Intergenerational Health Effects of Adult Learning Programs: Evidence from India*

Opinder Kaur[†]

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Abstract

I estimate the impact of a large-scale adult learning program on child health. Beginning in 2009, the government of India phased in an education campaign targeting rural women in districts with an adult female literacy rate of 50 percent or below. I exploit the exogenous variation created by the program implementation in a regression discontinuity framework using a nationally representative household survey. I find that children whose mothers are eligible for the program are less malnourished, with improved health outcomes measured by height-for-age and weight-for-age z-scores. The results are likely driven by increased diversity in children's diets and higher labor force participation of mothers. I do not find evidence for changes in fertility behavior and utilization of healthcare services. The results translate to a large social gain induced by favorable child health outcomes, suggesting additional scope for well-designed adult learning programs in developing countries to raise overall welfare.

JEL: I12, I15, I28, J13, O12

KEYWORDS: Adult learning programs, Child health, Z-scores, Regression discontinuity design

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[†]University of California, Riverside (email: okaur001@email.ucr.edu)

1 Introduction

Female education is one of the prime correlates of child health and well-being across and within countries, strongly associated with lower infant mortality and other measures of child health (Grossman 2006). The existing literature provides causal evidence in favor of improvement in child health by exploiting various exogenous variations such as compulsory schooling (Grytten et al. 2014), age-at-school entry policies (McCrary and Royer 2011), and other supply-side factors like the availability of schools (Breierova and Duflo 2004; Chou et al. 2010; Grépin and Bharadwaj 2015) or colleges (Currie and Moretti 2003). Yet very little attention has been paid to widespread adult learning programs primarily focusing on women with negligible education levels, who constitute two-thirds of the world's illiterate population. Such programs could make a significant impact in promoting women's empowerment and improving child health outcomes. However, the benefits they provide to children are not extensively studied.

This paper presents the first causal evidence of an adult learning program on child health in the context of the rural population. I do so by analyzing *Saakshar Bharat Mission* (SBM), aiming to promote and strengthen adult education, especially for women. SBM was the largest nationwide learning campaign launched by the federal government of India in collaboration with the state governments. The program lasted for over eight years and explicitly prioritized female participation to reduce gender inequality in education. Around 68 percent of the program beneficiaries were women (Ministry of Human Resource Development 2018).

I identify program effects on child health by taking advantage of the discontinuity created by the program eligibility rule. The rural districts with an adult female literacy rate of 50 percent or below, based on the 2001 Census of India, were eligible to participate. It created a discontinuity in the probability of receiving the treatment, that is, participating in the SBM program, around the literacy rate threshold. I leverage this variation in a regression discontinuity framework comparing outcomes for children born to eligible and ineligible mothers within a small window around the cutoff. Identification relies on the assumption that all unobserved determinants of child health evolve smoothly across the threshold. I accessed official data to identify the program's launch in eligible districts. I then link this information with data on mothers and children and their associated outcomes in the Demographic Health Survey (DHS). The analysis sample includes individuals in rural districts from 2010 to 2016.

I find that district-wide access to SBM improves child health (measured by z-scores) and reduces undernutrition. Specifically, children born to program-eligible mothers are taller and heavier for their age, which translates to an improvement of around 18 to 20 percent. Children are ten percentage points less likely to be moderately underweight. I find no change in fertility behavior for mothers, indicating no evidence for endogenous births. Since I do not observe actual program enrollment, these estimates capture the intent-to-treat (ITT) effects of the adult learning program.

The findings are robust to sensitivity tests, including bandwidth choices, polynomial specifications, local linear estimation, clustering assumptions, sample compositions, and placebo treatment effects. In addition, I employ a difference-in-discontinuity design, and the estimators generate consistent results. To shed light on the causal mechanism, I examine several pathways in improving child health measures. The results appear to be driven by diverse diet intake for children. I also find evidence for mothers' greater labor force participation, potentially contributing to children's diverse dietary patterns. I do not find evidence of higher utilization of healthcare services.

I conduct back-of-the-envelope calculations and find that the social gains due to improved child health outcomes can be as large as $458.5 million (in 2018 US dollars). It is a lower bound gain due to the fall in disease burden, and it excludes the induced long-term benefits such as higher schooling attainment, productivity gains, better labor market outcomes, and lower adult healthcare expenditure (Kakietek et al. 2017).

This paper is a part of the growing literature on evaluating the effects of mass adult learning programs on nonmarket outcomes. The empirical evidence reveals that most of these programs could bring only modest improvement in reading and numeracy skills for adults (Abadzi 2003; Aoki 2005; Carron 1990; Ortega and Rodríguez 2008). Despite limited improvement in literacy skills, recent research suggests that these programs impact a wide range of other positive outcomes, including higher household income, increased civic awareness and self-confidence, better adult health, and increased labor market participation (Abadzi 2003; Aoki 2005; Aker et al. 2012; Okech et al. 2001; Oxenham et al. 2012; Blunch 2009). In Ghana, Blunch (2013) uses an adult literacy program to find that program participation is associated with lower child mortality. To the best of my knowledge, this is the first paper providing causal evidence and exploring underlying mechanisms in a setting with extremely high rates of stunting and underweight paired with high rates of gender disparity. In India, 31% of children under five years of age are stunted, and 33.4% are underweight.[1] Additionally, the estimation methodology that I employ in this study addresses the potential endogeneity of maternal education decisions.

I also contribute to the literature on the role of maternal education in improving intergenerational health outcomes. Evidence suggests that educated mothers have greater knowledge to combine health inputs in producing child health and have greater efficacy in producing positive health outcomes from a given set of inputs (Grossman 2006). The majority of existing studies are focused on developed countries (Currie and Moretti 2003; Grossman 2006; Grytten et al. 2014; Lindeboom et al. 2009; Lochner 2011; McCrary and Royer 2011). An associated burgeoning set of studies in a developing world setting evaluates the impact of increased access to schooling (Breierova and Duflo 2004; Güneş 2015; Keats 2018; Andriano and Monden 2019; Shrestha 2019) and the role of different levels of education (Chou et al. 2010; Duflo et al. 2015; Grépin and Bharadwaj 2015). However, not all the studies come to the same conclusions regarding improving intergenerational health outcomes.[2]

From a policy perspective, findings from this study provide evidence in favor of effectively designing large-scale adult learning programs with particular targets on the rural population in developing countries. Given the crucial link between maternal education and child health, such interventions could promote labor force participation as well as child health. This substantial benefit is often not adequately quantified.

The rest of this paper is organized as follows. Section 2 provides a brief history of adult education programs in India and discusses the SBM program, and section 3 describes the data. Section 4 presents the methodology, section 5 discusses the corresponding results, and section 6 concludes.

[1]Data accessed from the World Health Organization (WHO) Global Health Observatory data repository.

[2]Chou et al. (2010), Currie and Moretti (2003), Grossman (2006) and Lundborg et al. (2014) have found a positive effect of maternal education on infant and child health outcomes whereas Arendt et al. (2021), McCrary and Royer (2011) and Lindeboom et al. (2009) found little to no effect on the health of infants, children and adolescents. A detailed investigation of literature by Grossman (2015) concludes that there is conflicting evidence of whether more schooling causes better health outcomes.

2 Background

2.1 Context

India accounts for 37 percent of the world's total adult illiterate population (UNESCO 2014). Since 1961, the country has shown growth in the adult literacy rate (Figure 1–Panel A).[3] However, despite the notable improvement, there still exists a concerning gender disparity between men (79 percent) and women (59 percent). The male-to-female literacy ratio stood at 1.33 in 2011, whereas a ratio equal to one indicates gender equality in literacy (Figure 1–Panel B). Illiteracy among women, especially in rural areas, continues to remain a challenge for India. Multiple reasons contribute to the country's low female literacy rate. A complex sociocultural stratification, deep-rooted patriarchal norms, lack of awareness among the poor, and growing economic divide often impede women's education (Govinda and Biswal 2006). The ineffectiveness of primary schools in enrolling and retaining students, accessibility to schools, technological barriers, and inadequate school facilities further worsens the situation (UNESCO 2003). It is further challenging to incentivize rural women to spend time on education because of the competing use of time and the long-run nature of returns on education (Abadzi 2003).

Since gaining independence in 1947, the Indian government has consistently worked to promote adult education in the country. The government launched significant initiatives in almost every decade: Social Education Program (1952), Farmers' Functional Literacy Program (1968), National Adult Education Program (1978), and National Literacy Mission (1988). However, critics labeled most programs as sporadic and with limited coverage, except National Literacy Mission (Ramabrahmam 1989). The launch of the National Literacy Mission program in 1988 created a favorable policy environment for adult education by targeting non-literates between 15–35 years of age. With an increase in literacy rate from 48 percent (1991) to 61 percent (2001), the program was labeled successful (Figure 1–Panel A). Despite noteworthy achievements, a careful examination reveals striking gender disparity and wide variation across states (Govinda and Biswal 2006). This demanded more concerted efforts to make the learning objective inclusive.

[3] UNESCO defines the adult literacy rate as the percentage of the population aged 15 years and above who can read and write a simple sentence with understanding.

2.2 Program description

Saakshar Bharat Mission (SBM) was the world's most extensive learning program launched in September 2009 on International Literacy Day. The flagship campaign aimed to promote adult education and reduce the gender gap. The program targeted rural adults of age 15 and older, as around 84 percent of India's non-literate live in rural India (2001 Population Census). SBM catered varying needs of individuals by providing basic literacy and numeracy to non-literate and non-numerate adults and equivalent formal education for neo-literates. In addition, the program provided skill training to participants, such as relevant skill development imperative in improving individuals' working and living conditions and information on health, sanitation, hygiene, agriculture, animal husbandry, and other social and cultural issues. It was described as a "people's program" because of its implementation approach and due to its close work with local communities (Kairies 2013). Being one of the largest skill-providing initiatives in India, SBM received a 'good' assessment rating for its performance in design, implementation, and impact (Bhandari et al. 2018).

SBM prioritized female participation with a prime focus on adolescent girls and women (Ministry of Human Resource Development 2009). More than two-thirds of the 76 million beneficiaries were females, i.e., around 52 million (Ministry of Human Resource Development 2018). Women from scheduled castes, scheduled tribes, minorities, and other disadvantaged groups were given preference. A large number of women volunteers and instructors were engaged to foster women's participation in the learning program. In addition, the teaching-learning materials were designed taking into account the gender, social and cultural barriers that women face.

The program was introduced in 2009 and completed in 2018. It was rolled out in a phased manner for optimum finance utilization. The districts with an adult female literacy rate of 50 percent and below, as per the 2001 Census of India, were eligible to receive the treatment. Based on the eligibility criteria, 410 districts qualified for the program (Figure A-1). However, the exact allocation rule for assigning districts into phases was not made public. Figure 2 presents a color-coded map of districts that received treatment across phases during the period under study (2010–2016).

An adult education center (AEC) was set up in every village to run the program, managed by two coordinators, of which at least one was a woman (Figure A-2). For the program instructions, locals were hired as literacy educators (volunteers) who received training before and during their instruction. On average, an educator was assigned 8 to 10 learners in a class and around 30 learners in a year. An AEC functioned for around 8 hours every day, and each group of learners attended classes for two to three hours per their availability. The participants (learners) were identified through a survey and received tuition, usually for 300 hours. Figure A-3 presents detailed information about the infrastructural build-up for smooth implementation of the SBM program.

The program curriculum included core content per the National Curriculum Framework for Adult Education. In addition, locally relevant content was added to the curriculum that included but was not limited to learners' livelihood challenges, personal and community development, gender equality, democracy, and local self-government. The adult educators and subject experts developed the learning material by identifying the needs and interests of learners. The Quality Assurance Committee then scrutinized the material. Upon final review, the material was field-tested, and revisions were undertaken before standardizing the teaching material.

Upon completion of instructional learning, participants had to take the Basic Literacy Assessment Test conducted by the National Institute of Open Schooling (NIOS).[4] The assessment tests were framed per NIOS guidelines, and were conducted twice a year, once in March and then in August. A three-hour exam tested the learners' reading, writing, and arithmetic skills. Those who successfully passed the test were issued certificates within 60 days, and the results were made available on the NIOS website.

2.3 Effect of Program Participation

Participation in the SBM program could directly affect job prospects for women through education and vocational training, such as making handicrafts, candles, etc. The availability of more financial resources could improve children's development, including better health indicators. Another channel that could potentially improve child health is knowledge gain. Evidence

[4]The National Institute of Open Schooling (NIOS) was established in November 1989 and is an autonomous organization formed by the Ministry of Human Resource Development(MHRD), now renamed as Ministry of Education, Government of India.

suggests that an educated mother can play a significant role in improving a child's health through timely decision making, positive health behavior, providing a nutritious diet, and efficient management of financial resources (Grossman 1972; Grossman 2006). I explore the effect on child health measured by anthropometric z-scores for children below five years of age. The purpose of focusing on this age group is that the early years of life are critical in molding various health and social outcomes throughout life (Irwin et al. 2007). In addition, I investigate the potential underlying channels if there was any improvement in functional literacy and evaluate the impact of skill development training on labor force participation. To do so, I restrict the analysis sample to women living in rural areas with either no education or incomplete primary education, who were the program's target population.

Qualitative evidence suggests that the program was successful in raising the overall literacy rate and closing the gender gap in the country (Hanemann et al. 2015; Kairies 2013; Bhandari et al. 2018). The rural adult literacy rate for females has increased from 47 percentage points in 2008 to around 59 percentage points in 2018 (Figure 1–Panel C).[5] The corresponding male-to-female literacy ratio is approaching one, implying moving closer to gender equality (Figure 1–Panel D). Further investigation of rural districts where the SBM program was launched indicates that the adult female literacy rate grew from 35 percentage points in 2001 to 45 and then to 53 percentage points in 2011 and 2018, respectively.[6]

The program provided a favorable environment for the learners to participate (Ministry of Human Resource Development 2018). The flexible class timings and low time commitment would have avoided creating major work substitutions for the participants. The use of mass media like radio and television to reach out to the target population and the participation of locals in program planning and implementation would have also drawn a favorable response towards SBM. Besides that, the generous funding support from the federal government would have further thrust state governments into executing the program effectively.[7] Depending on how efficiently it was implemented in a village, participants might have had varying program

[5]Figure A-4 presents the state-wise number of female beneficiaries of the program.

[6]Based on author's calculations using Census of India data (2001 and 2011) and Periodic Labor Force Survey (2018).

[7]SBM was predominantly funded and overseen by the federal Ministry of Human Resource Development, but the program implementation was highly decentralized, with each district responsible for the regional planning. The share of funding was 75:25 between the Federal and the State governments, whereas, for the North-Eastern states, the ratio was 90:10. The eight North-Eastern states were given special category status as they needed special consideration because of mountainous and rugged terrain, low population density and a sizable tribal population, strategic location, economic backwardness, and the non-viable nature of state finances.

effects.

Although well-intentioned, it is not apparent that the program would have reached all women who were the intended beneficiaries. With rigid sociocultural norms in place and restrictions imposed by the patriarchal system, bringing women out of their homes to attain education does not seem easy (Govinda and Biswal 2006). It is further challenging to motivate the elderly because of a lack of interest in education with growing age (National Research Council 2012). Additionally, the program could have been restrained from reaching all the beneficiaries either due to administrative inefficiencies, mismanagement of funds, or lack of coordination among implementation authorities due to the massive country-wide scale of the program (Arya 2010).

3 Data

3.1 Survey and Sample Description

The main data source for this study is the Demographic Health Survey (DHS) conducted in 2015-16.[8] It is a nationally representative survey with a sample size of around 620,000 households across 640 districts in India. It is a stratified sample selected in two stages wherein, at the first stage, the enumeration areas are randomly selected from the 2011 census of India files. In the next stage, Households within each enumeration area are selected randomly from the household listing. Each district is separated into urban and rural areas for stratification. The Primary Sampling Units are villages in rural areas and Census Enumeration Blocks in urban areas.

The detailed dataset comprises information on population health and nutrition for states in India. All women aged 15 to 49 in sampled households are interviewed. Information on individual characteristics (birth year, location of residence, education level, age, caste, religion), childbirth (year of birth, child gender, birth order), and detailed information on healthcare services utilization (vaccination, prenatal and postnatal care) and household characteristics (assets ownership, availability of electricity, toilet facility, piped drinking water) are collected. The data collection process started in January 2015 and was completed in December 2016 (Figure 3). The last phase of SBM was rolled out in 2017-18. Since the data is available only

[8]This dataset is also known as the National Family Health Survey (NFHS-4).

until 2016, I exclude observations from such districts.[9]

The analysis period of the study is from 2010 to 2016. To study the functional literacy and vocational education components of SBM, I restrict the analysis sample to mothers living in rural areas with either no education or incomplete primary education. I also exclude the small number of individuals who were visitors in the rural areas.[10] Assuming a nine-month pregnancy period, on average, and at least three months of program duration, I exclude births within 12 months of the program implementation from the analysis sample. These are potentially partially treated births, that is, those mothers who would have received the treatment before the inception of pregnancy. However, results are robust to including these births, as shown in section 5.2.

I determine SBM exposure based on the child's birth month-year information and district of residence reported in the survey. Ideally, an individual should be considered a program beneficiary if her district of residence could be observed during program implementation. In principle, it might be different from the current place of residence, as individuals might self-select into the program. However, since the internal migration rates in India are among the lowest in the world, this distinction is unlikely (Bell et al. 2015). Additionally, migration in India is predominantly within-district (Topalova 2007; Atkin 2016; Kone et al. 2018).[11] Therefore, it is reasonable to use the current district of residence as a proxy for location at the time of treatment receipt. In other words, treatment assignment based on the district of residence is not likely to have a substantive bias due to endogenous selection.

[9]In phase-7, eleven districts were assigned to receive the treatment. These were seven districts of Punjab (Mansa, Firozpur, Bathinda, Barnala, Muktsar, Sangrur, and Faridkot) and four districts of Jharkhand (Khunti, Jamtara, Seraikela-Kharsawan, and Simdega). However, some of these districts did not receive the treatment due to administrative failure.

[10]I exclude Sikkim and Tripura states from the analysis as the governments of these states ended up implementing programs in all the districts despite the eligibility rule. The Naxal districts (affected by left-wing extremism) were also part of the program, despite the eligibility criteria. However, most Naxal districts had literacy rates below 50 percent and were eligible for the treatment, except five (Uttar Bastar Kanker, Rajnandgaon, Purbi Singhbhum, Gondiya, Paschim Medinipur). I exclude these five districts from the analysis.

[11]Two of the most prevalent reasons for migration in India are because of employment opportunities and the post-marriage movement specifically for women. The men often migrate from rural to urban regions for better employment opportunities. Migration due to marriage for women is primarily intra-district. After marriage, on average, a woman moves approximately 21 miles from her residence (Bloch et al. 2004). In 2009, the average size of an Indian district was approximately 1,900 square miles, as per the Census of India (2011). Other studies also point towards within-district marriages (Topalova 2007; Kone et al. 2018). Both of these reasons support the argument for within-district migration in India

3.2 Government Archival Records

Initially, the federal government assigned all eligible treatment districts into three phases. The state governments were handed over the implementation task in association with district-level authorities. However, many states did not follow the guidelines due to administrative discrepancies. It delayed the actual program implementation, and SBM was extended from 2012 to 2018. As this delay was observed in most districts, the earlier proposed timings of program launch were no longer accurate.

To obtain the actual month and year of SBM implementation, I accessed official data using the right to information (RTI) act, archival records from federal and state governments, and newspaper reports. I identify the accurate timing of program launches across districts using this information. Figure 3 shows the timeline for the SBM program rollout. I link this administrative data with the Demographic Health Survey (DHS) data for mothers and children at the district level. For this study, I define the dates at the month-year level.

3.3 Key Variables and Summary Statistics

The primary outcome of interest is the anthropometric z-scores, based on the World Health Organization (WHO) child growth standards, for children below five years of age: height-for-age (HAZ) and weight-for-age (WAZ). These are widely used indicators for key physiological measures to determine the extent of undernourishment among children. The z-scores are assigned through an interpolation function that takes into account sex, age, height (in centimeters), and weight (in kilograms).[12] As z-scores data are available only for births five years prior to the survey year, births before 2010 could not be added to the analysis. Supplementary outcome variables include the probability of being stunted, underweight, and infant mortality.[13] Stunting signifies chronic malnutrition in a child, whereas being underweight is a measure of chronic and acute malnutrition. To explore potential causal channels, I study the program's effects on mothers' literacy and labor force participation, diversity in children's diet, utilization of healthcare services, benefits received during pregnancy, advice received for child care, and

[12] The calculations for z-scores are performed using WHO Anthro program software. Children with an incomplete date of birth information are assigned special values. Children with HAZ below -6 SD or above +6 SD or WAZ below -6 SD or above +5 SD are flagged for invalid data. Such observations are excluded from the estimation sample (Assaf et al. 2015).

[13] Stunting is defined as children whose HAZ is below negative two standard deviations under the mean on the WHO growth standards. Similarly, the probability of being underweight is defined using WAZ.

behavioral changes such as smoking.

Table 1 presents descriptive statistics for the analysis sample comprising 6,488 unique children and 5,098 mothers in 114 districts.[14] Statistics are presented by the treatment eligibility status. In the overall sample, 73 percent of the women have no type of formal education, 27 percent of the women have incomplete primary education, around 69 percent of women are Hindu, and 50 percent belong to disadvantaged castes. On average, women give birth to their first child at around 21. Groups look similar for wealth index, child's gender, and birth order on either side of the threshold. There are more literate women in the control districts. The gradient in health outcomes is evident; the raw averages for HAZ and WAZ are higher for the treated districts than for the control districts.

4 Empirical Methodology

4.1 Identification

The goal of this analysis is to estimate the effect of SBM eligibility on intergenerational health. It is challenging to quantify the spillover of adult learning programs on child outcomes, because of complex implementation structure. In order to obtain credible estimates, I rely on the exogenous variation created by program implementation in a regression discontinuity framework. I estimate reduced form model to determine whether SBM improved outcomes for children born to eligible mothers relative to ineligible mothers in the neighborhood of the threshold. Under the assumption that individuals are unable to sort themselves around the cutoff, this approach represents a treatment assignment that is as good as random. The estimating equation is as follows:

$$\begin{aligned} y_{ijd} = {} & \alpha + \beta \ Eligible_d + \gamma_1 Literacy\ Rate_d \\ & + \gamma_2 (Eligible_d \times Literacy\ Rate_d) + X'_{ij}\theta + B_i + \epsilon_{ijd} \end{aligned} \tag{1}$$

where y_{ijd} represents health outcomes for child i born to a mother j living in district d, 12

[14] Figure A-5 presents the state-wise number of districts included in the analysis.

months after launching of SBM in the district.[15] The variable $Eligible_{id}$ is an indicator variable equal to 1 if the child was born in a district with a literacy rate ≤ 50 percent and equal to zero otherwise; $Literacy\ Rate_d$ is the running variable and denotes the adult female literacy rate expressed as the distance from 50 percent cutoff (centered at zero). The interaction $Eligible_{id} \times Literacy\ Rate_d$ allows the relationship between the running variable and child health to vary arbitrarily on each side of the cutoff. The vector X_{ij} represents the set of covariates that includes a dummy variable for a child's gender, birth order, and Hindu (religion) mother. B_i denotes child-birth year fixed effects that control for any shocks to infant health, coinciding with the birth year beyond the district level. ϵ_{ijd} denotes the unobserved error term. Standard errors are adjusted for clustering at the district level, the level of treatment assignment. I present statistical inference based on different calculations of the standard errors (Kolesár and Rothe 2018).

The parameter of interest β represents the intent-to-treat (ITT) effect of SBM on child health outcomes y_{ijd}. The baseline specification for all results is a linear spline in $Literacy\ Rate_d$ employing an optimal bandwidth of 5 percentage points on either side of the cutoff selected using the Calonico et al. (2014) algorithm (CCT). I present evidence that the results are robust to higher-order polynomials and alternative bandwidths. Finally, to investigate the first stage, I replicate equation (1) using outcomes for individual mothers and include a dummy variable for being Hindu (religion) and child birth year fixed effects.

4.2 Validity Checks and Endogenous Births

The central identifying assumption with the regression discontinuity design is that all unobserved determinants of child health evolve smoothly across the literacy rate cutoff (Imbens and Lemieux 2008). Although this assumption is fundamentally untestable, it does have testable implications. First, the pre-determined characteristics of mothers should move smoothly through the cutoff. If the identifying assumption is violated, we would expect a significant difference in pre-determined characteristics at the literacy threshold. Table 2 presents the reduced form estimates for observed characteristics at the individual, household, and district levels. For ex-

[15] I incorporate a one-year gap between birth and the date of program implementation to exclude partially treated births. As the duration of the program was for a minimum of 3 months and assuming nine months of pregnancy on average, I chose a gap of one year.

ample, I investigate if a mother's age is related to program eligibility (Panel A–Column 3). The coefficient estimates for all such characteristics are statistically insignificant and small in magnitude in absolute terms. These results support the assumption that individuals are not sorting around the cutoff in response to the SBM program.

Second, the density of the running variable should be continuous across the threshold. However, the running variable, that is, *Literacy Rate*, is discrete.[16] Therefore, the conventional density tests could perform poorly. I employ a density test proposed by Frandsen (2017), which exploits the fact that if the probability mass function of the discrete running variable satisfies a specific smoothness condition, then the observed frequency at the threshold has a known conditional distribution. It allows the use of mass points adjacent to the cutoff. Figure 4–Panel A plots the frequency of districts, the level of treatment, by running variable and shows the test results. I fail to reject the null of no difference, implying no evidence of manipulation around the threshold.[17] Panel B (Figure 4) plots the frequency of mothers and presents similar test results. I do not find evidence of sorting around the eligibility threshold. These results provide credence that the identifying assumption is satisfied.

Although the evidence presented above suggests no sorting near the threshold, it is worth discussing the contextual details that may further lessen concerns about sorting. The program qualification for districts was exogenously determined based on the adult female literacy rate as per the 2001 Census of India data. Due to this eligibility criterion, the state or district level governments could not self-select into the program by simply tempering the data for two reasons. First, the Census data are collected by the federal authority in India and is independent of any association with states or districts. Second, since these data were collected in 2001, there were slim chances that any state or district would have known about the literacy program announced later in 2009. A threat of estimates being confounded would exist if another program was launched that used the same eligibility rule as the SBM program, that is, the 50 percent cutoff based on the adult female literacy rate. I have not found any information about such programs.

Identifying the effect of SBM on child health additionally requires addressing the potential

[16] A percentage (or rate) data is discrete if the underlying data that the percentages (or rates) are calculated from is discrete.

[17] To implement the Frandsen density test, I use the *rddisttestk* Stata command developed by Frandsen (2017). Under this test, the values of k determine the maximal degree of non-linearity in the probability mass function that is considered to be compatible with no manipulation. The results remain the same for different values of k.

problem of sample selection. This problem may arise if literacy affects the fertility decision. To shed some light on this important issue, I investigate whether the SBM program had any impact on endogenous births. I replace the dependent variable in equation (1) with the number of births (a measure of composition) and analyze the effect of the literacy program. Table 2 (Column 4 – Panel A) provides the point estimates for the total number of births between 2010 and 2016, the analysis period. I find no change in fertility behavior for mothers around the cutoff, indicating no evidence for endogenous births. The implication of this result is consistent with the age at first birth evolving smoothly around the threshold (Column 5 – Panel A).

5 Results

5.1 Main Results

First stage estimates that show the effect of the SBM program on maternal outcomes are shown in Table 3. All estimates include linear splines in the running variable and use a bandwidth of 5 percentage points on either side of the threshold. In addition, I include a dummy variable for being Hindu (religion) and child birth year fixed effects. Column (1) presents estimates for being lietrate. I find no improvement in literacy for mothers eligible for SBM. The coefficient estimate on literacy is negative and statistically insignificant. Column (2) reports the estimated effects of SBM on mother's labor force participation in the last 12 months.[18] The results suggest that mothers who were eligible for the literacy program are more likely to participate in the labor force. The labor force participation goes up by 17.8 percentage points. The size of the estimates is consistent with the findings of Acevedo et al. (2017), and Bandiera et al. (2020).

It is important to highlight that the sample size for column (2) is lower than column (1). This is because the labor outcomes were part of the long questionnaire for which a sub-sample of 15 percent of households were selected. To achieve a representative sample, interviews were conducted in every alternate selected household in 30 percent of the selected clusters. I tested that the selection for the long survey questionnaire was independent of the treatment status ($\beta = -0.019$, $s.e. = 0.025$).

[18] Labor force participation is defined as working in any of the following sectors: professional/technical/managerial, clerical, sales, agricultural, services, skilled and unskilled manual work.

Next, I estimate the effect of the SBM program on intergenerational health outcomes measured by z-scores (WHO growth standards) for children below five years of age. The main results are in Table 4 from estimating the baseline regression in equation (1). Columns (1) and (4) present the estimates with only running variable controls, and columns (2) and (5) additionally include birth-year fixed effects. I further add observed characteristics for children (birth order, gender, and religion of the mother being Hindu) in columns (3) and (6), the preferred estimates. I estimate the SBM program improved HAZ scores by 0.34 s.d. and WAZ scores by 0.30 s.d., on average. I find similar results for z-scores constructed using median reference (Table A-1). The baseline z-scores for HAZ and WAZ are -1.65 and -1.67, respectively. This implies that the SBM program improved z-scores by around 18 to 20 percent. Figure 5 (Panels A and B) presents visual evidence of the results in Table 4. The graphs are fitted linear polynomials overlaid on scatter plots of z- scores.[19]

Undernourishment deprives children of much-needed nutrients during the crucial phase of their growth, making them considerably vulnerable to diseases and death. It not only creates added pressure on the healthcare systems but also has a severe impact on a nation's economic progress. Table 5 provides the estimates of crucial physiological measures of undernutrition for children. Underweight (low weight for one's age) and stunting (being too short for one's age) commonly result from inadequate food intake and poor dietary quality for extended periods.[20] I find a negative effect of 10 percentage points on the likelihood of being moderately underweight (equivalent to a 25.5 percent decrease). The probability of severe underweight and severe stunting declined by around four percentage points. However, the estimates are not statistically significant.[21] The results suggest that SBM eligibility improved z-scores for children and decreased the probability of undernutrition, on average.

In addition, I look at the program's effects on infant mortality. The results indicate that SBM reduced infant mortality by 0.015. The estimated discontinuity is large in economic terms compared with the sample mean (0.053) but statistically indistinct from zero. If this would lead to any sample selection, then the main results of this study would presumably be a lower

[19]Figure A-6 in the online appendix presents the zoomed-in version of Figure 5, magnifying the discontinuity.

[20]Underweight children have weight-for-age z-score below negative two standard deviations from the mean on the WHO growth standards; stunted children have height-for-age z-score below negative two standard deviations from the mean.

[21]Severe-underweight and severe-stunting are defined as children whose WAZ and HAZ scores are below negative three standard deviations from the mean of the respective WHO growth standards, respectively.

bound of the true impact.

The findings presented above indicate that SBM did not succeed in increasing literacy among mothers, however, there is suggestive evidence of higher labor force participation, likely driven by skill development training. The knowledge gain under the adult literacy program is potentially behind improving child health outcomes for eligible mothers. There exists scant literature on adult learning programs looking at intergenerational health outcomes. A study that closely resembles this work is by Blunch (2013), which found a negative effect of an adult literacy program on child mortality in Ghana. Other scholarly works on the effect of different margins of education (primary, secondary and tertiary schooling) have found improvement in childbirth weight, infant mortality, and anthropometric measures (Currie and Moretti 2003; Grépin and Bharadwaj 2015; Güneş 2015).[22] Although not directly comparable, the results are consistent with such studies and offer support for policies promoting adult learning. It is important to note that since the target population belonged to a lower end of the welfare distribution, even a low-intensity treatment might have substantial welfare effects. Consistent with the law of diminishing returns, varying maternal education levels could plausibly have differential effects on child health outcomes.

5.2 Robustness Checks

To probe the robustness of the main results, I conduct various checks such as sensitivity to bandwidth and polynomial choices, alternative empirical specifications, varied clustering assumptions and placebo treatment effects. First, I examine the sensitivity of the findings to the choice of bandwidth—Figure 6 displays the point estimates from linear spline regressions for HAZ and WAZ using various bandwidths. The spikes correspond to 95% confidence intervals computed using standard errors clustered at the district level, and the vertical red line marks the CCT bandwidth. The range of bandwidth choice on the x-axis is from 0.03 to 0.07 with an increment of 0.0025; seventeen estimates are plotted. The estimates in both panels are stable, which infers that the main results are not sensitive to bandwidth choices.

To further demonstrate the robustness of the main results to the choice of polynomial, I

[22] Currie and Moretti (2003) found that with the availability of colleges in the United States, the prevalence of low birth weight reduces by around 10 percent. Grépin and Bharadwaj (2015) found that in Zimbabwe, one more year of secondary schooling decreases the probability of a child dying by about 21 percent. In Turkey, completion of a mother's primary schooling improves infant health and anthropometric measures Güneş (2015).

show the results of quadratic and local linear regressions for different bandwidths in Table 6. Columns (1) and (2) present estimates for quadratic spline with a 10 and 12 percent bandwidth, respectively. Column (3) shows estimates using local linear regression with data-driven MSE-optimal bandwidth selection procedure as shown in Calonico et al. (2014) and column (4) presents the local linear estimates corresponding to the baseline bandwidth (5%). The z-score estimates change a little across specifications.

The SBM program was implemented in a staggered way across the eligible districts for effective management of finances. I leverage this variation in program rollout timing and the eligibility threshold to estimate a difference-in-discontinuity specification.[23] I estimate the following equation:

$$\begin{aligned} y_{ijdt} = {} & \delta_0 + \delta_1\ Eligible_{id} + f(Literacy\ Rate_d) + f(Literacy\ Rate_d) \times Eligible_{id} \\ & + \delta_2\ Post_{idt} + \beta\ (Eligible_{id} \times Post_{idt}) + f(Literacy\ Rate_d) \times Post_{idt} \\ & + f(Literacy\ Rate_d) \times Eligible_{id} \times Post_{idt} + X'_{ij}\theta + B_i + \epsilon_{ijdt} \end{aligned} \tag{2}$$

where $Post_{idt}$ is an indicator variable equal to 1 if the child i was born in time t after SBM implementation in district d. In this specification, the coefficient of interest is β with the interaction term *Eligible*Post*.[24] The control variables remain the same as those included in the baseline RD estimation equation. I cluster the standard errors at the district level. Column (5) shows the results for difference-in-discontinuity specification using 5% bandwidth (Table 6). The estimates are statistically significant and fairly similar to the baseline specification.[25]

I also exploit temporal and geographical variation in a difference-in-differences framework. In doing so, given the staggered rollout structure of the program implementation, I use the estimation method proposed by Sun and Abraham (2021). The results from this exercise reinforce the findings presented throughout the text.[26]

[23] In the difference-in-discontinuity analysis sample, there are three categories of observations (children): ineligible for the program (control group), eligible for the program and born post-SBM implementation in a district (treated group), and eligible for the program but born pre-SBM implementation (partially treated group). This specification includes children born within a one-year duration of program implementation, which are not included in the main analysis sample.

[24] Some of the interaction terms in this specification cannot be estimated in practice due to missing variation in the data, which leads to the problem of perfect multicollinearity.

[25] I present the distributions of placebo treatment effects for the outcome variables based on the difference-in-discontinuity specification in online appendix Figure A-7.

[26] The difference-in-differences coefficient estimates are positive and significant: HAZ (β = 0.204, *s.e.* = 0.039) and WAZ (β = 0.051, *s.e.* = 0.019). There exist negative trends in the pre-treatment period. Given the evidence of a declining pre-trend in the child health outcomes, the estimated effects of the SBM program from difference-in-differences estimation are likely to be the lower

Next, I examine how estimates vary across clustering assumptions (Table 7). The standard errors are clustered at the district level in the baseline specification. First, I test the robustness of the results for standard errors clustered at the running variable (CRV) in Column (1). However, as per Kolesár and Rothe (2018), confidence intervals corresponding to CRV standard errors have poor coverage properties. They instead suggest making the bandwidth smaller and using Eicker-Huber-White (EHW) standard errors for inference. Column (2) presents the results for a smaller bandwidth, i.e., 3.5%. EHW standard errors are smaller than CRV standard errors. Alternatively, for discrete running variable cases with less number of support points close to the threshold, Kolesár and Rothe (2018) recommend using proposed confidence intervals (CI) to handle bias issues. Column (3) shows the bounding second derivative (BSD) procedure; corresponding CI are reasonably tight.[27] I also check the robustness of results by adding birth month-year fixed effects instead of birth year fixed effects. The magnitude of the coefficient estimates in Column (4) is similar to the baseline coefficient estimates (Table 7).

Mothers with higher education, i.e., those who have completed higher secondary education or above, were not eligible for the SBM program. I use this group in a simple placebo test to emphasize that the improvement in child health around the cutoff is specific to mothers with either no education or incomplete primary education, the primary target of the SBM program. Columns (1) and (2) of Table 8 showcase the point estimates have a negative sign and are statistically insignificant.

Lastly, I conducted a placebo test designed to detect other significant breaks in the bandwidth using false cutoffs over a range of 25 points on either side of the threshold. I replace the actual cutoff with another value at which the treatment status does not change. To avoid contamination due to actual treatment effects, I only use data from one side of the actual cutoff in the estimation samples. Such a restriction ensures that observations with the same treatment status are used for the placebo test. It is expected that no significant treatment effect will occur at these false cutoffs, that is, the treatment effect at each artificial cutoff should be zero by construction. I incrementally increase the cutoff from -25 to 25 by one point. Figure 7 plots the distribution of point estimates for HAZ and WAZ. The vertical red line denotes the actual

bound estimates of the true impact.

[27] The results are presented corresponding to $k = 0.02$. Similar results are obtained by using alternative k values.

estimates from Table 4. The percentage of placebo estimates larger than the baseline effects is reported on the x-axis. It can be seen that the estimates are in the tails of the distribution of point estimates. The actual point estimates for both HAZ and WAZ are smaller than all but only 6 percent of the placebo estimates, showing that the SBM program drives the effect in z-scores around the cutoff. These placebo tests provide reassurance regarding the validity of the study design.

5.3 Heterogeneous Treatment Effects

I investigate how the SBM affects different sub-samples defined over child characteristics. First, I estimate the program's effect based on a child's gender. The child sex ratio has been the lowest in India in the last five decades, 914 females against 1,000 males (Census of India 2011). It indicates the continuing preference for boys, which is detrimental to the health and welfare of girls as they often struggle to get adequate medical care and nutrition. I test if there is any gender-based differential treatment among children and present the results in Table 9 (Columns 1–4). The effects are not statistically different, and the point estimates indicate improvement in z-scores for both male and female children.[28]

Next, I explore if the effect of the SBM program varies across social strata. Caste-based social stratification has been deeply entrenched in Indian society for centuries. It has created a social and an economic divide within the country. People belonging to low castes (scheduled castes and scheduled tribes) are often deprived of basic necessities, which have serious consequences, especially on the health of women and children. Columns (5)–(8) present the results if there exists caste-based differential treatment among children.[29] The coefficient estimates are positive for low caste children but are less precisely estimated, presumably because of the small sample size.

Finally, I compare the effect of the SBM program across different age groups of children. Evidence suggests that growth faltering within the first two years of life is widespread in developing nations (Shrimpton et al. 2001). Even though faltering can continue to persist beyond

[28] The effect sizes are around 9 percent large for males relative to females for both HAZ and WAZ. However, there might exist power issues in this case. I considered expanding the analysis by including data from the previous DHS round (2005-06) to resolve the issue but the previous round of data provides information only at the state level. The survey did not include the GPS measurements and the names of the districts.

[29] A child is categorized as low caste if her mother belongs to either scheduled caste or scheduled tribe. These are historically the most disadvantaged social groups in India.

24 months, children below two years of age are extremely vulnerable to infection and diseases. To explore age heterogeneity, I split the sample of children into two groups: 0 to 24 and 25 to 59 months old. Columns (9)–(12) show that the increase in z-scores is consistent across both age groups, although point estimates for children from 0 to 24 months old are less precisely estimated.

5.4 Mechanisms

There are multiple channels in which knowledge gained from adult learning programs might improve infant and child health. For example, it might improve economic outcomes and increase earnings (Heckman et al. 2006) which could then raise the demand for higher quality children (Becker and Lewis 1973). Attaining skills could potentially raise the efficiency in producing child health, characterized as greater productive efficiency or allocative efficiency (Grossman 2006). Moreover, there could be a diffusion of information among peers attending the program (Kandpal and Baylis 2019; Kandpal et al. 2013). While it is not possible to test for all the mechanisms due to data limitations, I explore mechanisms such as diversity in the diet for children and utilization of healthcare services (Aizer and Currie 2014; Currie and Moretti 2003; Grépin and Bharadwaj 2015).

One vital way to improve children's malnutrition is to consume a diverse diet. A balanced diet comprising necessary nutrients during early childhood can promote growth. WHO has issued guidelines for essential food items and has grouped those into seven food groups.[30] DHS data provide information on food intake for children over the last 24 hours. Based on this information, I construct a dietary diversity score ranging from zero to seven. Minimum dietary diversity corresponds to consuming food from at least four of the seven groups over the last 24 hours. I generate a standardized minimum dietary diversity index (MDD) for children older than six months, as that is when most children start to consume solid foods (American Academy of Pediatrics). It is a measure designed by the WHO to assess diet diversity among children. The reduced-form estimate in column (1) of Table 10 shows that SBM had a significant positive

[30]Group 1: grains, roots, and tubers which comprise soup/clear broth or bread, noodles, other grains or fortified baby food or potatoes, cassava, tubers; Group 2: legumes and nuts which comprise beans, peas, or lentils; Group 3: dairy products which comprise formula milk or tinned powdered/fresh milk; or cheese, yogurt, other milk products or yogurt; Group 4: flesh foods which comprise the liver, heart, other organ meat or fish, shellfish or chicken, duck, or other birds); Group 5: eggs; Group 6: vitamin-A-rich fruits and vegetables, which comprise pumpkin, carrots, squash or dark green leafy vegetables or mangoes, papayas; and Group 7: other fruits and vegetables which comprise any other fruits.

impact of 18.6 percentage points on the dietary diversity index. This finding is consistent with the literature wherein knowledge gain allows mothers to understand better what foods are appropriate for their children (Ickes et al. 2015; Mallard et al. 2014; Nguyen et al. 2013). A comparison of the mean z-score age profile (in years) by treatment eligibility indicates that the anthropometric measures improve once children turn one, further supporting the dietary diversity argument (Figure A-8).[31]

To explore the behavioral changes of mothers, I look at the utilization of healthcare services during and after pregnancy in columns (2) to (6). The indices are created using multiple related variables, and each variable is standardized and weighted equally in the index construction (Kling et al. 2007).[32] The results suggest that the likelihood of four or more prenatal visits and initiating prenatal care in the first trimester have increased; however, the results are not statistically significant. Similarly, indices for advice received and benefits received during pregnancy and breastfeeding are positive but insignificant. In addition to the results presented in Table 10, I also check the impact on gender norms, women's health, use of contraceptives, and incidence of infectious disease among children. However, I do not find any impact due to the SBM program.

While this paper underscores positive changes related to program participation eligibility, it is possible that some other program launched in conjunction with SBM might be driving the results. As discussed in section 4.2, I have not found any other program launched overlapping with the timings of SBM implementation and using the same eligibility rule (50 percent cutoff based on the adult female literacy rate). Indeed, such large-scale programs are not launched in isolation. As part of a mass drive to open personal bank accounts, around one-seventh of SBM program learners were motivated to open and operate accounts under the *Jan Dhan Yojna*, and avail benefits of *Suraksha Bima Yojana*.[33] However, I do not find any impact on having a bank account or an insurance policy on child health.

[31] The Indian government has launched various programs to improve child nutrition since the 1960s, targeting different age groups. Such as the Integrated Child Development Services (ICDS) Scheme (for less than six years old), the Mid-day Meal Programme (for 6-11 years old), National Iron Plus Initiative (for all age groups of children and adolescents), among others. Out of these programs, the most relevant for children in the analysis group is the ICDS scheme, first launched in 1975. I do not find any effect of SBM eligibility on benefits received under the ICDS program.

[32] The variables used to create Received Advice Index are: received advice for institutional delivery, cord care, breastfeeding, keeping the baby warm, and family planning. The variables used for Received Benefits During Pregnancy Index construction are receiving supplementary food, health check-ups, and health and nutrition education during pregnancy. The variables used to create the Received Benefits While Breastfeeding Index are: received supplementary food, health check-ups, and health and nutrition education while breastfeeding.

[33] Information retrieved from Lok Sabha Question dated September 2016.

To summarize, a diverse diet for children seems to explain a substantial fraction of the results. In addition, higher maternal labor force participation could also contribute to improvement in child health outcomes. Better earning opportunities would allow parents to spend more money on high-quality food. The improvement in z-scores for children is concentrated among mothers aged between 21 and 40, a prime age to work (Figure A-9). The results in this section indicate that adult learning programs can potentially contribute towards reducing the incidence of poor child health outcomes

6 Conclusion

This paper has examined the effect of an adult learning program on child health in the Indian context. Such programs generate both direct and indirect spillover effects. However, it has been challenging to quantify such spillovers because of the programs' complex implementation structure. I exploit the discontinuity in eligibility resulting from the program rules to obtain plausible causal estimates. I find that the SBM program significantly improved child health outcomes measured by z-scores and reduced the risk of undernutrition. The effects are robust to multiple identification strategies, including difference-in-discontinuity that takes advantage of phase-wise program implementation. A further investigation of potential mechanisms reveals that the improvement is likely driven by consuming a diverse diet (including solid food) for children older than six months and below five years of age, consistent with nutrition and health literature (Arimond and Ruel 2004). I also find suggestive evidence that mothers' labor force participation has improved, potentially contributing to children's diverse dietary patterns. I find no impact on change in fertility behavior.

To put improvements in child health into perspective, I conduct basic back-of-the-envelope calculations for social gain. To simplify the analysis, I concentrate on the number of underweight births, i.e., children with WAZ below negative two standard deviations under the mean as per the WHO growth standards. The cost associated with the treatment of acute malnutrition is $125 per child (Bhutta et al. 2013). Taking the total number of moderate underweight children from control districts as a benchmark, a 26.5 percent decrease in underweight children implies that 3,189,645 children were saved from malnutrition due to the SBM program.[34] This decrease corresponds to a social gain of approximately $458.5 million (in 2018 US dollars). It presumably generates a lower bound estimate, as I only consider short-term economic gains. Improved child health could stimulate higher schooling outcomes, better labor market outcomes, productivity gains, and lower adult healthcare expenditure, further accelerating GDP contribution (Kakietek et al. 2017).

The analysis of an adult learning program contributes to an active policy discussion about the 2030 agenda for Sustainable Development, particularly to the second and fourth goals (SDG-2 and SDG-4), aiming to eradicate malnutrition and ensure quality education, respectively.[35] According to the Global Nutrition Report (2021), progress in tackling all forms of malnutrition remains "unacceptably slow". Despite improvements worldwide, around 150.8 million children are stunted (too short for one's age), and 50.5 million children are wasted (low weight for one's height). India is home to one-third of stunted children (46.6 million) and one-half of wasted children (25.5 million). Hunger is one of the main reasons behind worldwide malnutrition (FAO et al. 2021). With low to minuscule levels of social protection for children in developing and less developed nations, mothers could play a pivotal role in child development.

From a broader perspective, the main findings speak to associated spillovers in intergenerational health outcomes. Attempts to promote adult education could substantially alleviate gender disparities and uplift the socio-economic status of disadvantaged individuals in developing countries. It could further help boost the overall nutrition intake of children. While this study has focused on child health outcomes, the enrollment of women in formal schooling induced by the SBM might improve women's health and children's schooling outcomes. Further research is required to study these outcomes to understand whether the SBM program helped bring social mobility. These are relevant topics of paramount importance for future research.

[34] Total number of underweight children in control districts in rural India was 12,036,399 as per DHS data for 2015-16 (Author's calculation).

[35] SDG-2 seeks to eliminate all forms of malnutrition and hunger by 2030 by encouraging sustainable agricultural practices, supporting small-scale farmers, and ensuring equal access to land, markets, and technology. SDG-4 focuses on quality education, i.e., providing inclusive and equitable quality education and promoting lifelong learning opportunities for all (United Nations 2015).

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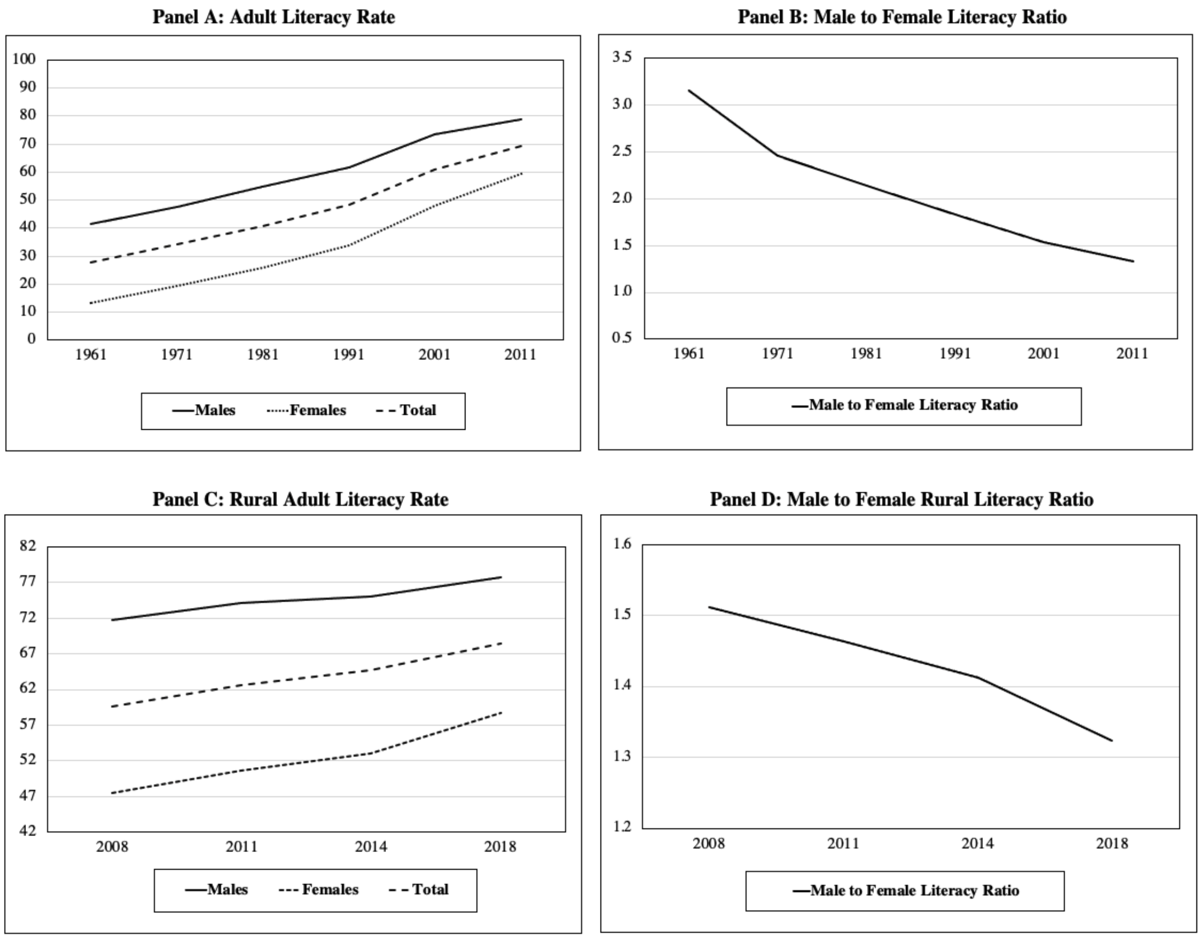
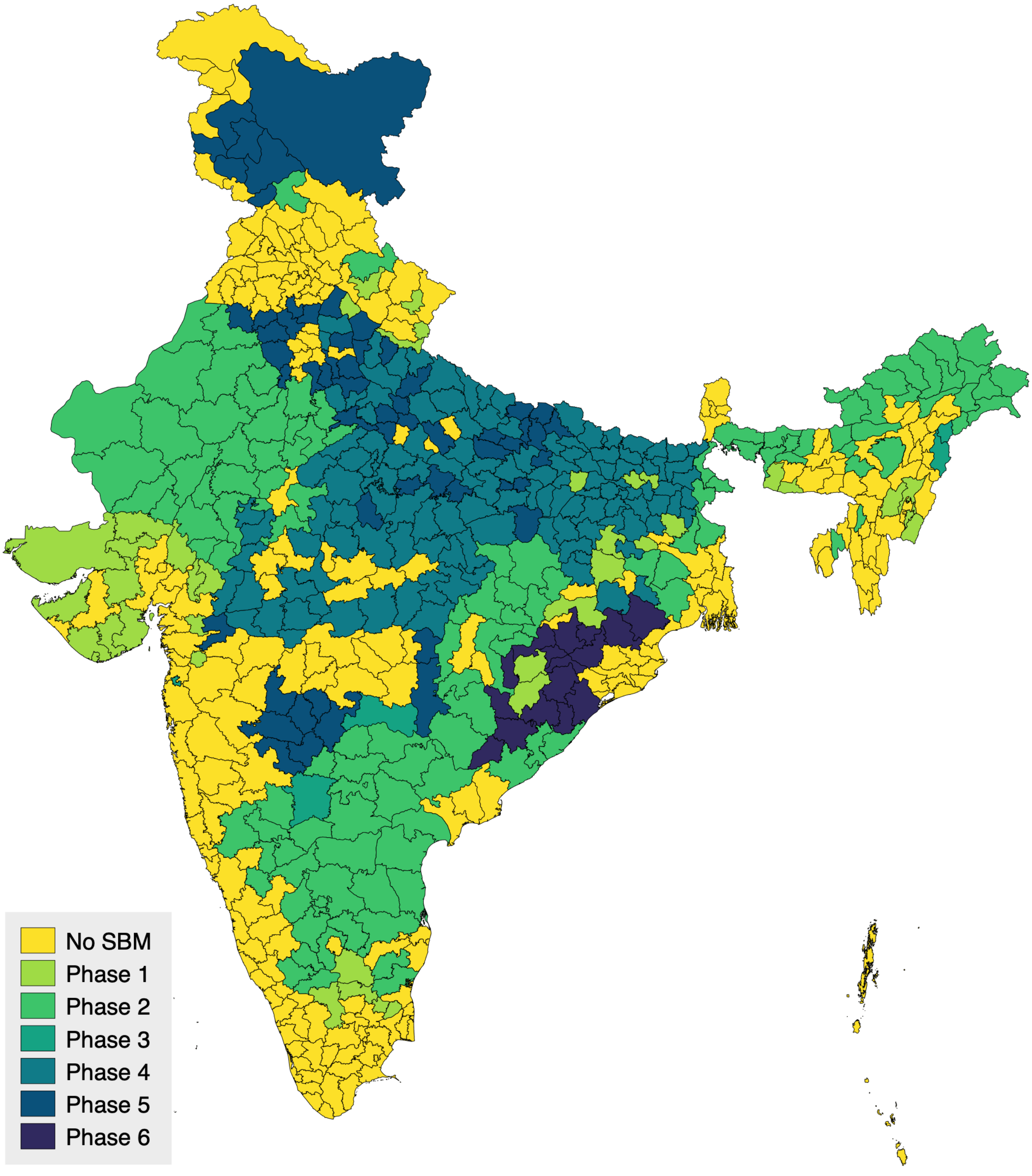
Figure 1: Adult Literacy Trends in India



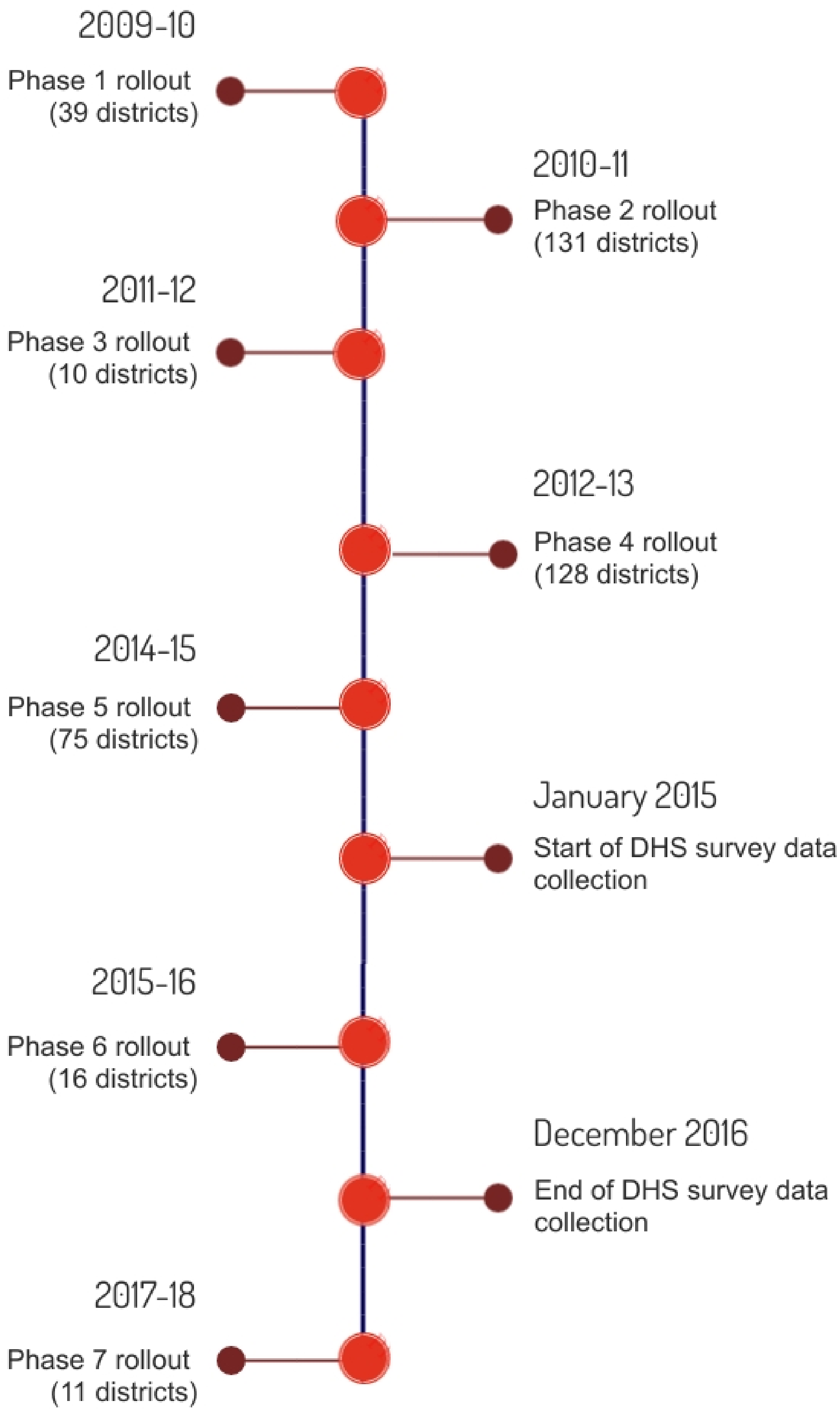
The figures present the trends for the adult population of 15 years and above age. Data source for figures in panels A and B is Population Census of India. Data source for figures in panels C and D is National Sample Survey rounds and Population Census of India.
Link to Section 2.1.
Link to Section 2.3.

Figure 2: Phase-wise Rollout of SBM Program



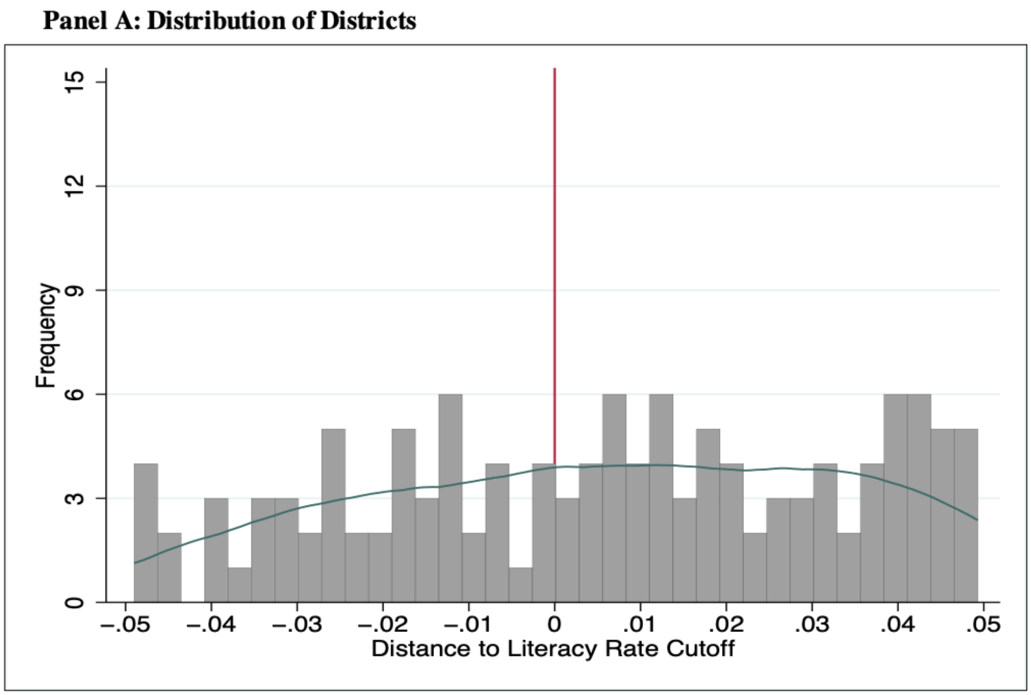
The color-coded map above shows the districts that implemented SBM program across different phases. The SBM program was rolled out in seven phases. In the seventh phase (2017-18), eleven districts were assigned to receive the program but some of these could not receive it because of administrative failure. These districts are not part of the analysis period and are colored yellow on the map.
Link to Section 2.2.

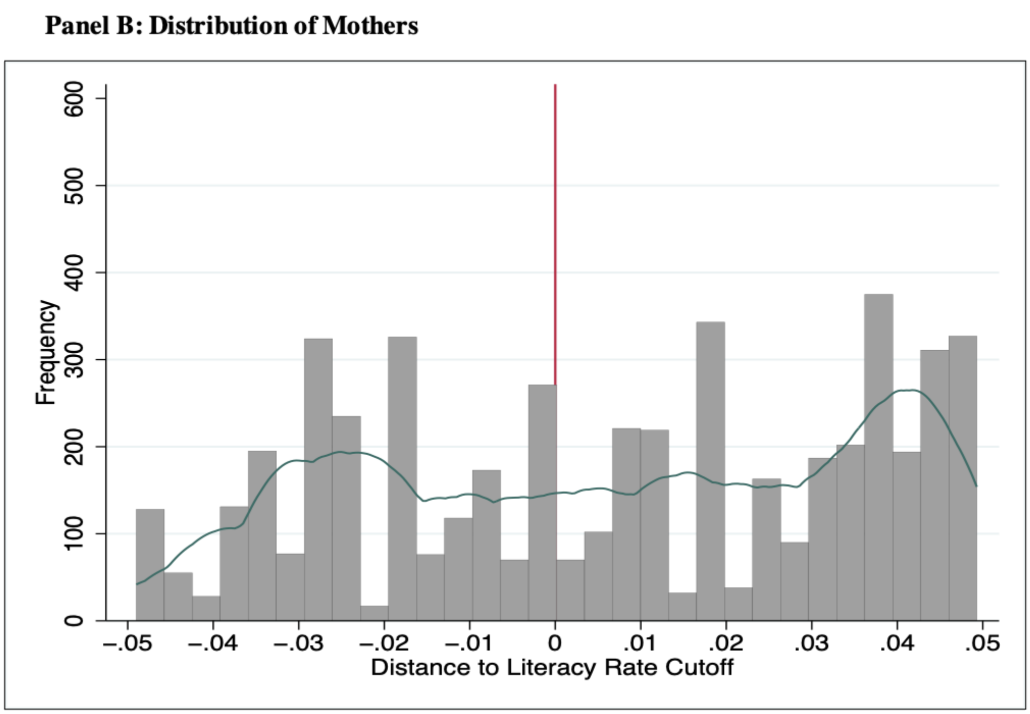
Figure 3: Timeline of SBM Implementation and Data Collection Period



Some districts in Phase-7 either did not receive the treatment because of administrative failure or received it between 2017 and 2018. Since the data is available until 2016, these districts are excluded from the analysis.
Link to Section 3.2.

Figure 4: Distributions Around the Literacy Cutoff

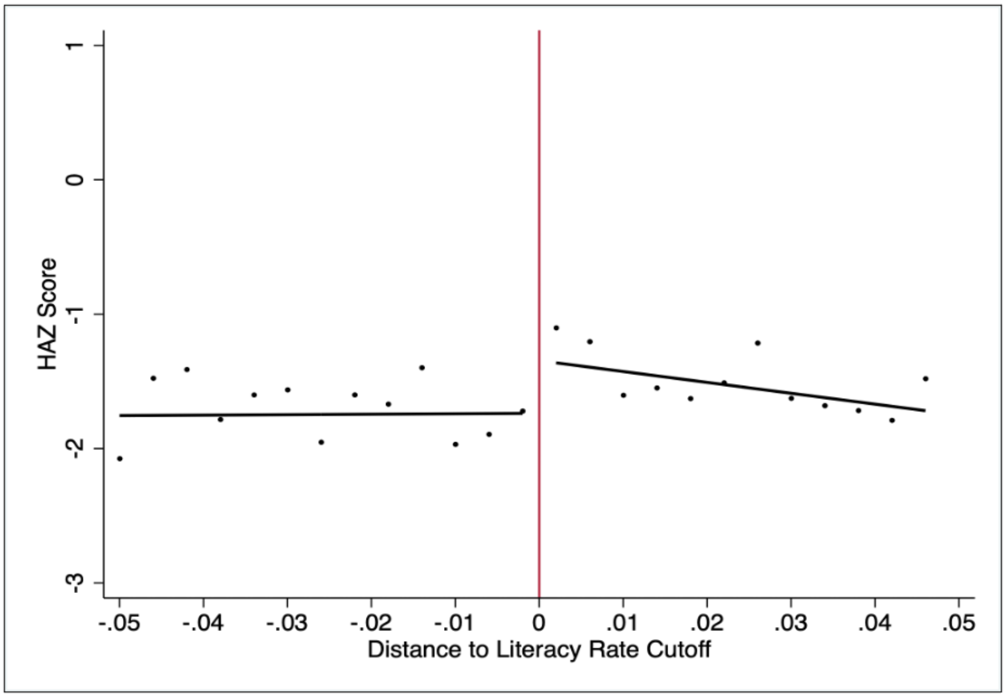




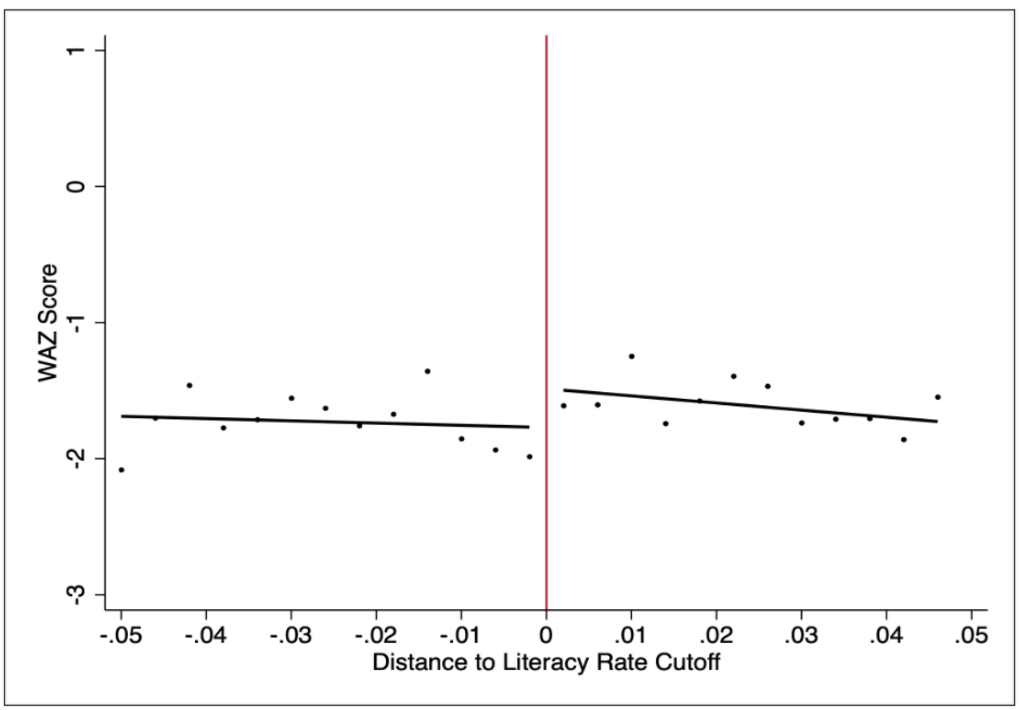
Panel A shows the distribution of districts and Panel B shows the distribution of mothers relative to the literacy rate cutoff centered at zero.
Manipulation tests for Panel A: p-value=0.52 ($k = 0$), p-value=1.00 ($k = 0.01$) and p-value=1.00 ($k = 0.02$).
Manipulation tests for Panel B: p-value=0.44 ($k = 0$), p-value=0.58 ($k = 0.01$) and p-value=0.59 ($k = 0.02$).
Note: The density tests are implemented using Stata command *rddisttestk* developed by Frandsen with the chosen $k = 0$, 0.01, 0.02. The larger k represents the mass at the threshold can deviate substantially from linearity before the test will reject with high probability, while a small k means even small deviations from linearity will lead the test to reject with high probability (Frandsen 2017).
Link to Section 4.2.

Figure 5: RD Graphs

Panel A: Height-for-Age z-score (HAZ)

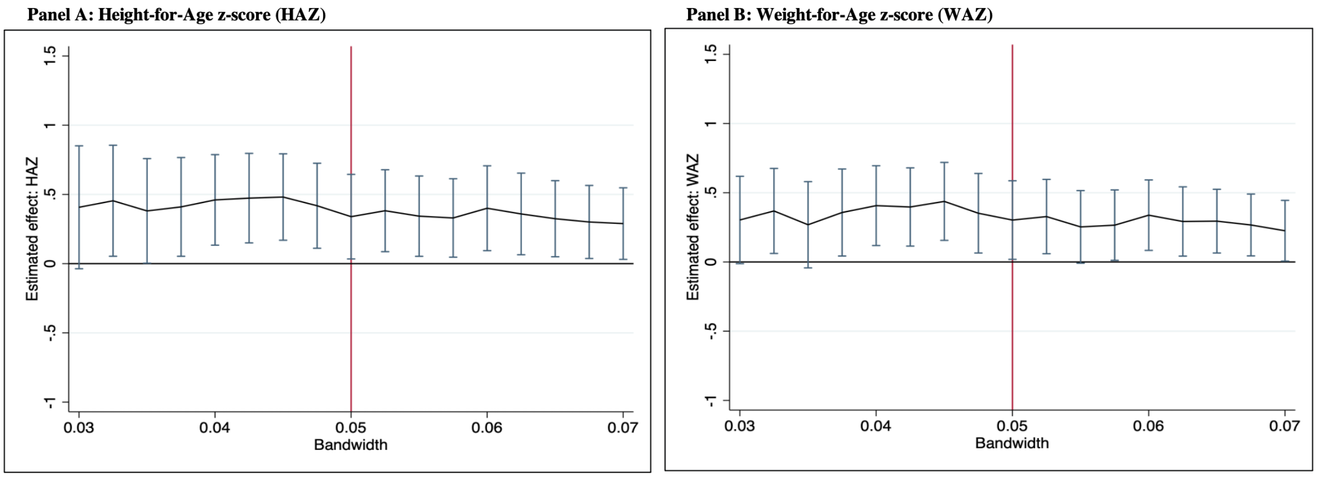


Panel B: Weight-for-Age z-score (WAZ)



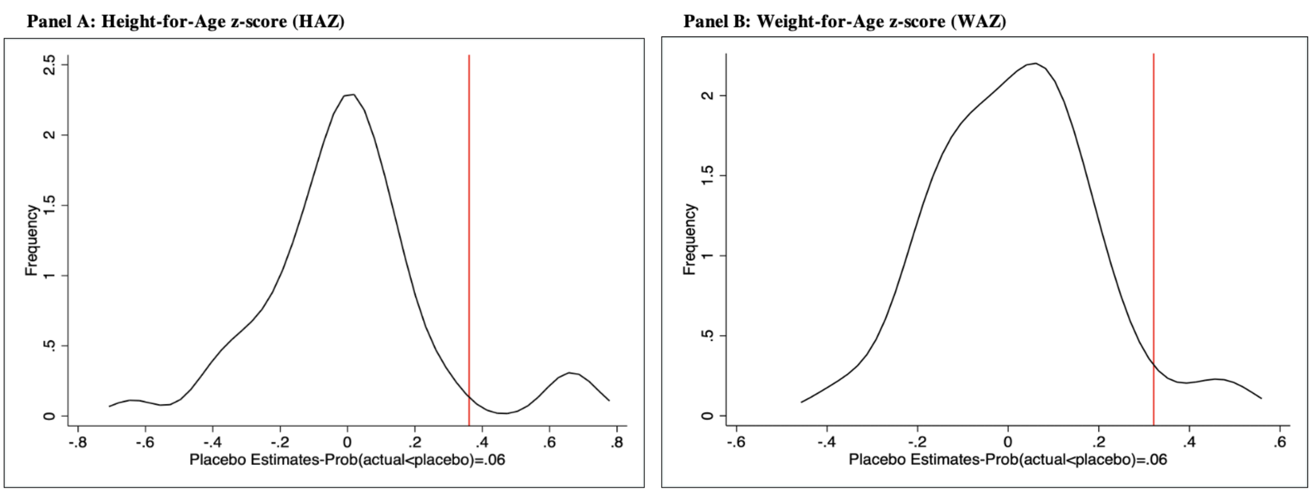
The vertical line denotes 50 percentage points eligibility cutoff of adult female literacy rate (centered at 0). Each circle represents the unconditional mean of z-scores in 0.4 percentage point bins, based on the distance to SBM cutoff. The solid lines are fitted values of z-scores from a linear spline over a bandwidth of 5 percentage points.
Link to Section 5.1.

Figure 6: Bandwidth Choice Sensitivity



Figures display point estimates from linear spline regressions using various bandwidths. Spikes correspond to the 95% confidence intervals computed using standard errors clustered at the district level. Vertical red line corresponds to CCT bandwidth.
Link to Section 5.2.

Figure 7: Placebo Treatment Effects (False Cutoff)



Each placebo estimate assigns a false SBM cutoff by incrementally adding one scale point to the female adult literacy cutoff over a range of [-50, 50] scale points. A reduced form equation is then employed to estimate the effect of SBM eligibility on z-scores. All estimates are obtained from a linear spline using a bandwidth of 0.05 points. The vertical line denotes the actual estimates. The fraction of placebo estimates larger than the actual estimate is reported on the x-axis.
Link to Section 5.2.

Table 1: Summary Statistics

	Control		Treated		Overall	
	Mean	SD	Mean	SD	Mean	SD
	(1)	(2)	(3)	(4)	(5)	(6)
Mothers' Characteristics						
No Education	0.69	0.46	0.75	0.43	0.73	0.45
Incomplete primary education	0.31	0.46	0.25	0.43	0.27	0.45
Wealth Index (1-5)	1.98	0.98	1.96	0.97	1.97	0.98
Hindu religion	0.68	0.47	0.69	0.46	0.69	0.46
Scheduled Caste/Scheduled Tribe	0.53	0.50	0.47	0.50	0.50	0.50
Age at first birth	20.47	3.80	20.62	3.77	20.56	3.79
Literate	0.22	0.41	0.16	0.37	0.19	0.39
Sample Size	2,224		2,874		5,098	
Children Characteristics						
Child gender	0.50	0.50	0.51	0.50	0.51	0.50
Birth order	2.91	1.83	2.79	1.68	2.84	1.75
Height-for-age z-score (HAZ)	-1.75		-1.57		-1.65	
Weight-for-age z-score (WAZ)	-1.73		-1.63		-1.67	
Sample Size	3,003		3,485		6,488	
Number of Districts	49		65		114	

The table presents mean values for mothers' and children's characteristics. An optimal bandwidth of ±0.05 around the literacy thresholds has been used to define the sample of mothers and children (see text for details). A total of 410 districts were eligible for the SBM program out of 640 districts.
Link to Section 3.3.

Table 2: Balance Check on Observables

Panel A: Mother Characteristics

	(1) Urban	(2) Hindu	(3) Age	(4) # of Births (last 5 years)	(5) Age at First Birth
SBM Eligible	-0.067	0.132	-1.026	0.039	0.604
	(0.073)	(0.166)	(0.849)	(0.067)	(0.393)
Sample size	6,598	5,098	5,098	5,098	5,098
Mean	0.227	0.688	28.21	1.483	20.56

Panel B: Other Characteristics

	(1) Owns House	(2) Owns Land	(3) Husband Education (Years)	(4) Female Child	(5) Birth Order
SBM Eligible	-0.171	-0.037	0.350	-0.002	-0.409
	(0.111)	(0.084)	(0.884)	(0.025)	(0.287)
Sample size	842	736	842	6,488	6,488
Mean	0.428	0.253	4.684	0.494	2.845

Panel C: Household Characteristics

	(1) Electricity	(2) Piped Drinking Water	(3) Toilet Facility	(4) Household Assets Index	(5) Household Wealth Index
SBM Eligible	0.015	0.119	-0.154	-0.038	-0.240
	(0.063)	(0.095)	(0.155)	(0.066)	(0.292)
Sample size	5,014	5,098	5,014	5,014	5,098
Mean	0.810	0.260	0.487	-0.035	2.455

Panel D: District Characteristics

	(1) Females	(2) Hindu	(3) Health Centres	(4) Cultivators	(5) Household Industry
Literacy Cutoff	0.001	0.009	12.960	-0.048	-0.011
	(0.005)	(0.059)	(9.502)	(0.0785)	(0.015)
Sample size	118	118	118	118	118
Mean	0.486	0.792	39.280	0.310	0.050

The sample is restricted to the literacy rate within 5% on both sides of the eligibility threshold. All specifications control for linear splines in literacy rate. Controls include the year of birth fixed effects. Standard errors are shown in parentheses and are clustered at the district level. * significant at 10%, ** significant at 5%, *** significant at 1%.
Link to Section 4.2.

Table 3: First Stage Estimates of the Effect of SBM on Maternal Outcomes

	(1) Literate	(2) Labor Force Participation (Last 12 months)
SBM Eligible	-0.038	0.178**
	(0.040)	(0.089)
Sample size	5,098	842
Mean	0.185	0.316

The sample is restricted to the literacy rate within 5% on both sides of the eligibility threshold. All specifications control for linear splines in literacy rate. Covariates include child year of birth fixed effects, and Hindu mother. Standard errors are shown in parentheses and are clustered at the district level: * significant at 10%, ** significant at 5%, *** significant at 1%.
Link to Section 5.1.

Table 4: Main Results - Effect of SBM on Children Health Outcomes Z-scores

	Height-for-Age Z-score			Weight-for-Age Z-score		
	(1)	(2)	(3)	(4)	(5)	(6)
SBM Eligible	0.418***	0.348**	0.339**	0.312**	0.290*	0.303**
	(0.151)	(0.157)	(0.154)	(0.153)	(0.154)	(0.143)
Effect Size	25.27%	21.03%	20.49%	18.63%	17.32%	18.10%
Birth year FE	No	Yes	Yes	No	Yes	Yes
Controls	No	No	Yes	No	No	Yes
Mean	-1.654	-1.654	-1.654	-1.674	-1.674	-1.674
Sample size	6,488	6,488	6,488	6,488	6,488	6,488

The sample is restricted to the literacy rate within 5% on both sides of the eligibility threshold. All specifications control for linear splines in literacy rate. Columns (3) and (6) includes controls for birth order, child gender, and Hindu mother. A total of 114 districts were included in the RD analysis sample – 65 treated and 49 control districts. Standard errors are shown in parentheses and are clustered at the district level: * significant at 10%, ** significant at 5%, *** significant at 1%.
Link to Section 5.1.

Table 5: Effect of SBM on Nutritional Status and Infant Mortality

	(1) Moderate Underweight	(2) Severe Underweight	(3) Moderate Stunting	(4) Severe Stunting	(5) Infant Mortality
SBM Eligible	-0.104**	-0.039	-0.021	-0.038	-0.015
	(0.049)	(0.035)	(0.040)	(0.039)	(0.011)
Sample size	6,488	6,488	6,488	6,488	7,641
Mean	0.391	0.120	0.442	0.193	0.053

The sample is restricted to the literacy rate within 5% on both sides of the eligibility threshold. All specifications control for linear splines in literacy rate. Covariates include child year of birth fixed effects, birth order, child gender, and Hindu mother. Standard errors are shown in parentheses and are clustered at the district level: * significant at 10%, ** significant at 5%, *** significant at 1%.
Link to Section 5.1.

Table 6: **Effect of SBM Robust to Alternative Specifications**

HAZ

	Quadratic Spline		Local Linear		RD w/ DID
	(1)	(2)	(3)	(4)	(5)
	+/-10%	+/-12%	CCT	+/-5%	+/-5%
SBM Eligible	0.410**	0.425***	0.252**	0.417**	
	(0.167)	(0.154)	(0.122)	(0.171)	
SBM Eligible * Post					0.358*
					(0.195)
Sample size	13,606	15,341	13,458	6,488	8,417
Mean	-1.642	-1.639	-1.641	-1.654	-1.730

WAZ

	Quadratic Spline		Local Linear		RD w/ DID
	(1)	(2)	(3)	(4)	(5)
	+/-10%	+/-12%	CCT	+/-5%	+/-5%
SBM Eligible	0.362***	0.340***	0.239***	0.361***	
	(0.139)	(0.127)	(0.100)	(0.138)	
SBM Eligible * Post					0.465***
					(0.132)
Sample size	13,606	15,341	13,116	6,488	8,417
Mean	-1.655	-1.656	-1.649	-1.654	-1.736

Specifications in columns (1) and (2) control for quadratic spline in literacy rate using the listed bandwidth. Optimal bandwidths for local linear regression in column (3) are obtained using the procedures in Calonico, Cattaneo, and Titiunik (2014). For column (4) local linear specification, the sample is restricted to the literacy rate within 5% on both sides of the eligibility threshold. Column (5) corresponds to differences-in-discontinuity design. Covariates include child year of birth fixed effects, birth order, child gender, and Hindu mother. Standard errors are shown in parentheses and are clustered at the district level. * significant at 10%, ** significant at 5%, *** significant at 1%.

Link to Section 5.2.

Table 7: Effect of SBM Robust to Alternative Standard Errors Clustering Assumptions and Birth Month-Year Fixed Effects

HAZ

	(1) Clustering at Running Variable	(2) Eicker-Huber-White Inference	(3) BSD Inference (Kolesár-Rothe 2018)	(4) Birth Month-Year Fixed Effects
SBM Eligible	0.339**	0.381***	0.417***	0.326**
	(0.155)	(0.118)	(0.093)	(0.155)
CI	(0.032, 0.646)	(0.150, 0.612)	(0.234, 0.601)	
Sample size	6,488	4,323	1,457@	6,488
Mean	-1.654	-1.616		-1.654

WAZ

	(1) Clustering at Running Variable	(2) Eicker-Huber-White Inference	(3) BSD Inference (Kolesár-Rothe 2018)	(4) Birth Month-Year Fixed Effects
SBM Eligible	0.303**	0.269***	0.312***	0.302**
	(0.139)	(0.078)	(0.062)	(0.142)
CI	(0.027, 0.577)	(0.114, 0.423)	(0.191, 0.434)	
Sample size	6,488	4,323	1,457@	6,488
Mean	-1.674	-1.635		-1.674

For column (1), the sample is restricted to the literacy rate within 5% on both sides of the eligibility threshold and for column (2), the sample is restricted within 3.5%. In column (3), the value of parameter k is 0.02 for BSD inference. CI represents the corresponding confidence intervals. Columns (4) includes birth month-year fixed effects instead of birth year fixed effects. Specifications in both columns (1), (2) and (4) control for linear splines in literacy rate and covariates include child year of birth fixed effects, birth order,child gender, and Hindu mother. Column (3) specification excludes covariates. Standard errors are shown in parentheses and are clustered at the district level: * significant at 10%, ** significant at 5%, *** significant at 1%.
@ The sample size reflects the effective sample size used in computation using BSD approach (Kolesár and Rothe, 2018).
Link to Section 5.2.

Table 8: Placebo Test for Mothers with Higher-education (not eligible for SBM)

	Mothers with Higher Education	
	(1)	(2)
	HAZ	WAZ
SBM Eligible	-0.105	-0.051
	(0.138)	(0.155)
Sample size	4,201	4,201
Mean	-0.988	-1.084

All specifications control for linear splines in literacy rate using 5% bandwidth on both sides of the cutoff. The analysis sample for columns (1) and (2) comprises births to mothers with higher education who were ineligible for the treatment. Controls include birth order, child gender, Hindu mother, and year of birth fixed effects. Standard errors are shown in parentheses: * significant at 10%, ** significant at 5%, *** significant at 1%.
Link to Section 5.2.

Table 9: Heterogeneous Effects - Effect of SBM on Z-scores

Child Gender

	HAZ		WAZ	
	(1) Female	(2) Male	(3) Female	(4) Male
SBM Eligible	0.328*	0.360**	0.293*	0.322**
	(0.183)	(0.173)	(0.160)	(0.147)
Sample size	3,207	3,281	3,207	3,281
Mean	-1.584	-1.724	-1.629	-1.718

Child Caste

	HAZ		WAZ	
	(5) Low Caste	(6) High Caste	(7) Low Caste	(8) High Caste
SBM Eligible	0.348	0.347*	0.232	0.257*
	(0.216)	(0.183)	(0.159)	(0.146)
Sample size	3,033	3,455	3,033	3,455
Mean	-1.694	-1.620	-1.656	-1.691

Child Age

	HAZ		WAZ	
	(9) 0-24 months	(10) 25-59 months	(11) 0-24 months	(12) 25-59 months
SBM Eligible	0.368	0.327**	0.226	0.372***
	(0.223)	(0.155)	(0.204)	(0.127)
Sample size	2,828	3,660	2,828	3,660
Mean	-1.410	-1.843	-1.564	-1.759

The sample is restricted to the literacy rate within 5% on both sides of the eligibility threshold. All specifications control for linear splines in literacy rate. Covariates include child year of birth fixed effects, birth order, child gender, and Hindu mother. Columns (1)–(4) excludes covariates for child gender. Standard errors are shown in parentheses and are clustered at the district level. * significant at 10%, ** significant at 5%, *** significant at 1%.
Link to Section 5.3.

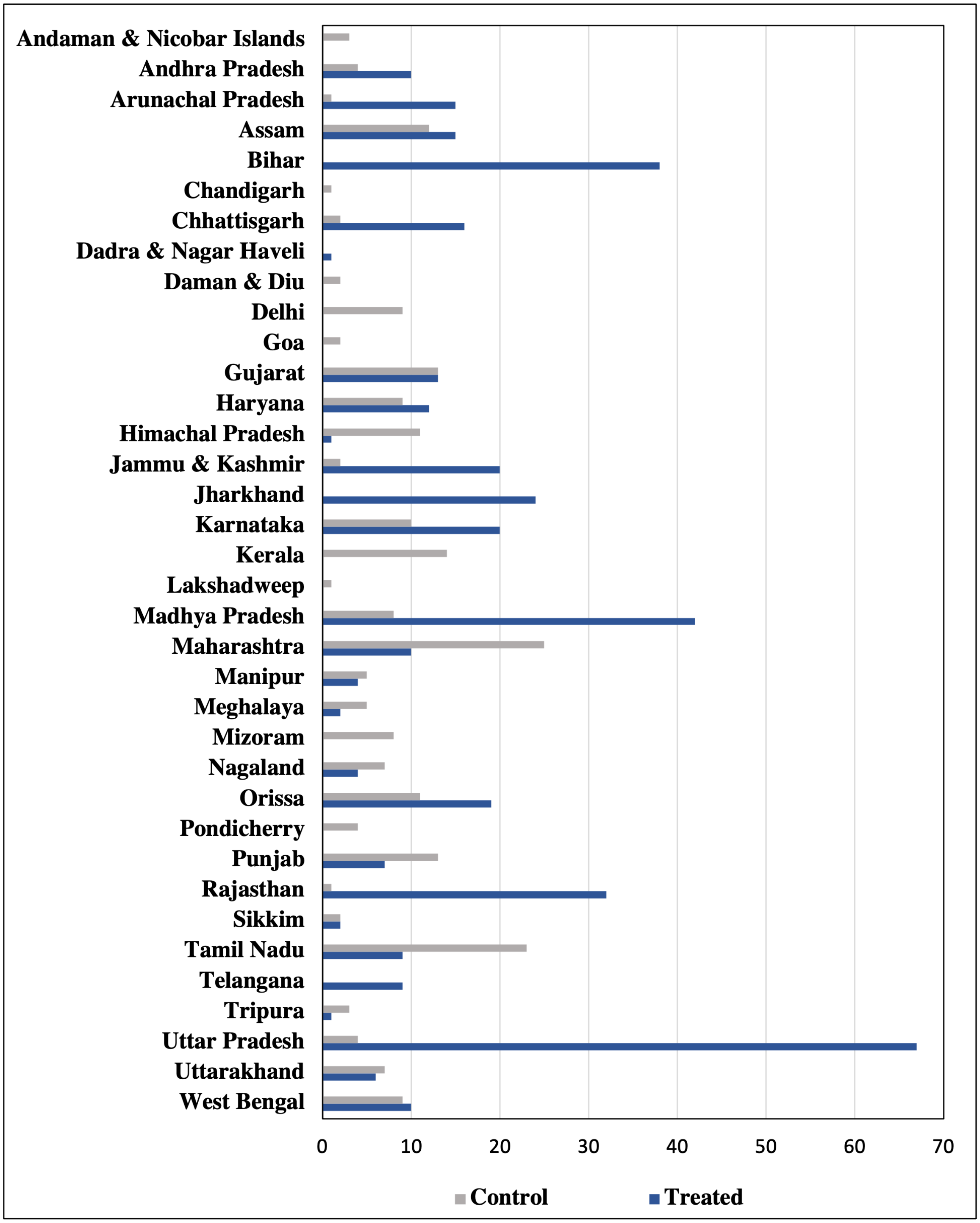
Table 10: Mechanisms - Effects of SBM on Diet Diversity and Healthcare Services Utilization

	(1) Minimum Dietary Diversity Index	(2) Prenatal Visits 4+	(3) Prenatal Care Initiated in First Trimester
SBM Eligible	0.186**	0.093	0.018
	(0.087)	(0.093)	(0.053)
Sample size	5,801	4,845	3,989
Mean	0.00	0.375	0.638
	(4) Received Advice Index	**(5) Received Benefits During Pregnancy Index**	**(6) Received Benefits While Breastfeeding Index**
SBM Eligible	0.177	0.133	0.057
	(0.166)	(0.171)	(0.154)
Sample size	2,627	3,282	2,959
Mean	0.00	0.00	0.00

The sample is restricted to the literacy rate within 5% on both sides of the eligibility threshold. All specifications control for linear splines in literacy rate. Covariates include child year of birth fixed effects and Hindu mother. Column (1) additionally includes covariates for birth order and child gender. The dependent variables for column (1), and columns (4) to (6) are z-score indices. Standard errors are shown in parentheses and are clustered at the district level. * significant at 10%, ** significant at 5%, *** significant at 1%.
Link to Section 5.4.

Online Appendix: Not for Publication

Figure A-1: State-wise Number of Districts Eligible for SBM



The figure plots the state-wise frequency of districts eligible for the SBM program. The y-axis labels the states of India. Link to Section 2.2.

Figure A-2: Women Learning in an Adult Education Centre in India

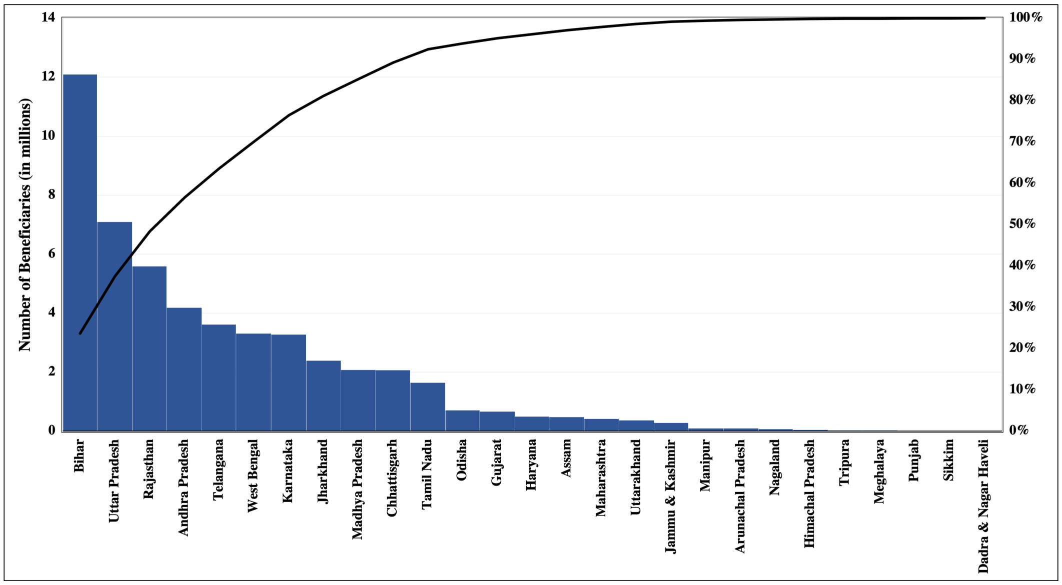
Picture credits: orissadiary.com
Link to Section 2.2.

Figure A-3: SBM Implementation – By The Numbers

410	Districts eligible for SBM
404	Districts – SBM implemented
164 thousand	Gram Panchayats covered
156 thousand	Adult Education Centers (AECs) setup
6.55 Million	Literacy centers commenced teaching learning process
4.89 Million	Volunteer Teachers trained by Master Trainers
265 thousand	Master Trainers trained by Resource Persons
13.76 thousand	Resource Persons trained
275 thousand	Preraks trained to organize activities in AECs
14	Languages – basic literacy material (primers) printed & distributed
28	Local dialects – basic literacy material (primers) printed & distributed
107.4 Million	Learners Identified
98.8 Million	Learners enrolled for SBM
96.3 Million	Learners appeared for Assessment Tests
76.4 Million	Learners passed Assessment Tests and certified as literates

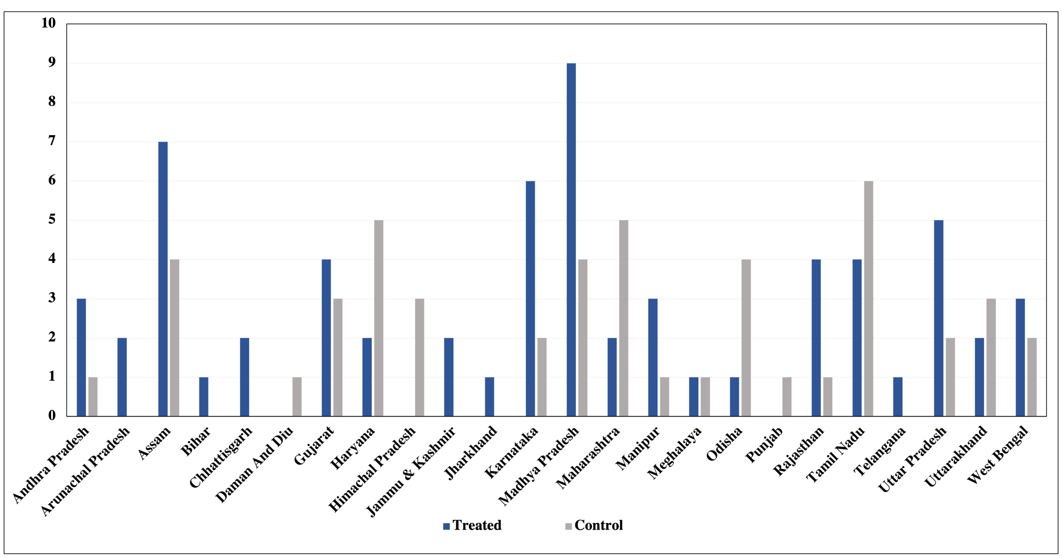
The figure above presents the information about infrastructural build up for implementation of SBM program at a massive scale. Source: Annual Report 2017-18 and Annual Report 2019-20 (Ministry of Human Resource Development).
Link to Section 2.2.

Figure A-4: State-wise Number of Female Beneficiaries of SBM



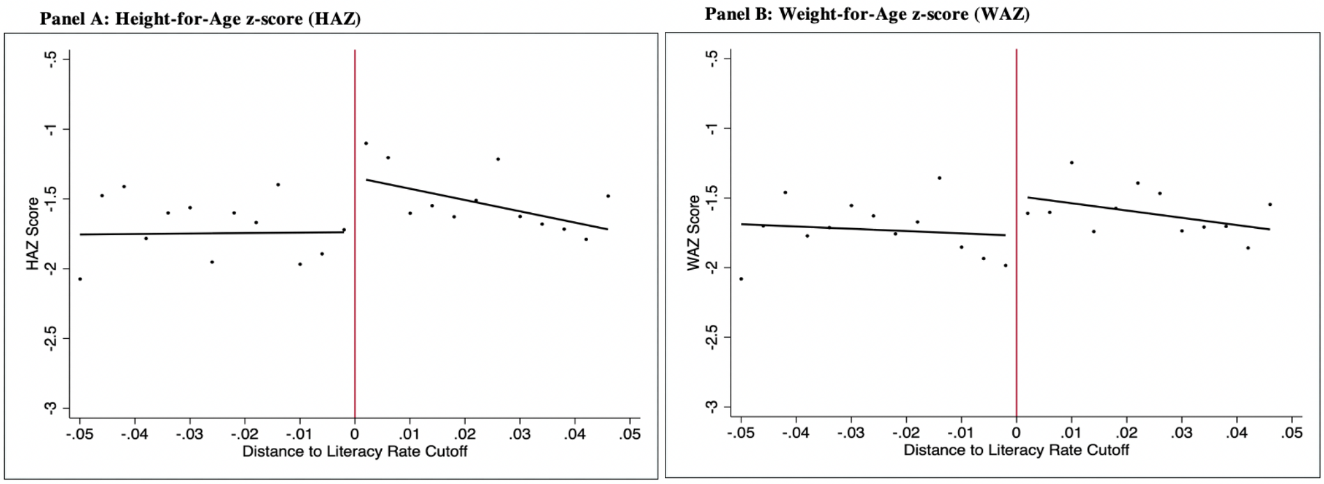
The Pareto chart shows the state-wise ordered frequency of female beneficiaries (left y-axis). The right y-axis shows the cumulative percentage of female beneficiaries. The x-axis labels the states of India. The total number of successful female learners under the adult literacy program (SBM) were 52 million.
Data source: Ministry of Human Resource and Development (2018)
Link to Section 2.3.

Figure A-5: State-wise Number of Districts Included in the Analysis



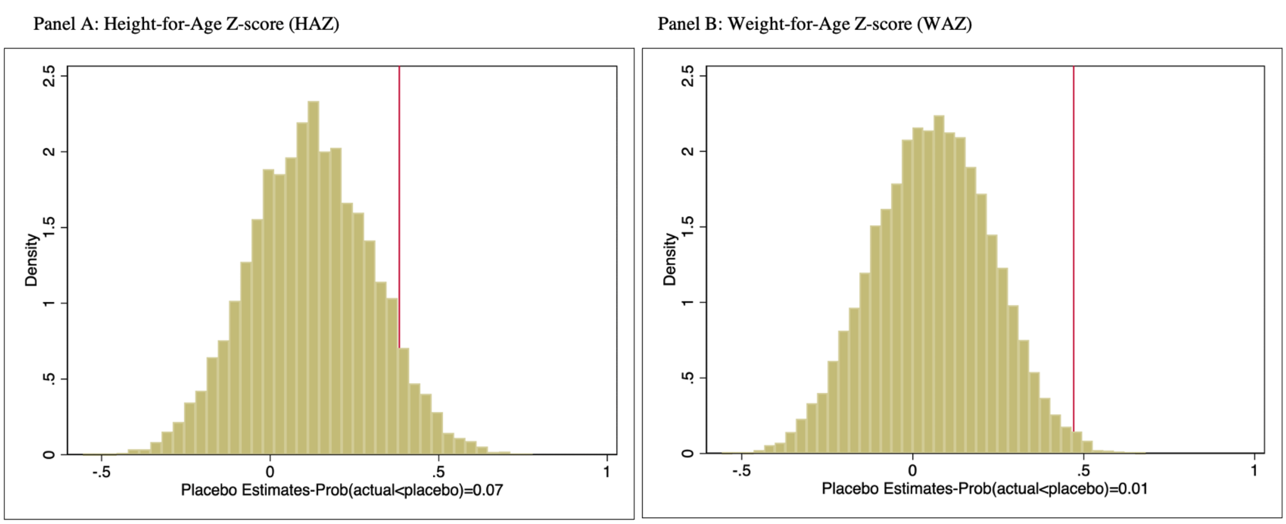
Note: The figure plots the state-wise frequency of districts included in the RD analysis sample. The x-axis labels the states of India.
Link to Section 3.3.

Figure A-6: RD Graphs (Zoomed in)



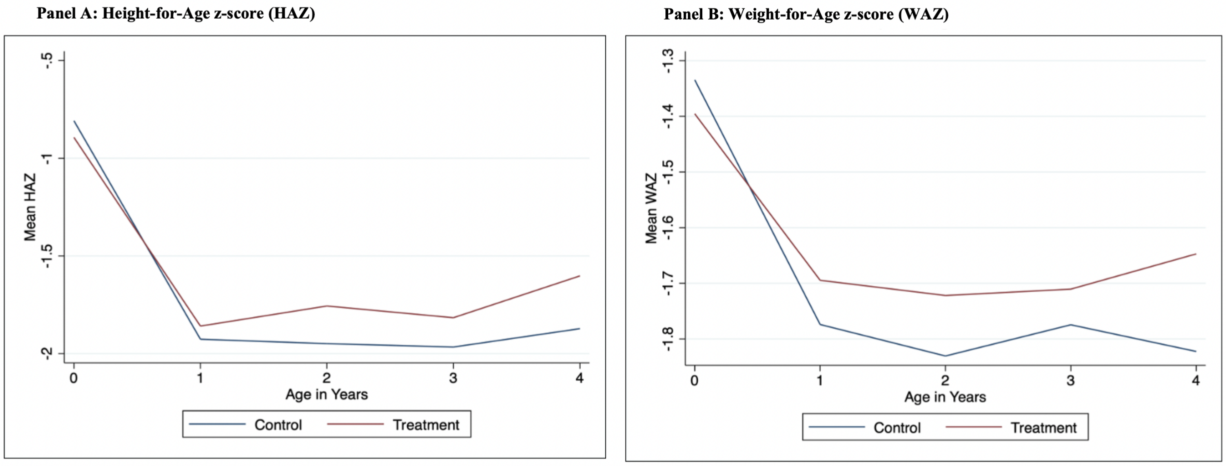
The vertical line denotes 50 percentage points eligibility cutoff of adult female literacy rate (centered at 0). Each circle represents the unconditional mean of z-scores in 0.4 percentage point bins, based on the distance to SBM cutoff. The solid lines are fitted values of z-scores score from a linear spline over a bandwidth of 5 percentage points.
Link to Section 5.1.

Figure A-7: Placebo Treatment Effects (False Program Implementation Dates)



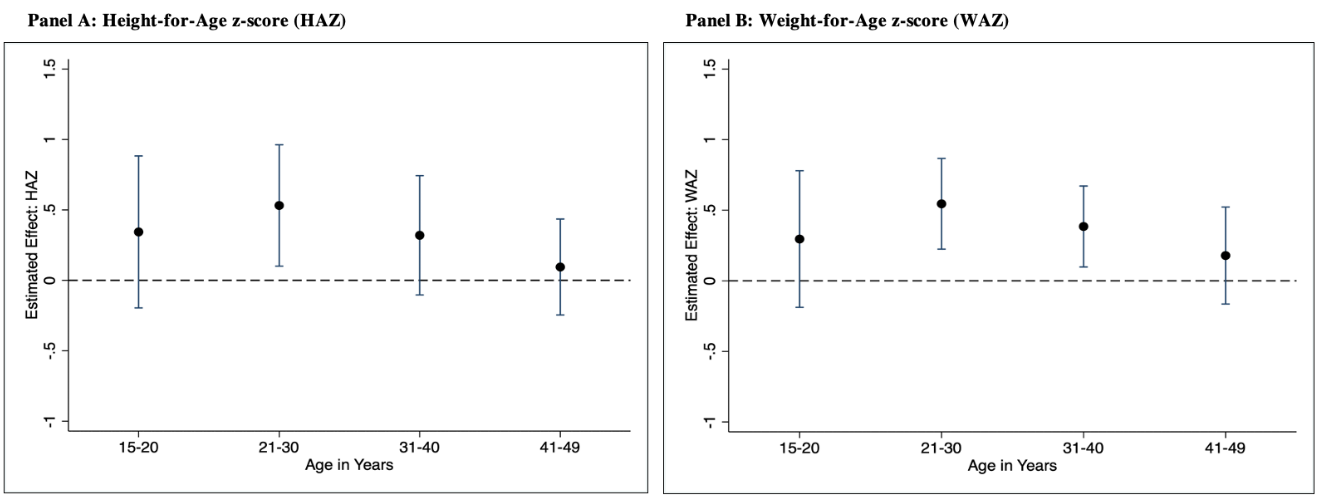
Distribution of estimated placebo treatment effects resulting from 10,000 random assignments of districts to treatment status. The placebo treatment effect estimates correspond to randomly assigned SBM implementation dates to districts with the dates drawn from the actual set of implementation program dates, without replacement. In a given year, the same number of districts have the placebo implementation introduced as had the actual implementation, but the placebo assignment will be to a random selection of districts. The vertical red line corresponds to the location of the actual treatment effect. The fraction of placebo estimates larger than the actual estimate is reported on the x-axis. The actual point estimate for HAZ is smaller than all but 7 percent of the placebo estimates and for WAZ it is smaller than all but only 1 percent of the placebo estimates.
Link to Section 5.2.

Figure A-8: Mean HAZ and WAZ Age Profile



Figures present the z-score age profile by control and treatment groups. Panels A and B uses the RD analysis sample around the literacy threshold, and uses the optimal bandwidth of ±0.05.
Link to Section 5.4.

Figure A-9: Treatment Effects by Mother's Age



Figures display point estimates from linear spline regressions using optimal bandwidth of 5% on both sides of the eligibility threshold by mother's age. Spikes correspond to the 95% confidence intervals computed using standard errors clustered at the district level.
Link to Section 5.4.

Table A-1: Effect of the SBM on Z-scores (Median Reference)

	Height-for-Age z-score			Weight-for-Age z-score		
	(1)	(2)	(3)	(4)	(5)	(6)
Treat	0.375***	0.318**	0.307**	0.329**	0.317**	0.328**
	(0.135)	(0.142)	(0.141)	(0.136)	(0.139)	(0.130)
Birth year FE	No	Yes	Yes	No	Yes	Yes
Controls	No	No	Yes	No	No	Yes
Mean	-1.483	-1.483	-1.483	-1.769	-1.769	-1.769
Sample size	6,394	6,394	6,394	6,394	6,394	6,394

The sample is restricted to the literacy rate within 5% on both sides of the eligibility threshold. All specifications control for linear splines in literacy rate. Columns (3) and (6) includes controls for birth order, child gender, and Hindu mother. A total of 114 districts were included in the RD analysis sample – 65 treated and 49 control districts. Standard errors are shown in parentheses and are clustered at the district level: * significant at 10%, ** significant at 5%, *** significant at 1%.
Link to Section 5.1.