Microcredit may not have any effect on household calorie

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[3]An IFPRI study of eight developing countries in Asia and Africa (Zeller and Sharma, 2000) found that between 50% and 90% of loans from MCIs were spent on consumption related purchases.

availability if the calorie-income curve is relatively flat. If there is significant non-linearity, MCI participation may increase calorie availability only at low incomes. On the other hand, microcredit is likely to affect the nutritional status of women and children in the household directly by increasing the resources available to participating households and indirectly by increasing their dietary (or calorie) intake.

3. The Microcredit Programme and the Data

Microcredit can be thought of as small credit made available to poor people who cannot enter the formal credit market. It requires no collateral and generally focuses on women. Loans are provided through informal groups mobilised as part of a programme strategy to reach out to the poor. The programme is based on joint liability and offers targeted training and information sessions to borrowers with the aim of assisting them to best use their loans.

Bangladesh has one of the world's oldest microcredit programmes. MCIs in Bangladesh adopt the Grameen Bank approach to lending. Specifically, households eligible for microcredit are those with <50 decimals (half an acre) of land and, in particular, groups of women who become jointly liable for the repayment of the loan in the absence of any collateral requirement. Initial loans are typically between US$40 and US$150 and are made available for a range of socially acceptable income-generating activities, with MCI members permitted to borrow larger sums once they have repaid their first loan.

Our dataset was collected by the Bangladesh Institute of Development Studies (BIDS) with financial support from the World Bank. The data were collected primarily to monitor and assess the impact of the Palli Karma-Sahayak Foundation (PKSF) MCIs. PKSF operates as a regulatory body that monitors the activities of MCIs in Bangladesh. The survey covers a wide range of MCIs that vary both in terms of their loan disbursement and coverage. One notable MCI in the survey is the Association for Social Advancement (ASA), which was established in 1991 and has become a market leading MCI in Bangladesh in terms of number of beneficiaries and loan disbursement. Another notable MCI in the survey is Proshikha, which is the fourth largest microcredit programme in Bangladesh. Other notable MCIs that we study here include the Society for Social Services (SSS) and Thengamar Mohila Sabuj Sangha (TMSS). As of December 2004, SSS was the tenth largest MCI in Bangladesh in terms of cumulative disbursements and outstanding borrowers. TMSS is one of the top 50 MCIs in Bangladesh. The other MCIs included in the BIDS/PKSF survey are relatively small and have similar types of programme activities.

The dataset contains information from about 3,000 households, which were selected from 91 villages across 23 thanas (sub-districts) within 13 districts. Four rounds of the survey were conducted (in 1997–98, 1998–99, 1999–2000 and 2004–05) over a period of 8 years. The participating households were selected from 13 MCIs, one from each of the 13 districts in which the survey was conducted. Among the 91 villages in which the survey was administered, there were 11 control villages in the first round. The final round of the survey covered only eight control villages as some of the control villages turned into programme villages in the subsequent rounds of the survey. As there were fewer control villages in the final round, targeted households from the treatment villages that expressed a willingness to participate in the programme were also surveyed. The decision on which households to include was made based on observable characteristics reported in the census in 1997, before the first round of the survey. Thus, control households consist of people living in villages where there were no programmes available and households within the treatment villages who had not participated in the programme by the final round of the survey.

The surveys contain detailed information on the food consumption behaviour of the household and anthropometric data for all household members. We use data from the first, third and fourth round of the survey, because the second round did not contain the same detailed anthropometric data. The first, third and fourth round of the survey also contains detailed information on personal and household characteristics of participants.

The final dataset is an unbalanced panel from the first, third and fourth round of the survey; there are 2,577 households in the first round, 2,540 households in the third round and 2,358 households in the fourth round. The attrition between the first and fourth rounds was less than 10%, representing about 1.2% per year. This figure is relatively low and does not pose any serious concern for our analysis (see Islam, 2011 for details). As a robustness check on our results, we also analysed separately the consumption behaviour of those who dropped out and those who remained in the survey and we did not find any difference between these two groups. Hence, our results reported below are not corrected for attrition bias.

Differences in the food situation between MCI members and non-members are based on their membership status during a given round. The participating group consists of households in which at least one individual is a member of one or more MCIs during a given round. As the loan amount varies primarily depending on the length of participation in the programme, we also use the total amount borrowed by participating households in any particular year as an alternative definition of programme participation.[4]

3.1. Measuring household food security

In the present study, we consider three different quantitative measures of food security, widely used in the literature, to evaluate the impact of microcredit programme participation on the food security situation in rural Bangladesh. These can be categorised as: (i) calorie (energy) availability – both as absolute calorie availability and as a categorical measure, representing shortfall from a standard norm; (ii) dietary diversity indicators; and (iii) anthropometric indicators for children below 5 years of age and women of reproductive age. We do not include the self-reported or experiential food security measure, in the absence of relevant data.[5] We now discuss the construction of each of these indicators in more detail.

3.1.1. Calorie availability

The Household Consumption Expenditure Survey (HCES) collected (retrospectively) detailed data on the quantity and value of food items consumed by households over the 7 days preceding the date of inquiry.[6] We have used detailed data on food

[4]The loan amount is in ten thousand taka adjusted by the agricultural price index with 1997–98 as the base year.

[5]Information on self-reported food security based on perception of ‘lack of enough food’ is available for 1 year only.

[6]The exception was cereals, for which the recall period was 3 days.

expenditure on items purchased from the market to arrive at household calorie availability, while calories from auto-consumption are obtained from 'quantities' alone. The quantity estimates of the food items consumed by a household were converted to calorie availability by applying conversion factors using the Gopalan *et al.* (1981) nutrition chart, which is routinely used in large-scale nutrition surveys, such as India's National Sample Survey Organisation (see NSSO, 2012).[7]

The estimate for total calorie equivalent of all food items consumed by the household during the reference period was derived by aggregating calories over different food groups.[8] Finally, we calculated equivalised calorie availability, expressed as kilocalories per day, by dividing the aggregate calorie figure at the household level by the OECD-modified equivalence scale, following Hagenaars *et al.* (1994), which assigns a value of 1 to the first adult, 0.5 to each additional adult member and 0.3 to each child under the age of 15. Equivalised calorie availability takes into account that consumption needs may differ across households based on their composition. For example, consumption needs will differ between a household consisting of only working age adults and a household with one or more children.

We have computed calorie availability, rather than calorie intake. The former may not necessarily represent the 'true' level of intake of a household for two reasons. Firstly, there may be members of the household who might have consumed free meals outside the home and, secondly, persons other than household members might have been entertained as guests (see Strauss and Thomas, 1995). In the presence of information[9] on 'number of meals taken away from home' and 'number of meals served to guests', calorie availability can be adjusted using an appropriate adjustment factor (see Minhas, 1991) to obtain a measure much closer to true intake.

3.1.2. Choosing the calorie threshold

Data on food expenditure, gathered through the HCES, can be converted to calories using price per unit or calorie per unit conversion factors. However, it should be noted that inter- and intra-individual variations in nutrient requirement, based on health status, activity level and genetics may complicate the definition of an appropriate intake threshold (Barrett, 2002). Since calorie needs vary with climate and also with age, gender and activity status, a single norm, irrespective of the level at which it is set, cannot capture these differential requirements. Minimum calorie requirements are therefore specified for an average household using norms developed by the Bangladesh Bureau of Statistics (BBS). The BBS uses two different thresholds to measure the incidence of food poverty. According to the direct calorie intake (DCI) method,

[7]Few countries have appropriate calorie conversion tables, with which to estimate the adequacy of the consumption of all essential nutrients as well as dietary energy. In the absence of a detailed Bangladesh specific food composition table, we used India's food composition table. The rationale for so doing is that the dietary pattern of Bangladesh is very similar to that of certain states in India, such as West Bengal, for historical reasons. The Indian Food Composition Table (Gopalan *et al.*, 1981) has been previously used by researchers working on similar issues in Bangladesh – for example see Chaudhury (1985).

[8]The major food groups in the BIDS survey are: cereals, pulses, edible oil, vegetable, meat, egg, milk, fruits, fish (big and small), spices, other food products including sugar, biscuits and drinks including tea.

[9]This information is not available in the current dataset.

2,122 kcal per person per day is considered to be the cut-off for defining 'absolute poverty' while 1,805 kcal *per capita* per day is defined as the cut-off for 'hard-core poverty' (BBS, 2000). Consistent with the above minimum energy requirements, we use 2,122 kcal and 1,805 kcal *per capita* per day, respectively, to define 'absolute food poverty' and 'hard-core food poverty'.

3.1.3. Household dietary diversity indicators

We use two different measures to capture the extent of diversity in the diet of households (following Hoddinott, 1999a,b; Migotto *et al.*, 2006); namely, the Food Variety Score (FVS) and the Dietary Diversity Score (DDS). We use the 12-scale Household Dietary Diversity Score (HDDS), developed by the Food and Nutrition Technical Assistance (FANTA) Project of the United States Agency of International Development (USAID), to aggregate food items in the HCES under the following food groups – cereals, roots and tubers, vegetables, fruits, meats, eggs, fish and other seafood, pulses/legumes/ nuts, milk and milk products, oils and fats, sugar and honey, and miscellaneous such as spices, condiments and beverages. FVS is a measure of the number of food items, while DDS accounts for the number of food groups consumed by the household. The DDS ranges from zero ('non-diverse') to 12 ('diverse').

3.1.4. Anthropometric and nutritional status

Three standard indices of physical growth that describe the nutritional status of children are included in the present analysis: 1) Height-for-age, 2) Weight-for-height, and 3) Weight-for-age. Each of the three anthropometric indicators is expressed in standard deviation units (*z*-scores) from the median of the reference population. Children with *z*-scores below -2 SD from the median of the reference population are considered undernourished, while those with *z*-scores below minus -3 SD from the median are classified as severely undernourished (WHO, 2006).

Children whose height-for-age *z*-score is below -2 SD from the median of the reference population are considered short for their age or stunted, which reflects persistent nutritional deprivation over a long period of time and may be caused by low birth weight and intrauterine growth restriction, which, in turn, may reflect maternal undernutrition. In other words, stunting represents chronic undernutrition. Children whose weight-for-height *z*-score is below -2 SD from the median of the reference population are classified as thin for their height or wasted, which may be a result of inadequate nutrition or infection from disease in the recent past. Wasting represents acute malnutrition. Weight-for-age is a composite index of height-for-age and weight-for-height, and takes into account both chronic and acute undernutrition. Children whose weight-for-age *z*-score is below -2 SD from the median of the reference population are defined as being underweight.

Body mass index and MUAC were employed to analyse the extent of acute malnutrition among women of reproductive age (15–49 years). Following the cut-offs specified for BMIs of adults in BBS/UNICEF (2007), a woman is considered to be underweight if her BMI is below 18.5 and chronic underweight if her BMI lies below 16. Similarly, she is said to suffer from MUAC-malnutrition if her MUAC is less than, or equal to, 22.1 cm and severe MUAC-malnutrition if her MUAC is below 21.4 cm (WHO, 1995).

Low maternal BMI indicates undernutrition. Women aged 15–49 years with BMI <18.5 kg/m^2 are thin and tend to have increased risk of intrauterine growth restriction, which increases the risk of neonatal mortality and future stunting in offspring

(Black *et al.*, 2008). MUAC is a measurement that allows health workers to quickly determine if a patient is acutely malnourished. Due to its simpler and faster assessment procedure, this indicator is a useful marker for determining under nutrition in emergency situations (Tang *et al.*, 2013). Although low BMI was recognised as a valuable tool for detecting severe malnutrition, it was often found to be a difficult measure to use in settings where resources are scarce and demands are high. MUAC is a simpler and quicker screening tool, and researchers have found strong associations between low MUAC (<22 cm for women and <23 cm for men) and low BMI (<18.5) in developing country settings (see Tang *et al.*, 2013).

3.1.5 Basic Descriptive Statistics

The descriptive statistics for the key demographic variables for treatment and control groups are reported in the top panel of Table 1, while the lower panel reports the results of the outcome variables by treatment status for different survey rounds.[10] Figure 1 plots the relationship between microcredit loan amount and selected indicators of food security. The estimated non-parametric relationship between the loan amount provided by microcredit programmes and each of the four different indicators of food security suggests that microcredit could improve the food security situation of households.

4. Estimation Methodologies

Individual, household and village-level unobservable characteristics could influence the household's decision to participate in the programme and the MCI's decision to select a particular village for its operation. Estimating the causal impact of microcredit programme participation on household level food security, therefore, necessitates addressing non-random programme placement and the self-selection of households into microcredit programmes. In order to address the concern regarding comparability of participant and comparison groups, we estimate our regression model using a strategy that builds on the propensity score matching (PSM) method proposed by Rosenbaum and Rubin (1983). We combine the regression method with PSM, and use regression-adjusted PSM (Heckman *et al.*, 1998) that addresses selection based on observables and unobservables.

The main purpose of using PSM is to match groups of participants to non-participants. In order to do so, we first estimate propensity scores for each household using a standard logit model that regresses participation status of the household in the first round of the survey on their initial set of household- and village-level observable characteristics. Second, we compare participant and non-participant households based on these propensity scores. We estimate regressions for only the subset of matched individuals lying within the common support. We use the nearest neighbour matching estimator with the five nearest neighbours.

We estimate the following fixed effects regression model:

$$FS_{jt} = \alpha_j + \beta_1 H_{jt} + \theta P_{jt} + \lambda \tau_t + \varepsilon_{jt}, \tag{5}$$

[10]See also the online Appendix-1, Table S1 for summary statistics for participating and non-participating households for the full sample as well as just for eligible households.

Table 1
Descriptive statistics

Variables of interest	Round I: 1997–1998			Round III: 1999–2000			Round IV: 2004–2005		
	Treated	Control	Difference	Treated	Control	Difference	Treated	Control	Difference
Panel A: Demographic variables									
Age of household head	44.01	45.24	**−1.23**	46.26	47.52	**−1.26**	47.62	47.87	−0.25
Number of working people	2.80	2.81	−0.01	2.98	3.06	−0.08	3.63	3.56	0.07
Household size	5.71	5.50	**0.21**	6.09	6.03	0.06	7.23	7.23	0.00
Highest education by any member	5.29	5.75	−0.46	5.92	6.64	**−0.72**	7.08	7.43	−0.35
Total arable land (in decimals)	57.72	84.01	**−26.29**	64.92	101.72	**−36.8**	54.55	91.0	**−36.45**
Number of children	2.93	2.69	**0.24**	2.32	2.10	**0.22**	3.00	3.02	−0.02
Number of women	2.72	2.57	**0.15**	2.99	2.88	0.11	3.32	3.20	0.12
Number of old people	0.21	0.30	**−0.09**	0.35	0.44	**−0.09**	0.28	0.33	**−0.05**
Number of married people	2.40	2.37	0.03	2.72	2.68	0.04	3.20	3.11	0.09
If woman is household head	0.05	0.07	**−0.02**	0.05	0.06	−0.01	0.09	0.13	**−0.04**
Panel B: Outcome variables									
Equivalised calorie availability per day	4,544.32	4,573.67	−29.35	4,074.36	4,098.79	−24.43	3,937.12	3,944.60	−7.48
FP using cut-off of 1,805 kcal/person/day	0.28	0.27	0.01	0.52	0.52	0.00	0.57	0.59	−0.02
FP using cut-off of 2,122 kcal/person/day	0.47	0.44	0.03	0.71	0.68	0.03	0.77	0.77	0.00
Food Variety Score (FVS)	20.53	20.08	**0.45**	11.44	12.97	**−1.53**	18.28	19.26	**−0.98**
Dietary Diversity Score (DDS)	9.34	9.21	0.13	6.31	6.74	**−0.43**	8.02	8.31	**−0.29**
Incidence of stunting	0.58	0.58	0.00	0.28	0.39	−0.11	0.45	0.52	−0.07
Incidence of wasting	0.31	0.28	0.03	0.15	0.15	0.00	0.14	0.15	−0.01
Incidence of underweight	0.60	0.58	0.02	0.29	0.39	−0.10	0.26	0.33	−0.07
Body Mass Index (BMI)	18.37	18.59	**−0.22**	19.60	21.17	**−1.57**	19.81	19.85	−0.04
Mid-upper arm circumference (MUAC)	23.00	23.05	−0.05	24.06	25.68	**−1.62**	23.09	23.34	**−0.25**

Notes: 'Difference' is the difference between participant (treated) and non-participant (control) households. Differences that are statistically significant at the 5% level are in bold. Incidence of food poverty (FP) is calculated using BBS cut-offs of 2,122 kcal/person/day and 1,805 kcal/person/day (for absolute and hardcore food poverty, respectively).

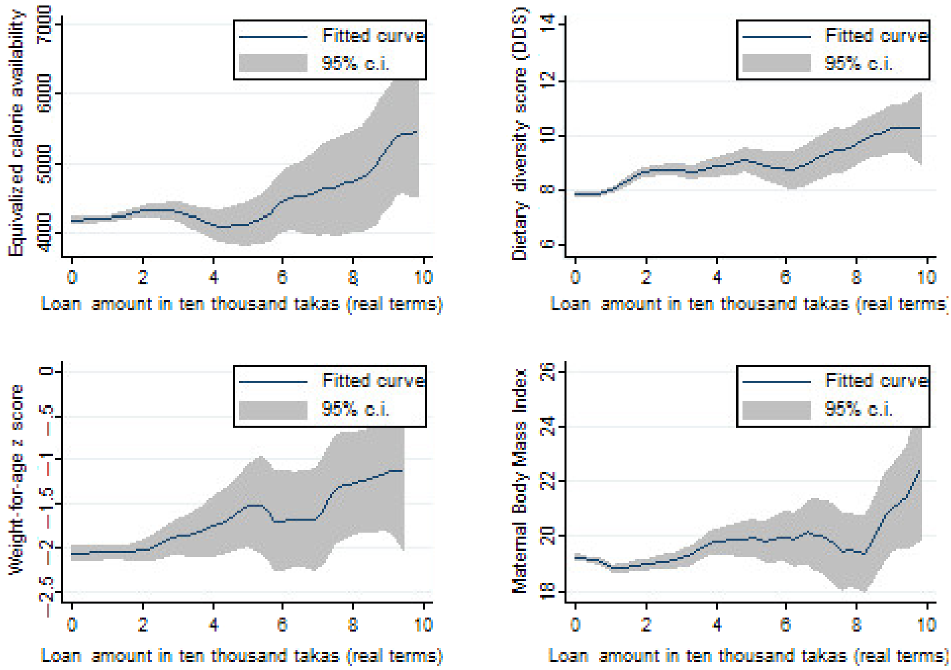

Figure 1. Non-parametric relationship between microcredit and indicators of household food security

***Note*:** Household calorie availability is expressed as kilocalories. Dietary Diversity Score accounts for the number of food groups consumed by the household and ranges from zero (representing a 'non-diverse' diet) to 12 (a 'diverse' diet). A child under the age of 5 years is considered to be underweight if its weight-for-age *z*-score is less than −2.

where FS_{jt} represents the different indicators capturing both the incidence and extent of food insecurity of household j at time t and H_{jt} is a vector of household level characteristics. α_j captures household-level fixed effects while $\lambda\tau_t$ represents the year fixed effects. ε_{jt} is the household specific error term, which is non-systematic and varies across households. P_{jt} denotes the microcredit programme participation status of household j in year t. We are particularly interested in the sign, and value, of the parameter θ. The parameter θ denotes the effect of programme participation on different indicators of household food security.

We also use the log of the amount of microcredit loan borrowed as an additional measure of participation. The latter captures the marginal impact of additional loans borrowed from microcredit. It uses the variation of loans across different groups of borrowers, rather than simply comparing between treatment and comparison groups. Hence, the two measures of participation capture different effects of interest. As microcredit borrowers receive larger loans after successfully repaying previous loans, higher loan amounts indicate longer-term participation. Hence, P_{jt} also indirectly measures the effects associated with duration of participation in the microcredit programme. When we use (log of) the loan as the participation measure (P_{jt}), a positive and significant coefficient on θ means that there are benefits associated with larger loan size or longer-term participation.

We control for unobserved household level characteristics using household level fixed effects. We use year fixed effects to capture macro-economic shocks and prices that could potentially affect the household's food security. To account for any correlations in errors across villages and year, we compute clustered–robust standard errors at the village-year level. As we use household level fixed effects, we only include a subset of all household level characteristics that vary over time. The control variables used in the regression model are age of household head, number of working-age people in the household, size of the household, highest education achieved by any household member, total arable land (in decimals), number of children (aged 0–15 years), number of women in the household, number of old people in the household (aged 60 years and above), number of married people in the household and gender of the household head.

To check the robustness of our results, we also estimate our model by considering only eligible households, selected based on the eligibility criterion set by MCI officials. We re-run equation (5) using only eligible households. This makes it possible for us to assess the impact of microcredit programme participation by comparing participating households to only those households who have never participated, but are eligible.

5. Results and Discussion

The PSM results for equation (5) are presented in Tables 2 and 3. Table 2 shows the effect of programme participation on absolute calorie availability, incidence of food poverty and dietary diversity among households in rural Bangladesh, while Table 3 presents the results for the nutritional status of children under the age of 5 years and women of reproductive age (15–49 years). As we are primarily interested in examining whether participation in microcredit programmes affects the food security situation of households, in each of the tables we only report the relevant coefficient, $\widehat{theta}$. However, as discussed above, each specification includes a full set of controls and includes year and household fixed effects.

5.1. Impact on calorie consumption and incidence of food poverty

The results in Panel A of Table 2 show that microcredit programme participation significantly increases calorie availability and reduces incidence of food poverty at the household level. Household's equivalised calorie availability increases by 3%, suggesting that households do benefit from microcredit participation in terms of calorie availability.[11]

The impact of loan amount is also positive and significant implying that calorie availability is highly responsive to increases in available resources resulting from increased access to microcredit. Access to microcredit generates investment-led and insurance-led benefits, which implies that access to microcredit is generating additional income or is helping households stabilise their income. Moreover, many loans

[11]The results with a full set of controls are presented in the online Appendix-1, Table S2. The results for the impact of microcredit on absolute calorie availability are robust to the use of the different measures of per-day calorie availability: household calorie availability per day increases by 3%, *per capita* calorie availability per day by 2% or the use of equivalised calorie availability calculated using square root of household size, which improves by 2%. These results are available upon request.

Table 2
PSM-regression results: Effects on calorie availability, incidence of food poverty and dietary diversity

Variables of interest	Log of equivalised calorie availability per day		Hard-core food poverty		Absolute food poverty	
Panel A: Household calorie availability						
Participation status	0.03*		−0.04**		−0.01	
	(0.02)		(0.02)		(0.02)	
Log of loan amount		0.05***		−0.06***		−0.06***
		(0.01)		(0.01)		(0.01)
Observations	7,420	3,638	7,445	3,640	7,445	3,640
R^2	0.07	0.10	0.15	0.18	0.15	0.18
Number of households	2,692	1,837	2,692	1,837	2,692	1,837

Variables of interest	Food Variety Score (FVS)		Dietary Diversity Score (DDS)	
Panel B: Household dietary diversity				
Participation status	−0.20		−0.12	
	(0.32)		(0.12)	
Log of loan amount		0.47**		0.21***
		(0.24)		(0.08)
Observations	8,020	3,880	8,020	3,880
R^2	0.30	0.32	0.25	0.28
Number of households	2,694	1,869	2,694	1,869

Notes: All specifications include the following covariates: age of household head, number of working age people in the household, size of the household, highest education achieved by any member, total arable land (in decimals), number of children aged 0–15 years, number of women in the household, number of old people in the household, gender of household head and number of married people in the household. All specifications also control for year and household fixed effects. We correct standard errors for village–year clusters. Clustered standard errors are presented in parentheses. ***$P < 0.01$, **$P < 0.05$, *$P < 0.1$. Loan Amount is in ten thousand taka in real terms. We have used the 'OECD-modified equivalence scale' as proposed by Hagenaars *et al*. (1994) to calculate equivalised calorie availability, which assigns a value of 1 to the first adult, then 0.5 to each additional adult member and 0.3 to each child. Incidence of food poverty is calculated using BBS cut-offs of 2,122 kcal/person/day and 1,805 kcal/person/day (for absolute and hardcore food poverty, respectively). The exclusion criteria for *per capita* per day calorie availability (used for food poverty) are 500 kcal and 5,000 kcal, following Headey and Ecker (2013). Food Variety Score (FVS) is a measure of the number of food items while Dietary Diversity Score (DDS) accounts for the number of food groups consumed, based on the 12 scale FANTA-HDDS.

obtained by poor households are also used for consumption, mainly for food (Zeller and Sharma, 2000). Microcredit allows low-income households to augment their otherwise meagre resources and acquire adequate food and other basic necessities. Intuitively, it is expected that calorie intake of the poor (at the lower end of the income distribution) will respond positively to increased expenditure, but as expenditure increases further the elasticity will decline, possibly to zero, or even become negative at

Table 3

PSM-Regression results: Effects on nutritional status of children and women of reproductive age

	Severe stunting		Total stunting		Severe wasting		Total wasting		Severe underweight		Total underweight	
Panel A: Child nutrition status (0–59 month old)												
Participation status	−0.16**		−0.20**		−0.07**		0.10		0.07		−0.27***	
	(0.07)		(0.09)		(0.04)		(0.10)		(0.06)		(0.06)	
Log of loan amount		−0.00		−0.09		0.00		0.01		−0.04		−0.02
		(0.03)		(0.07)		(0.03)		(0.09)		(0.06)		(0.05)
Observations	1,319	766	1,319	766	1,273	746	1,273	746	1,463	839	1,463	839
R^2	0.08	0.16	0.09	0.12	0.07	0.06	0.07	0.12	0.05	0.09	0.11	0.11
Number of households	994	595	994	595	973	580	973	580	1,087	638	1,087	638
	Body Mass Index (BMI)		Incidence of chronic Underweight		Incidence of Underweight		Mid-upper arm circumference (MUAC)		Severe malnutrition		Total malnutrition	
Panel B: Nutrition status of women of reproductive age (15–49 years)												
Participation status	0.09		−0.01		−0.06***		0.09		−0.02		−0.01	
	(0.10)		(0.01)		(0.02)		(0.10)		(0.02)		(0.02)	
Log of loan amount		0.19***		−0.02		0.01		0.16**		−0.01		−0.04**
		(0.07)		(0.01)		(0.01)		(0.08)		(0.01)		(0.01)
Observations	4,116	2,219	4,116	2,219	4,116	2,219	4,052	2,178	4,052	2,178	4,052	2,178
R^2	0.22	0.22	0.03	0.06	0.14	0.14	0.07	0.06	0.04	0.05	0.03	0.04
Number of households	2,235	1,422	2,235	1,422	2,235	1,422	2,216	1,400	2,216	1,400	2,216	1,400

Notes: All specifications include the following covariates: age of household head, number of working age people in the household, size of the household, highest education achieved by any member, total arable land (in decimals), number of children aged 0–15 years, number of women in the household, number of old people in the household, gender of household head and number of married people in the household. All specifications also control for year and household fixed effects. Panel A also includes age and gender of the child, while Panel B also includes age, marital status of the individual, education level (illiterate, can read only, can sign only, can read and write), and family type (extended or not). We correct standard errors for village–year clusters. Clustered standard errors are presented in parentheses. ***$P < 0.01$, **$P < 0.05$, *$P < 0.1$. Loan amount is in ten thousand taka in real terms. Total is defined as either moderate or severe. The exclusion criterion used for child malnutrition in Bangladesh is as follows – for weight-for-height z-scores (wasting) it is −4 and 5, for weight-for-age (underweight) −5.66 and 2.34 and −5.75 and 2.25 for height-for-age (stunting) using BBS/UNICEF (2007, table 3). Chronic underweight is below a BMI of 16, while underweight is below BMI 18.5, following WHO (1995) and BBS/UNICEF (2007, table 2). All BMIs lie within the recommended limits of 12 and 40 for Bangladesh, following BBS/UNICEF (2007).

high enough expenditure levels (Behrman and Deolalikar, 1987; Strauss and Thomas, 1995). The overall results presented in Table S3 of the online Appendix, point to the possibility that the calorie-income curve is sufficiently non-linear in rural Bangladesh, thus leading to significant increases in calorie availability for low income households.

The results in Panel A of Table 2 also suggest that compared to non-participants, participating households are more likely to meet the minimum dietary energy requirements. We find robust evidence that participation in MCI programmes significantly lowers the probability of being food-poor, however, it disproportionately benefits those suffering from hard-core poverty. Incidence of hard-core food poverty[12] is reduced by 4%, however, we find no effect of participation on absolute food poverty. We also find robust evidence that microcredit (measured as loan amount) reduces the likelihood of food poverty as the coefficient on incidence of food poverty is negative and significant, irrespective of the cut-off used.

One reason why the impact of programme participation on absolute food poverty is insignificant could be that participation status improves calorie intake up to a certain point, but once that basic calorie need is satisfied, economic benefits do not get translated into increased calorie consumption. Instead, households diversify into higher-value micronutrient-rich foods. At this calorie threshold, non-food items, such as education and healthcare, may also receive preference over food items. In general, the results in the top panel of Table 2 imply that participation in microcredit programmes benefits households both at the intensive (calorie consumption) and extensive margins (likelihood of being food poor), particularly for those who are most vulnerable to food insecurity.

5.2. *Impact on dietary diversity indicators*

The impact of microcredit programme participation on different indicators of household dietary diversity is presented in the bottom panel of Table 2. When food security is measured in terms of dietary diversity indicators, programme participation is found to have a mixed impact, depending on the definition used to define participation. The overall results suggest that participation status does not have any significant impact on the standard measures of diversity in the household diet. It appears that additional income generated from participation in MCIs is only leading to increased calorie availability, rather than having a positive effect on household dietary diversity. However, increased access to microcredit through increased loan amount does significantly increase household dietary diversity (see also Table S3 in the online Appendix). Below a certain threshold level of expenditure, households concentrate on acquiring additional calories (without corresponding increase in diversity); however, once that level is met, further increases in expenditure (through increased loan amount in this case) might cause both calories and dietary diversity to increase (Behrman and Deolalikar, 1987).

[12]These results are also robust to the use of different definitions of calorie cut-off used. We find evidence that programme participation also significantly reduces the incidence of food poverty, defined by a calorie cut-off of 1,770 kcal/person/day following FAO/WHO/UNU (2004), which lies significantly below the cut-off used to calculate hard-core food poverty by BBS. The results are available upon request.

5.3. Impact on nutritional status of children and women of reproductive age

Next, we report the results for the effect of programme participation on the nutritional status of children and women of reproductive age. Panel A in Table 3 presents the results for child nutritional status, while Panel B presents results for the nutritional status of women of reproductive age. The coefficients in Panel A of Table 3 show that programme participation is associated with significant decline in the prevalence of stunting among children under the age of 5 years. MCI participation reduces the prevalence of severe stunting by 16% as well as total stunting by 20%. The significant effects on stunting may be explained by the fact that stunting represents chronic or long term undernutrition, which is a consequence of prolonged food deprivation. This can be intergenerational, in which poor nutrition of the mother results in low stature of the offspring via the effects of intrauterine growth retardation (Victoria *et al.*, 2008). Stunting can also result from food deprivation in the first 2 years of life (Steckel, 2008).

However, participation in microcredit status does not have the same effect on wasting. Microcredit reduces the incidence of severe wasting by 7%. The corresponding coefficient is statistically significant. When we consider the effects total wasting we do not find any statistically significant effect. The results for underweight status presented in the last two columns of Panel A of Table 3 reveal that participation in MCI reduces the likelihood of being underweight (total) by 27%, but has no impact on the likelihood of being severely underweight. The loan amount does not have any impact on any of the three anthropometric indicators.

We examine the effect of microcredit programme participation on nutritional status of women of reproductive age in Panel B of Table 3. The results suggest that women of reproductive age in households that are participating in microcredit programmes experience a significant decline in the incidence of being underweight – participation in MCI significantly reduces the prevalence of undernutrition among women of reproductive age by reducing the probability of being underweight by 6%. However, the estimated coefficients of programme participation on the level of BMI and MUAC of reproductive age are insignificant. This result may suggest that, in general, the extent of malnutrition among women is caused more by gender related discrimination than economic deprivation (Mangyo, 2008). Interestingly, access to additional resources in the form of larger loan amounts from MCIs do have a significant positive effect on nutrition status of women of reproductive age, measured in terms of BMI and MUAC.

We also estimated equation (5) using the standard fixed effects regression which uses the full sample. The results are very similar to those presented in Tables 2 and 3. The results corresponding to the PSM regression results in Table 2 are presented in Table S4 in the online Appendix. Microcredit programme participation is found to have a significantly positive impact on equivalised calorie availability per day (increases by 3%) and negative effect on the incidence of hard-core food poverty, which declines by 4%. We also do not find any significant effect of participation status on household dietary diversity, but the size of the microcredit loan is found to have a significant and positive effect on household dietary diversity, measured in terms of food variety and dietary diversity scores. The results corresponding to the PSM regression results in Table 3 are reported in Table S5. The results are similar to those in Table 3. We find evidence that participation in microcredit programmes reduces the prevalence of stunting and malnutrition among children aged below 5 years and the incidence of being underweight among women of reproductive age.

We also re-run equation (5) on the eligible households and present the results in Tables S6 and S7 in the online Appendix. The results presented in Table S6 and S7 are very similar to those reported in Tables 2 and 3. Comparing Table S6 with Table 2, the coefficient on participation status in Table S6 ceases to be significant for household's equivalised calorie availability and hard-core food poverty, but the sign and significance of the other variables are the same in Table S6 as in Table 2 and the magnitude of the coefficients of those variables that are significant are quite similar. Comparing Table S7 with Table 3, the sign and significance of the variables in Panel A are the same and the magnitudes of the coefficients are similar. The results in Panel B are also very similar across the two tables. The only differences are that participation status has a significant effect on reducing severe malnutrition in Table S7, but not in Table 3. Overall, the results presented in this paper are therefore robust to the estimation methodology used.

5.4. Impact of duration of programme participation on food security

We also examine whether the length of membership of a microcredit programme affects food security of the household. The return from microcredit is likely to vary with the length of participation. Microcredit borrowers receive larger amount loans as their length of participation increases and they maintain satisfactory progress in loan repayment. Hence, households may not realise the full returns until they receive larger loans to finance their investments. For this reason, results from solely short-term evaluations are likely to bias the overall impacts of the programme. To address this issue we follow Islam (2011), and categorise households based on their length of participation. Islam (2011) addresses potential selection bias as the participants who became members earlier could differ from those who join later. We follow a similar classification of households based on the length of their participation. We run equation (5) for different groups of participants where the measure of participation is the log of the amount of the loan borrowed in each year.

Accordingly, we define the first category as the 'continuing participants', who were regular microcredit participants in each of the three rounds. The second category is the 'newcomers', who were not microcredit participants in the first round, but joined before the third round or between the third and fourth rounds. The third category is the 'leavers', who were microcredit participants in the first round, but dropped out before the third round or between the third and fourth rounds. The final category is the 'drifters', who are occasional clients of MCIs, who do not fit readily into any of the first three categories. In our dataset across the three rounds, 47.2% were continuing participants, 14% were newcomers 1, 22.3% were leavers and 16.5% were drifters.

Results for each of these categories are presented in Table 4. We find significant differences in household-level food security, measured in terms of calorie availability and incidence of food poverty, across categories of programme participants. We find a significant effect of the amount of microcredit on absolute calorie availability and food poverty for continuing participants, which is robust across all specifications. The results presented indicate that a 1% increase in the amount of loan borrowed by continuing participants from a MCI could increase their calorie availability by 4% and

Table 4
Impact of the duration of programme participation on calorie availability, incidence of food poverty and dietary diversity

Variables of interest	Log of equivalised calorie availability per day	Hard-core food poverty	Absolute food poverty	Food Variety Score (FVS)	Dietary Diversity Score (DDS)
Continuing participants	0.04***	−0.06***	−0.05***	0.52**	0.22**
	(0.01)	(0.01)	(0.01)	(0.26)	(0.09)
Drifters	0.05**	−0.05	−0.06*	0.33	0.15
	(0.03)	(0.03)	(0.03)	(0.35)	(0.12)
Newcomers	0.09**	0.02	0.03	−1.72*	−0.50
	(0.03)	(0.07)	(0.06)	(0.98)	(0.31)
Leavers	0.01	−0.05	−0.07*	0.45	0.21
	(0.03)	(0.04)	(0.04)	(0.35)	(0.13)

Notes: All specifications include the following covariates: age of household head, number of working age people in the household, size of the household, highest education achieved by any member, total arable land (in decimals), number of children aged 0–15 years, number of women in the household, number of old people in the household, gender of household head and number of married people in the household. All specifications also control for year and household fixed effects. We correct standard errors for village–year clusters. Clustered standard errors are presented in parentheses. ***$P < 0.01$, **$P < 0.05$, *$P < 0.1$. We have used the 'OECD-modified equivalence scale' as proposed by Hagenaars *et al.* (1994) to calculate equivalised calorie availability, which assigns a value of 1 to the first adult, then 0.5 to each additional adult member and 0.3 to each child. Incidence of food poverty is calculated using BBS cut-offs of 2,122 kcal/person/day and 1,805 kcal/person/day (for absolute and hardcore food poverty, respectively). The exclusion criteria for *per capita* per day calorie availability (used for food poverty) are 500 kcal and 5,000 kcal, following Heady and Ecker (2013). Food Variety Score (FVS) is a measure of the number of food items while Dietary Diversity Score (DDS) accounts for the number of food groups consumed, based on the 12 scale FANTA-HDDS.

reduce the incidence of hard-core and absolute food poverty by 6% and 5%, respectively.

For leavers, however, we do not find evidence of any positive impact of MCI participation on food security, except for an impact on absolute food poverty, which may suggest that households do not gain from ceasing to be members of an MCI. It is understandable that there is no impact on food security since they participated in a MCI for a short term only, which did not allow them sufficient time to realise the gains in terms of improved economic access.

The results for newcomers are somewhat mixed. The impact on food security, measured in terms of calorie availability, is larger for newcomers than for continuing participants. The increase in calories may come at the expense of diet quality as there is a reduction in the FVS score for newcomers. The overall results imply that the marginal impact of microcredit on calorie availability is slightly lower for continuing participants. This could also mean that microcredit programme participation motivates households to act in a more responsible manner (Gamble and Prabhakar, 2005) such that continuing participants also invest in self-employment that increases household income and mitigates risk, instead of investing further resources in calorie consumption. It is also to be noted that on average continuing participants have a higher level of food availability. In 1997–98, they had an equivalised calorie availability of 4,555.22 kcal as opposed to 4,457.33 kcal for newcomers. Hence, continuing participants need not increase their calorie availability as much as other participants, such as newcomers, who gain 9% in terms of increase in calories for every 1% increase in microcredit.

6. Conclusion

Despite the growth in food production and its availability, food insecurity is still a major problem in rural Bangladesh, particularly during the lean seasons when employment opportunities are sparse. Ability to borrow from MCIs assists households to diversify into self-employment based activities, whose returns do not vary much with agricultural production, thus smoothing consumption and improving household food security.

We examined, for the first time, the impact of microcredit programme participation on several indicators of food security. We focus on three different measures; namely, calorie availability – both at the extensive margin (incidence of food poverty) and intensive margin (absolute calorie availability), anthropometric indicators (both women and child nutritional status) and dietary diversity indicators. Three main conclusions emerge. The first is that programme participation and the amount of the loan improves calorie availability and reduces the incidence of food poverty, at least the incidence of hard-core poverty; however, microcredit programme participation, in itself, does not appear to increase dietary diversity.

Second, if food security is measured in terms of anthropometric indicators, evidence is mixed. Microcredit participation decreases the incidence of stunting among children under the age of 5 years suggesting that participation significantly improves long-term child health. The effect of microcredit participation on child wasting and being underweight is, however, weak and mixed. Women of reproductive age who participated in MCIs were less likely to be underweight, but participation status has no effect on the level of BMI and MUAC. The loan amount however has a significant positive effect on both indicators.

Finally, the findings from the impact of duration of programme participation, suggest that the effect of programme participation on food security might be non-linear over time. In the short run, MCI participation has no significant effect on food security, measured in terms of calorie consumption or food poverty, before improving food security in the long run. Continuing participants are found to benefit significantly and consistently across all measures of household food security used in the analysis. More generally, these findings point to the importance of using longer-term programme participation data to evaluate the effects of microcredit.

Supporting Information

Additional Supporting Information may be found in the online version of this article:

Table S1. Descriptive statistics for full sample and eligible households.

Table S2. Propensity Score Matching – Regression results with full set of controls.

Table S3. Variation in impact of microcredit programme participation by household asset holding.

Table S4. Regression results: Effects on calorie availability, incidence of food poverty and dietary diversity.

Table S5. Regression results: Effects on nutritional status of child and women of reproductive age.

Table S6. Regression results for eligible households only: Effects on calorie availability, incidence of food poverty and dietary diversity.

Table S7. Regression results for eligible households only: Effects on nutritional status of children and women of reproductive age.

Table S8. Results of the Propensity Score Matching balance test.

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