Beyond Literacy: Intergenerational Health Effects of Adult Learning in India*

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Abstract

I estimate the intergenerational effects of a large-scale adult learning program on child health in rural India. Beginning in 2009, the government launched the *Saakshar Bharat Mission*, targeting women in districts with female literacy rates of 50 percent or below. I exploit this eligibility rule in a regression discontinuity design using data from the nationally representative Demographic and Health Survey. Children of eligible mothers have significantly better health outcomes, with higher height-for-age and weight-for-age z-scores corresponding to an 18 to 20 percent reduction in the nutrition deficit. These gains appear to be driven by higher maternal labor force participation and more diverse child diets, rather than fertility changes or greater healthcare utilization. These findings demonstrate that large-scale adult learning programs can yield substantial intergenerational health benefits and broader social gains, underscoring their value as complementary investments in human capital and overall welfare in low- and middle-income countries (LMICs).

Keywords: multifaceted adult learning programs, child health, anthropometric z-scores, regression discontinuity design
JEL Codes: I12, I15, I28, J13, O12

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1 Introduction

Undernutrition among children remains one of the most pressing public health challenges in low- and middle-income countries (LMICs), with the highest prevalence of stunting in South Asia (UNICEF et al. 2021; Global Nutrition Report 2021).[1,2] These early-life deficits have lasting consequences for human capital formation, including impaired physical growth, lower educational attainment, reduced labor productivity, and diminished lifetime earnings (Grantham-McGregor et al. 2007; Currie and Almond 2011; Black et al. 2013).[3] As women are often the primary caregivers, their education, skills, and empowerment play a critical role in determining children's health and nutrition. Yet, in rural India, women face severe disadvantages: literacy rates lag far behind men's, economic opportunities are scarce, and autonomy within households is limited (UNICEF et al. 2019).

In 2009, the Government of India launched the *Saakshar Bharat Mission* (SBM), the largest nationwide adult learning program with the explicit aim of reaching rural women.[4] The program offered approximately 300 hours of instruction, combining three components: (i) basic literacy and numeracy, (ii) job skills, and (iii) life skills such as health, hygiene, and nutrition practices. Unlike formal schooling, the SBM was designed for women who had already missed out on education in their youth and who were often from highly disadvantaged backgrounds (MHRD 2009). Most adult education programs have traditionally focused on literacy training. However, for rural women, basic literacy often does not translate into immediate or meaningful economic gains (Hanushek and Woessmann 2008; Banerjee et al. 2015). In contrast, job skills and life skills training respond more directly to women's priorities. Job skills training creates pathways to income generation, strengthening women's economic position and improving the resources available for their children (Blattman, Fiala and Martinez 2014; Bandiera et al. 2017). Life skills, such as knowledge on health, hygiene, and nutrition, help reduce illness and lower household healthcare costs (De Walque 2007; Dupas 2011).

This paper provides the first causal evidence on the intergenerational health impacts of a large-scale multifaceted adult learning program (ALP) using a regression discontinuity design that exploits the program's eligibility rule. Rural districts with an adult female literacy rate of 50 percent or below, as recorded in the 2001 Census of India, were eligible to participate. This rule generates a discon-

[1]Stunting refers to children being too short for their age. In 2020, an estimated 149.2 million children under age five were stunted worldwide, including 54.3 million in South Asia (UNICEF et al. 2021).

[2]India has high prevalence of stunting (31 percent) and underweight (33.4 percent) among children under five years of age (World Health Organization (WHO) Global Health Observatory data repository, 2021).

[3]A recent estimates suggest that childhood stunting reduces private-sector revenues in LMICs by up to $265 billion annually (Akseer et al. 2022).

[4]Of its more than 76 million beneficiaries, over 52 million (68 percent) were women (MHRD 2018).

tinuity in the probability of program participation around the literacy threshold, which I leverage by comparing outcomes for children of eligible and ineligible mothers within a narrow bandwidth around the cutoff. Identification relies on the assumption that unobserved determinants of child health evolve smoothly across the threshold. To implement this design, I combine administrative data on the timing of SBM rollout in eligible districts with household- and child-level information from the Demographic and Health Survey (DHS). The analysis sample includes children and mothers residing in rural districts observed between 2010 and 2016.

I find that access to SBM led to meaningful improvements in child health. Children of program-eligible mothers exhibit significantly higher height-for-age and weight-for-age z-scores. These improvements correspond to an 18 to 20 percent reduction in the nutrition deficit relative to well-nourished children. In addition, they are 10 percentage points less likely to be moderately underweight. I find no evidence of changes in fertility behavior, suggesting that the results are not driven by endogenous childbearing decisions. Since individual-level enrollment records are unavailable, the estimates capture intent-to-treat (ITT) effects of the program.

The results are robust to a wide range of sensitivity checks, including alternative bandwidths, polynomial specifications, local linear estimation, clustering assumptions, sample compositions, and placebo treatment effects. In addition, I implement a difference-in-discontinuity design, which yields consistent estimates. To explore mechanisms, I examine several pathways through which SBM may have affected child health. I find no evidence of improved maternal literacy, but there is suggestive evidence of increased female labor force participation, plausibly driven by the program's job-skills training. In addition, children of eligible mothers consume more diverse diets, consistent with gains from the program's life-skills component. By contrast, I find no evidence of greater use of healthcare services. These patterns suggest that the improvements in child health were driven less by formal literacy acquisition and more by enhanced maternal empowerment and household decision-making fostered by the program.

Back-of-the-envelope calculations suggest that the social gains from improved child health attributable to SBM are substantial, amounting to at least \$458.5 million (2018 US dollars). This estimate reflects only the short-run reduction in disease burden and should be viewed as a lower bound. It excludes potentially large dynamic benefits, including higher schooling attainment, productivity gains, improved labor market outcomes, and reduced healthcare expenditures in adulthood (Kakietek et al. 2017).

This paper contributes to the growing literature evaluating the effects of large-scale ALPs on non-market outcomes, with a focus on childhood undernutrition. A well-established finding is that most ALPs yield only modest improvements in adult literacy and numeracy (Abadzi 2003; Aoki 2005;

Carron 1990; Ortega and Rodríguez 2008). Nevertheless, a more recent body of work suggests that these programs can generate a wide range of broader benefits, including higher household income, greater civic participation and self-confidence, improved adult health, and increased labor market activity (Abadzi 2003; Aoki 2005; Aker, Ksoll and Lybbert 2012; Okech et al. 2001; Oxenham et al. 2012; Blunch 2009). Evidence from Ghana, for example, shows that participation in adult literacy programs is associated with lower child mortality (Blunch 2013). To the best of my knowledge, this is the first paper to provide causal evidence on the impact of a mass ALP on child nutrition, while also examining the mechanisms through which these effects arise. In addition, by exploiting a regression discontinuity design, this study addresses the potential endogeneity of maternal education decisions.

This paper also relates to the literature on multifaceted skill-training interventions designed to improve the livelihoods of disadvantaged women. This paper also relates to the literature on multifaceted skill-training interventions designed to improve the livelihoods of disadvantaged women. These programs typically provide a package of income-generating assets, training in entrepreneurial activities, life skills (including health and nutrition), healthcare utilization, and awareness of social, legal, and political rights. Such interventions can enable participants to escape poverty by fostering self-reliance. A large body of evidence shows that multifaceted skill training and asset transfer programs targeting the ultra-poor improve earnings, consumption, psychological well-being, health, asset accumulation, and both short- and long-term occupational outcomes (Banerjee et al. 2015; Bandiera et al. 2017; Misha et al. 2019; Banerjee, Duflo and Sharma 2021). Similar programs that transfer cash rather than assets have also been found to enhance labor market outcomes (Blattman, Fiala and Martinez 2014; Blattman et al. 2016; Gobin, Santos and Toth 2017). A smaller set of studies investigates spillovers to child health, documenting positive effects on anthropometric outcomes (Jalal and Frongillo 2013; Raza, Van de Poel and Van Ourti 2018). In contrast, the program studied here is an information-based intervention without any monetary or asset transfers, allowing me to isolate the role of knowledge and skills in shaping intergenerational health outcomes.

A key takeaway from this study is that large-scale adult learning programs can be an effective policy tool for enhancing women's knowledge and generating intergenerational health benefits. Yet over the past two decades, the popularity of such programs has declined, largely because they have struggled to produce substantial improvements in literacy outcomes (Easton and Samples 2015). As a result, such programs have received less policy attention and drawn less funding. This narrative, however, overlooks the multifaceted nature of most ALPs, which combine literacy and numeracy training with job- and life-skills components. Evidence suggests that while it is difficult to achieve meaningful literacy gains in short-duration programs, other components, such as, job skills or health and nutrition training, can be acquired more quickly and yield significant benefits.

Extending the duration of literacy and numeracy training, alongside leveraging mobile technology and internet-based platforms, may enhance effectiveness and reach populations in remote areas at lower cost. Policymakers should, therefore, view ALPs not as substitutes for formal schooling but as complementary interventions that can improve welfare, particularly for rural populations in developing and least-developed countries.

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

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 made significant strides in improving adult literacy rates (Figure 1–Panel A).[5] Despite this progress, there is still a significant gender gap between men (79 percent) and women (59 percent) in India. The male-to-female literacy ratio was 1.33 in 2011, indicating that there is still work to be done to achieve gender equality in literacy, as illustrated in Panel B of Figure 1. Illiteracy among women, especially in rural areas, continues to remain a challenge for India. Women in rural areas face numerous challenges to education due to complex sociocultural stratification, patriarchal norms, lack of awareness, and economic inequality (Govinda and Biswal 2006). These challenges are compounded by primary schools' ineffectiveness in enrolling and retaining students, lack of school accessibility, technological barriers, and inadequate school facilities (UNESCO 2003). Furthermore, rural women may find it challenging to prioritize education due to competing demands on their time and the long-term nature of returns on education (Abadzi 2003).

The Indian government has made consistent efforts to promote adult education since gaining independence in 1947. The government launched significant initiatives in almost every decade, such as the Social Education Program (1952), Farmers' Functional Literacy Program (1968), National Adult Education Program (1978), and National Literacy Mission (1988). However, these programs were criticized for their sporadic nature and limited coverage, with the exception of the National Literacy Mission (Ramabrahmam 1989). The launch of the National Literacy Mission program in 1988 was a significant step towards promoting adult education, as it targeted non-literates between

[5]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.

15 and 35 years of age, resulting in an increase in the literacy rate from 48 percent in 1991 to 61 percent in 2001 (Figure 1–Panel A). Despite this success, there were significant gender disparities and wide variations across states, which demanded more concerted efforts to make learning objectives inclusive (Govinda and Biswal 2006).

2.2 Program description

Saakshar Bharat Mission (SBM), launched on International Literacy Day in September 2009, was the world's most extensive learning program. 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 The SBM program had a multifaceted approach with three primary objectives: (1) functional literacy and numeracy skills, (2) job skills development program, and (3) life skills development program. The program provided basic literacy and numeracy to non-literate and non-numerate adults and formal education to neo-literates. It also offered skill training crucial in improving individuals' working and living conditions, including agriculture and animal husbandry, nutrition information, hygiene and sanitation, personal and social development. Due to its implementation approach and close work with local communities, it was described as a “people's program” (Kairies 2013). SBM was one of India's largest skill-providing initiatives and 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 (MHRD 2009). More than two-thirds of the 76 million beneficiaries were females, i.e., around 52 million (MHRD 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.

SBM 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).

Under the program implementation, approximately 156 thousand adult education centers (AECs) in rural villages, with at least one female coordinator appointed to manage each center (Figure A-

2). The program received a sanctioned budget of 1.6 billion US dollars. Around 5 million local volunteers received training for the program instructions before and during their teaching assignments. On average, each educator was responsible for instructing a class of 8 to 10 learners, with a total of around 30 learners per year. AECs were operational for 8 hours per day, and learners attended classes for 2 to 3 hours according to their availability. Participants were identified through a survey and received approximately 300 hours of tuition. Further details about the program's infrastructure are presented in Figure A-3.

The program was designed to incorporate core elements from the National Curriculum Framework for Adult Education, supplemented with locally relevant content that addressed learners' specific livelihood challenges. Learning materials were developed through collaboration between adult educators, subject experts, and learners, with a focus on identifying the needs and interests of learners. A Quality Assurance Committee scrutinized the material before it was field-tested and revised. Once finalized, the teaching material was standardized and used to provide instruction to learners. The program printed basic literacy primers in 14 languages and 28 local dialects to ensure that learners received instruction in their preferred language.

Upon completion of the instructional learning, participants had to take the Basic Literacy Assessment Test conducted by the National Institute of Open Schooling (NIOS).[6] The assessment tests were designed based on the NIOS guidelines and were administered twice a year, in March and August. The three-hour exam evaluated the learners' reading, writing, and arithmetic skills. Certificates were issued to those who successfully passed the test within 60 days, and the results were made available on the NIOS website.

2.3 Effect of Program Participation

Participation in the SBM program has the potential to impact job opportunities for women through education and vocational training. Additionally, the availability of financial resources may lead to improved child development, including better health outcomes. Education is also a critical factor in improving child health as research has shown that educated mothers can make informed decisions about their children's health, adopt positive health behaviors, provide a nutritious diet, and manage finances effectively (Grossman 1972; Grossman 2006). In this study, the focus is on the effect of the SBM program on child health, measured by anthropometric z-scores for children under the age of five, as the early years of life are critical in shaping health and social outcomes throughout life (Irwin et al. 2007). Furthermore, the study examines the potential mechanisms

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

through which the program may have improved functional literacy and evaluates the impact of skill development training on labor force participation. The analysis sample is restricted to women living in rural areas with 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). Specifically, the rural female adult literacy rate increased from 47 percentage points in 2008 to approximately 59 percentage points in 2018 (Figure 1–Panel C), and the male-to-female literacy ratio is approaching one, indicating progress towards gender equality (Figure 1–Panel D). [7] Examining rural districts where the SBM program was implemented reveals that the adult female literacy rate rose from 35 percentage points in 2001 to 45 and then to 53 percentage points in 2011 and 2018, respectively.[8]

According to the Ministry of Human Resource Development (MHRD 2018), the SBM program provided an enabling environment for learners to participate. The program's flexibility in terms of class timings and low time commitment minimized the possibility of significant work substitutions for participants. Additionally, the use of mass media such as radio and television to reach the target population and the involvement of locals in program planning and implementation were also factors that may have contributed to the program's success. Moreover, the generous funding support from the federal government, which was responsible for overseeing the program, would have incentivized state governments to execute the program effectively. [9] It is worth noting that the implementation efficiency of the program may have varied across villages, thereby impacting the extent of the program's effects on participants.

Despite good intentions, it is unclear whether the program reached all the women who were intended beneficiaries. Sociocultural norms and the patriarchal system can create significant barriers to bringing women out of their homes to attain education (Govinda and Biswal 2006). The elderly may also be less motivated to participate in education due to growing age and a lack of interest (National Research Council 2012). Furthermore, administrative inefficiencies, mismanagement of funds, or lack of coordination among implementation authorities may have prevented the program

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

[8] These findings were based on the author's computations using Census of India data (2001 and 2011) and the Periodic Labor Force Survey (2018).

[9] 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 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.

from reaching all its beneficiaries, given its massive country-wide scale (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.[10] 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 dataset used in this study provides comprehensive information on population health and nutrition across various states in India. The study focuses on women aged 15 to 49 residing in selected households who were interviewed to gather information on individual characteristics such as birth year, location of residence, education level, age, caste, and religion. In addition, data on childbirth, healthcare services utilization (vaccination, prenatal and postnatal care), and household characteristics (assets ownership, availability of electricity, toilet facility, piped drinking water) were collected. The data collection process was initiated in January 2015 and was concluded in December 2016 (Figure 3). It is worth noting that the last phase of the SBM program was implemented in 2017-18; therefore, the observations from such districts are excluded from the analysis.[11]

The study analyzes data from 2010 to 2016 to examine the impact of SBM on functional literacy and vocational education. The analysis is limited to mothers residing 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.[12] 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,

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

[11]Phase-7 of the program was implemented in eleven districts, including seven districts of Punjab (Mansa, Firozpur, Bathinda, Barnala, Muktsar, Sangrur, and Faridkot) and four districts of Jharkhand (Khunti, Jamtara, Seraikela-Kharsawan, and Simdega). However, due to administrative failures, some of these districts did not receive the treatment.

[12]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.

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).[13] 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.

3.2 Government Archival Records

The Indian federal government originally assigned all eligible treatment districts into three phases for the implementation of the SBM. The state governments were responsible for executing the program in collaboration with district-level authorities. However, due to administrative discrepancies, many states did not follow the guidelines, leading to delays in program implementation. As a result, the SBM was extended from 2012 to 2018. Given this delay, the original proposed launch dates for the program were no longer accurate, as it affected most districts.

To accurately determine the timing of the SBM program implementation, I utilized various sources such as official records obtained through the right to information (RTI) act, archival records from federal and state governments, and newspaper reports. By accessing this information, I was able to identify the precise timing of the program rollout across districts, which is shown in Figure 3. To link this administrative data with the Demographic Health Survey (DHS) data for mothers and children at the district level, I defined the dates at the month-year level. This approach enabled me to obtain a comprehensive understanding of the program's implementation and its impact on the target population.

[13]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, Rao and Desai 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

3.3 Key Variables and Summary Statistics

The main outcome of interest in this study is the anthropometric z-scores based on the World Health Organization (WHO) child growth standards for children below the age of five: height-for-age (HAZ) and weight-for-age (WAZ). These z-scores are used to determine the extent of under-nourishment in children and are assigned using an interpolation function that takes into account age, gender, height, and weight. [14] As z-scores data are only available for births five years prior to the survey year, births before 2010 are excluded from the analysis.

Other outcome variables include the probability of being stunted, underweight, and infant mortality. Stunting is defined as children whose HAZ is below negative two standard deviations under the mean on the WHO growth standards, while the probability of being underweight is defined using WAZ. Stunting signifies chronic malnutrition in a child, whereas being underweight is a measure of chronic and acute malnutrition. To explore potential causal channels, the study also investigates 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 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.[15] Statistics are presented by the treatment eligibility status. In the overall sample, 73 percent of the women have no type of formal education, 50 percent belong to disadvantaged castes, and around 69 percent of women are Hindu. 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. A negative z-score, say -1.75, indicates that a child is below the age- and gender-specific WHO standards by 1.75 standard deviations. A z-score of zero implies that a child is growing in nutritionally sufficient conditions and with adequate health protections. 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.

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

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

4 Empirical Methodology

4.1 Identification

The aim of this study is to assess the impact of SBM eligibility on intergenerational health outcomes. Given the complex implementation structure of the program at such a large scale, it is challenging to accurately measure the spillover effects of ALPs on child outcomes. Therefore, 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 examine whether SBM had a positive effect on children's health outcomes born to eligible mothers relative to ineligible mothers in the neighborhood of the eligibility 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:

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

where y_{ijd} represents health outcomes for child i born to a mother j living in district d, 12 months after launching of SBM in the district.[16] The variable $Eligible_{id}$ is an indicator variable equal to 1 if child i was born in a district d with a literacy rate $\leq$ 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 linearly 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 child health, coinciding with the birth year beyond the district level. ϵ_{ijd} is 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, Cattaneo and Titiunik (2014) algorithm (CCT). I present evidence that the results are robust to higher-order polynomials and alternative bandwidths.

[16] 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. The results are robust to including these observations.

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 example, 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.[17] 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.[18] 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

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

[18] 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.

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. To the best of my knowledge, such programs do not exist.

Identifying the effect of SBM on child health additionally requires addressing the potential problem of sample selection. This problem may arise if knowledge gain from SBM 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 program effect. Table 2 (Column 4 – Panel A) provides the point estimates for the total number of births between 2010 and 2016, which is the period of analysis. 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

I begin by estimating the effect of the SBM program on intergenerational health outcomes measured by z-scores (WHO growth standards) for children below five years of age using an eligibility threshold based on the adult female literacy rate. The main results are in Table 3 from estimating the baseline regression in equation (1). All estimates include linear splines in the running variable and use a bandwidth of 5 percentage points on either side of the threshold. 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 that the SBM program reduced deficit from well-nourished children of HAZ scores by 0.34 s.d. and of 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 translates to a deficit reduction from well-nourished children for around 18 to 20 percent. Figure 5 (Panels A and B) presents visual evidence of the results in Table 3. The graphs are fitted linear polynomials overlaid on scatter plots of z- scores.[19]

The prevalence of undernourishment among children during their early years is a critical public health concern that can lead to increased healthcare burden and hinder economic growth. Table 4 presents the results of the analysis, which examined the physiological measures of undernutrition

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

in children. Being underweight (low weight for one's age) and stunted (being too short for one's age) are common manifestations of undernutrition and are indicative of inadequate food intake and poor dietary quality over an extended period.[20] I find a 10 percentage points reduction on the likelihood of being moderately underweight (equivalent to a 26.5 percent decrease). While there is a reduction of approximately four percentage points in severe underweight and stunting, the estimates are not statistically significant.[21] The results suggest that children who were eligible for SBM had improved z-scores on average and a lower likelihood of undernutrition.

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 bound of the true impact.

There exists scant literature on ALPs looking at intergenerational health outcomes. A study that closely resembles this work is by Blunch (2013), which found a negative effect of an adult learning 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. Additionally, the law of diminishing returns suggests that varying levels of maternal education may 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 band-

[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.

[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).

width—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 show the results of quadratic and local linear regressions for different bandwidths in Table 5. 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, Cattaneo and Titiunik (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:

$$\begin{aligned} y_{ijdt} = {} & \delta_0 + \delta_1 Eligible_{id} + \delta_2 Literacy\ Rate_d + \delta_3 (Eligible_{id} \times Literacy\ Rate_d) \\ & + \delta_4 Post_{idt} + \beta (Eligible_{id} \times Post_{idt}) + \delta_5 (Literacy\ Rate_d \times Post_{idt}) \\ & + \delta_6 (Literacy\ Rate_d \times Eligible_{id} \times Post_{idt}) + X'_{ij}\theta + B_i + \epsilon_{ijdt} \end{aligned} \tag{2}$$

where $Post_{idt}$ is an indicator variable equal to 1 if the child i was born in year 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 5). The estimates are statistically significant and fairly similar to the baseline specification.[25]

[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.

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]

Next, I examine how estimates vary across clustering assumptions (Table 6). 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 6).

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 7 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

[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 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.

WAZ. The vertical red line denotes the actual estimates from Table 3. 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 8 (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 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.

[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.

5.4 Mechanisms

There are multiple channels in which knowledge gained from ALPs might improve child health. For example, it might improve economic outcomes and increase earnings (Heckman, Stixrud and Urzua 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, Baylis and Arends-Kuenning 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). In this section I investigate three main objectives of the program: (1) functional literacy skills, (2) job skills, and (3) life skills.

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 9 shows that SBM had a significant positive 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, Hurst and Flax 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]

[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.

[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,

Next, I investigate the effect of the SBM program on maternal outcomes. Column (2) of Table 9 presents estimates for ablility to read a sentence. I find no improvement in reading ability of mothers eligible for SBM. The coefficient estimate on literacy is negative and statistically insignificant. Column (3) reports the estimated effects of SBM on mother's labor force participation in the last 12 months.[32] 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 (3) 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 ($\beta = -0.019$, $s.e. = 0.025$).

To explore the behavioral changes of mothers, I look at the utilization of healthcare services during and after pregnancy in columns (4) to (8). The indices are created using multiple related variables, and each variable is standardized and weighted equally in the index construction (Kling, Liebman and Katz 2007).[33] 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 9, 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*

first launched in 1975. I do not find any effect of SBM eligibility on benefits received under the ICDS program.

[32] 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.

[33] 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.

Bima Yojana.[34] However, I do not find any impact on having a bank account or an insurance policy on child health.

The findings presented above indicate that SBM did not succeed in increasing reading ability among mothers, however, there is suggestive evidence of higher labor force participation, likely driven by skill development training. Furthermore, a diverse diet for children seems to explain a substantial fraction of the results. 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 knowledge gain under SBM is potentially behind improving child health outcomes for eligible mothers.

6 Conclusion

This paper has examined the effect of an ALP 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 do not find any evidence of higher literacy among mothers and no impact on change in fertility behavior. The knowledge gained under the SBM program is potentially behind improving child health outcomes for eligible mothers.

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. Being underweight could cause issues in the growth and development of a child and could lead to anemia, vitamin deficiencies, and a compromised immune system. The cost associated with the treatment of acute malnutrition is $125 per child (Bhutta et al. 2013). Taking

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

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.[35] 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 a large-scale ALP 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.[36] 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 their 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.

[35] 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).

[36] 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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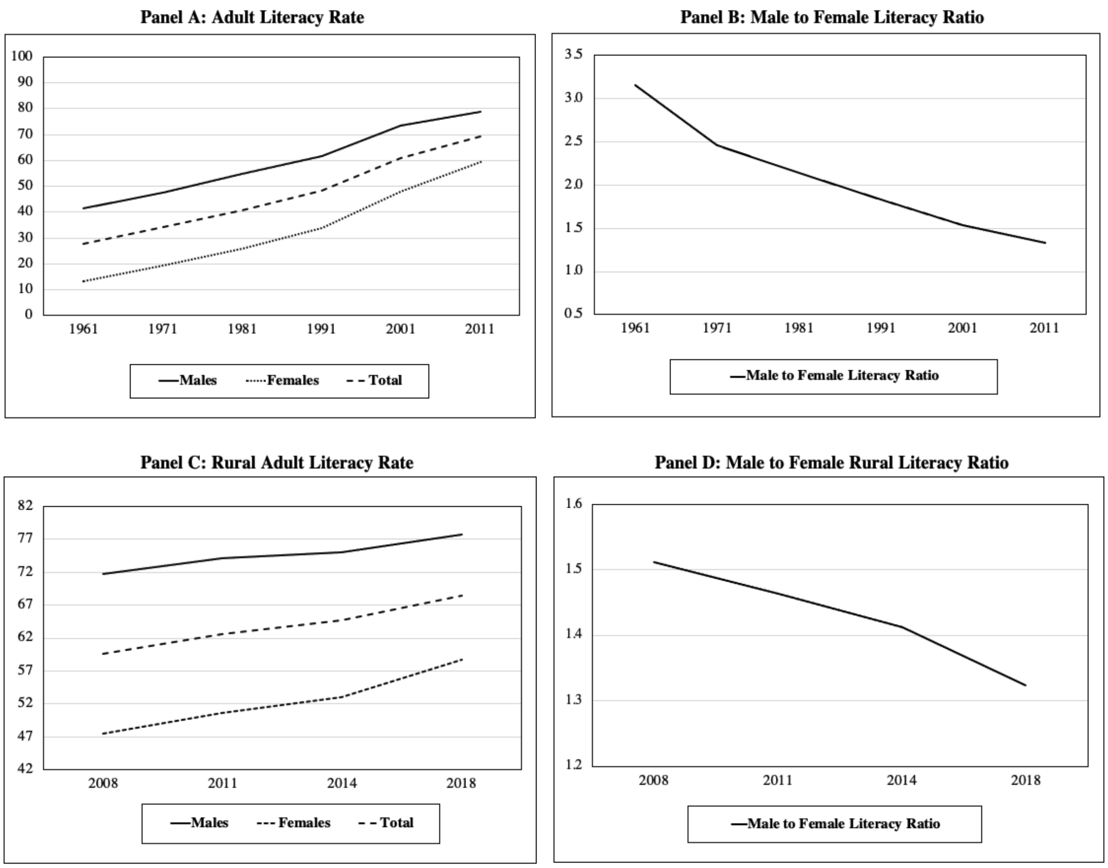
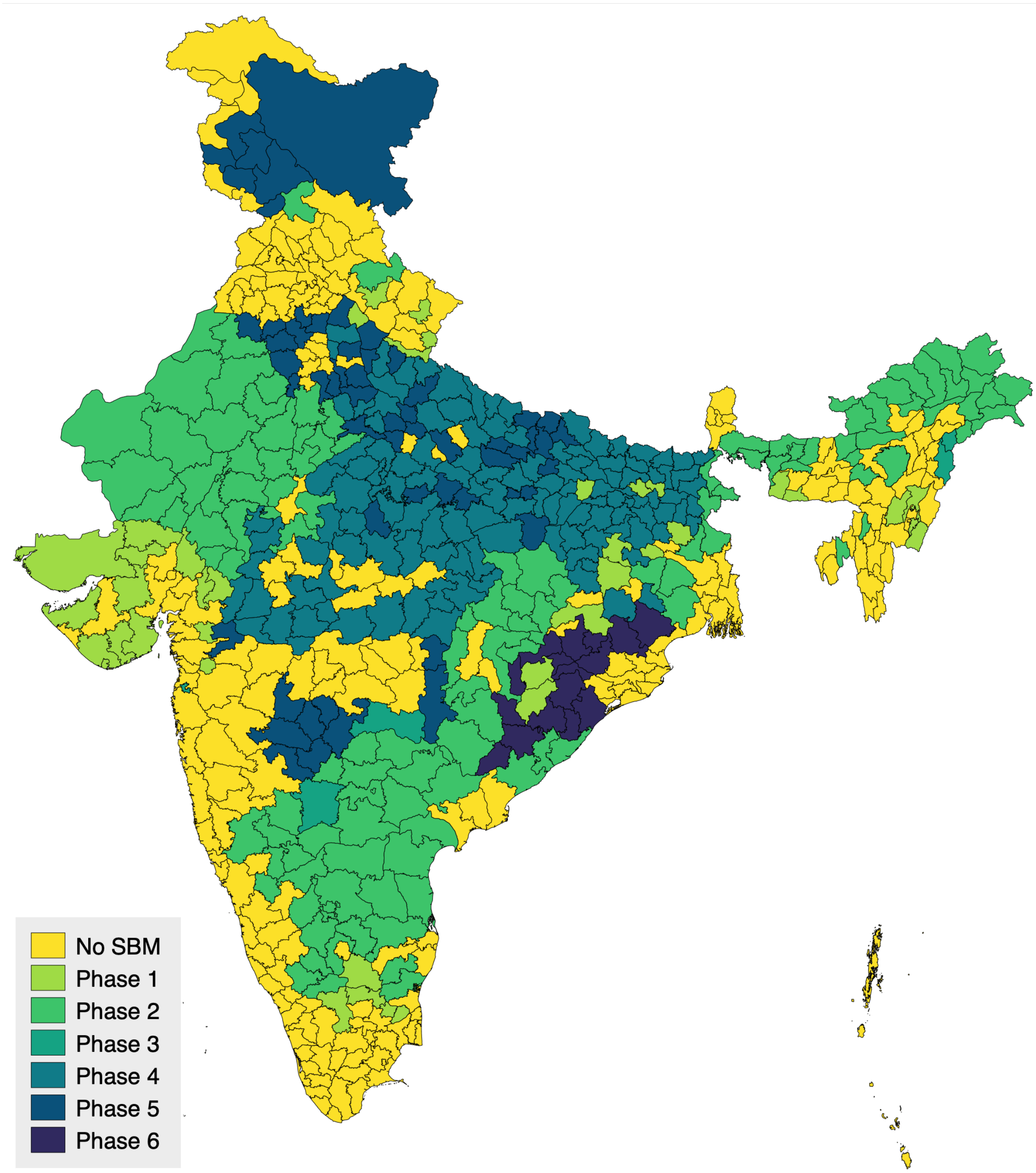
Figure 1: Adult Literacy Trends in India



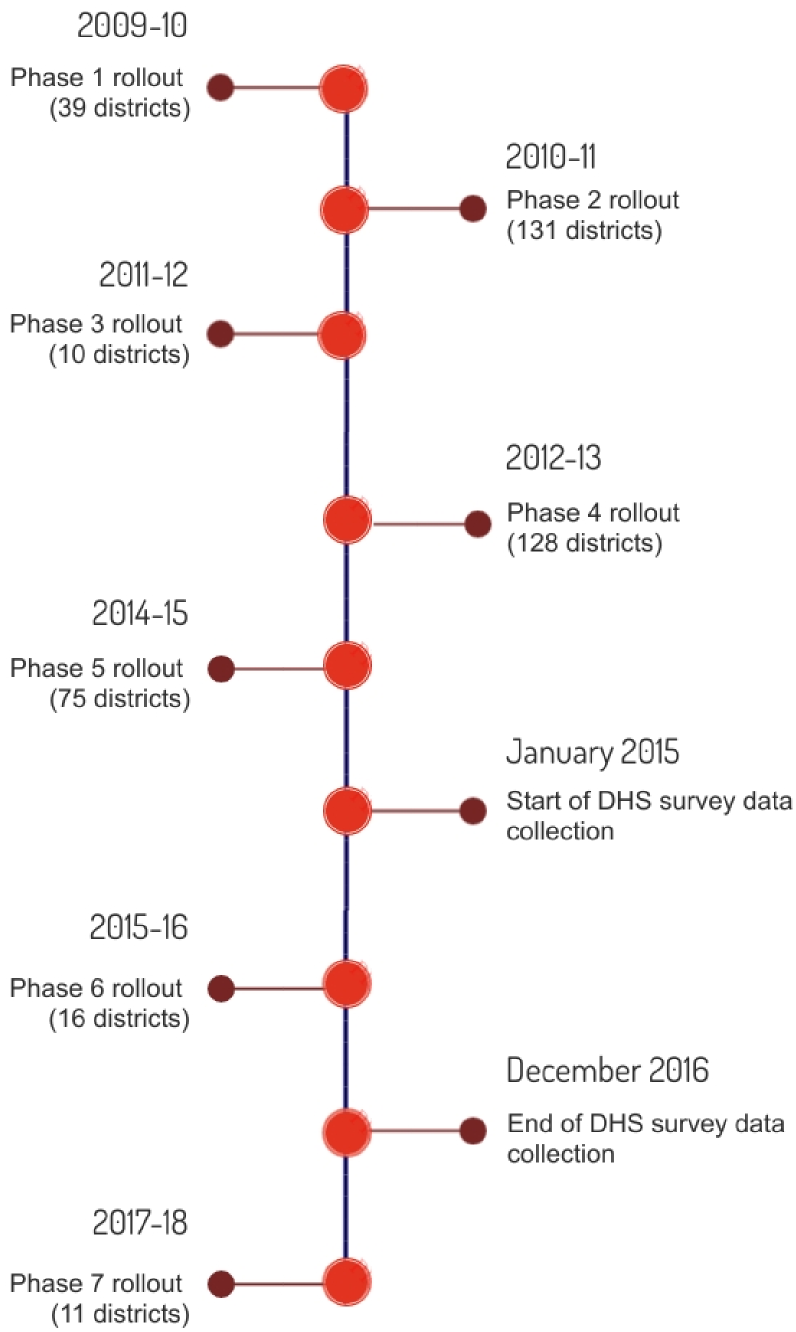
Notes: The figures present the trends for the adult population of 15 years and above age. Data source for figures in panels A and B is Population Census of India. Data source for figures in panels C and D is National Sample Survey rounds and Population Census of India. Link to Section 2.1. Link to Section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

Figure 2: Phase-wise Rollout of SBM Program



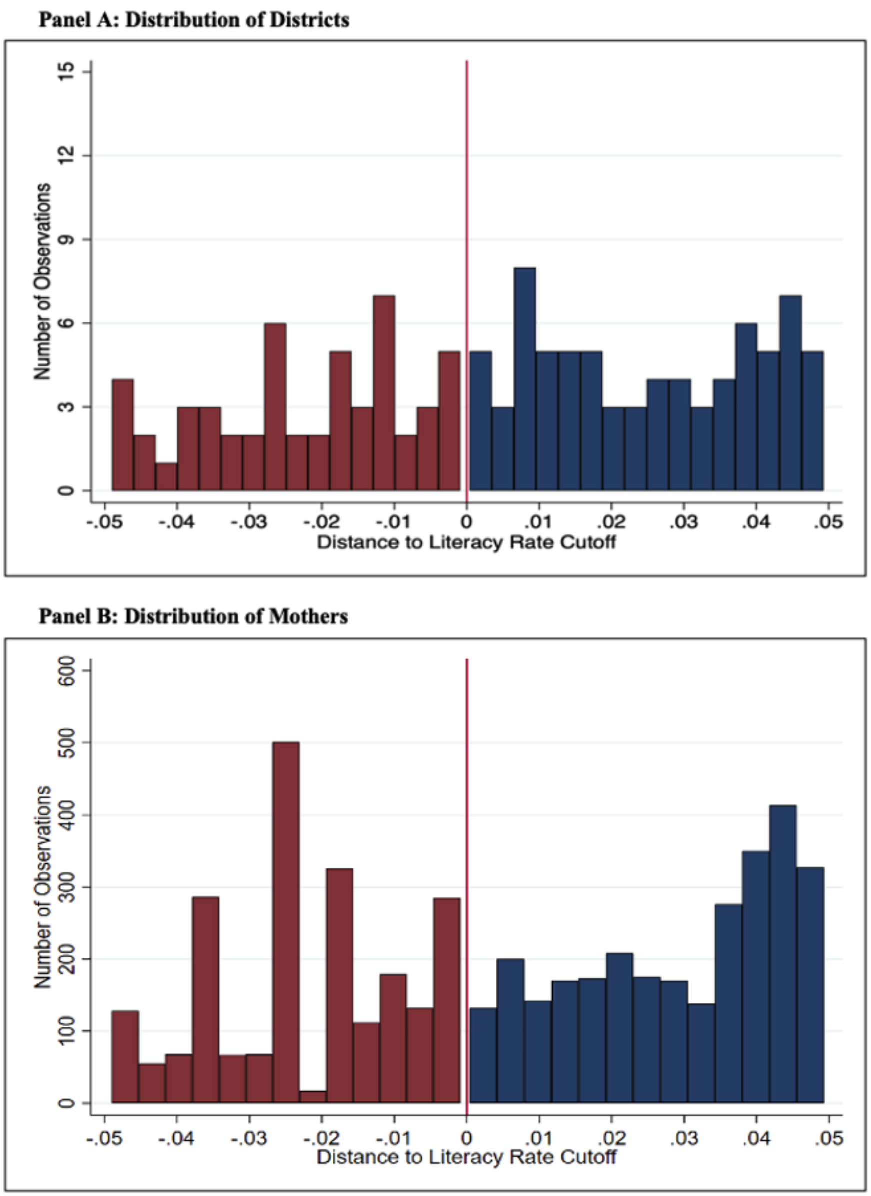
Notes: The color-coded map above shows the districts that implemented SBM program across different phases. The SBM program was rolled out in seven phases. In the seventh phase (2017-18), eleven districts were assigned to receive the program but some of these could not receive it because of administrative 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



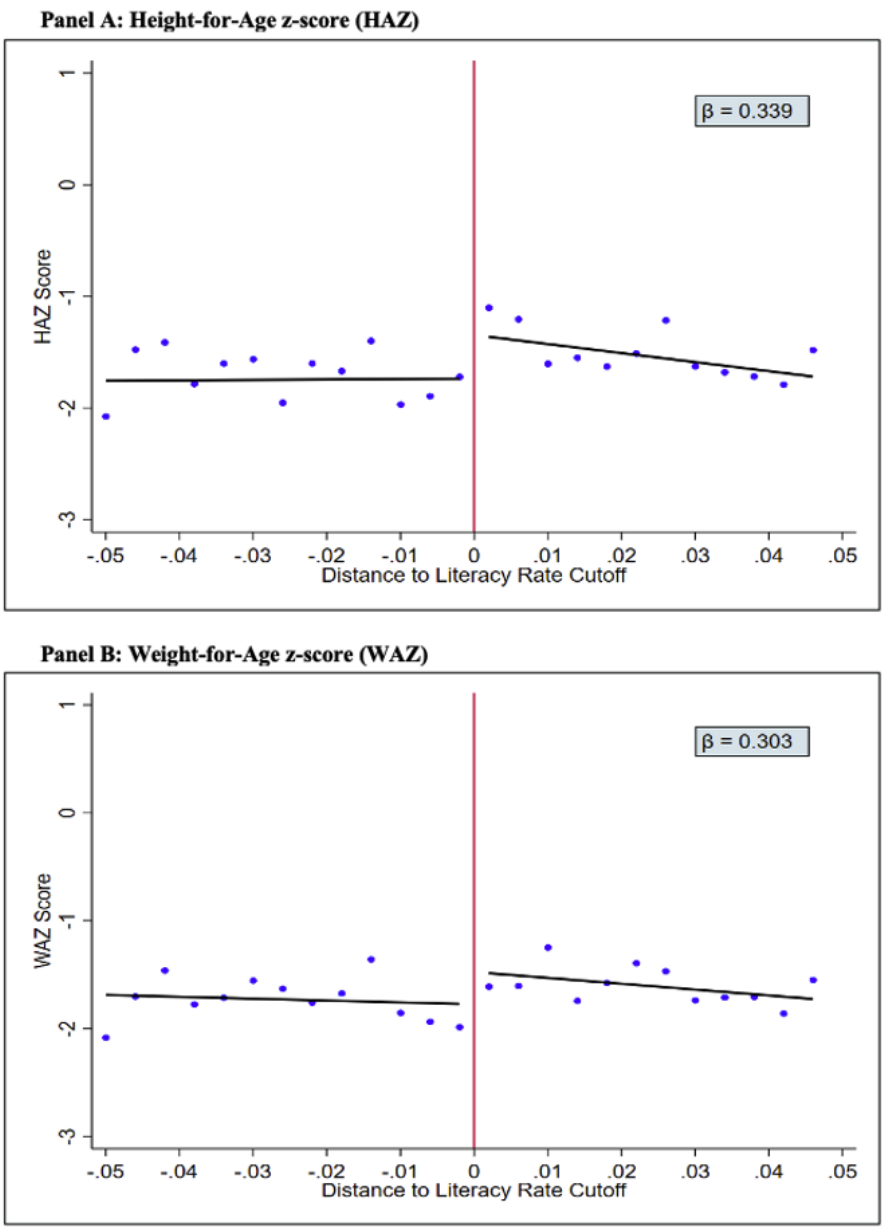
Notes: Some districts in Phase-7 either did not receive the treatment because of administrative failure or received it between 2017 and 2018. Since the data is available until 2016, these districts are excluded from the analysis. Link to Section 3.2.

Figure 4: Distributions Around the Literacy Cutoff



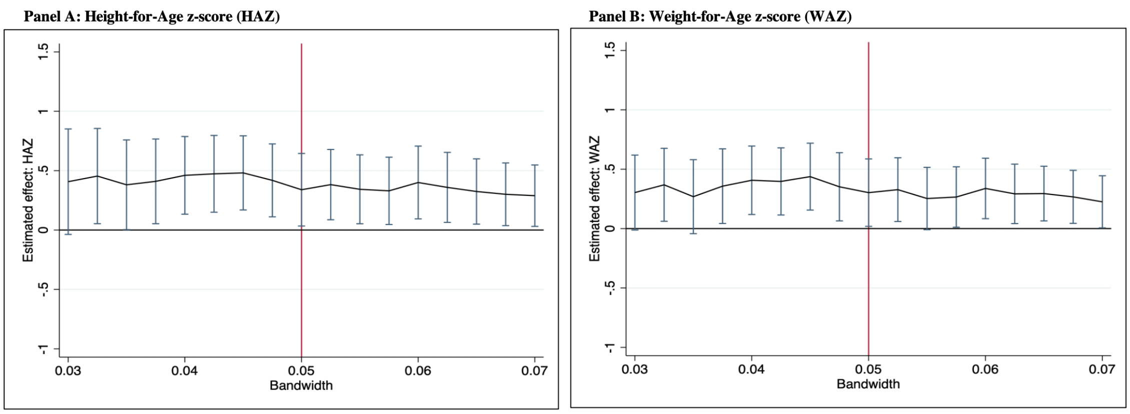
Notes: Panel A shows the distribution of districts and Panel B shows the distribution of mothers relative to the literacy rate cutoff centered at zero. Manipulation tests for Panel A: p-value=0.52 ($k = 0$), p-value=1.00 ($k = 0.01$) and p-value=1.00 ($k = 0.02$). Manipulation tests for Panel B: p-value=0.44 ($k = 0$), p-value=0.58 ($k = 0.01$) and p-value=0.59 ($k = 0.02$). 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



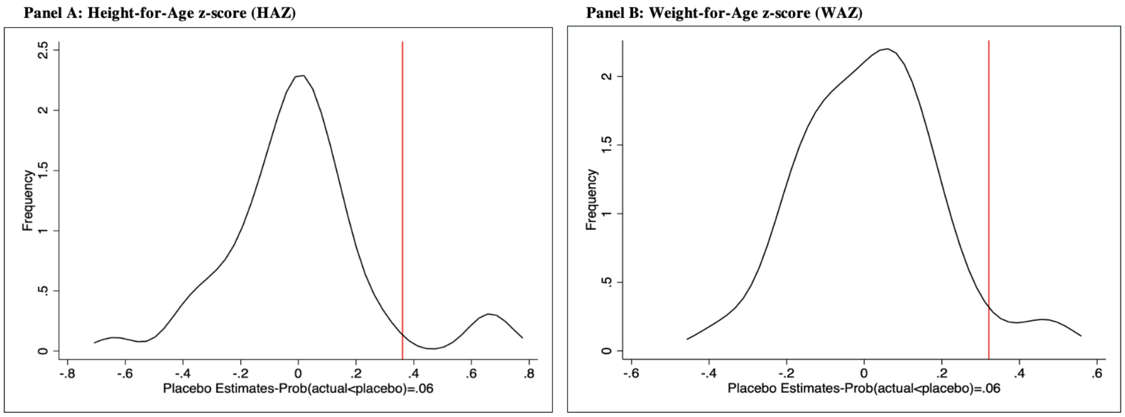
Notes: The vertical line denotes 50 percentage points eligibility cutoff of adult female literacy rate (centered at 0). Each circle represents the unconditional mean of z-scores in 0.4 percentage point bins, based on the distance to SBM cutoff. The solid lines are fitted values of z-scores from a linear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

Figure 6: Bandwidth Choice Sensitivity



Notes: 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)



Notes: 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
Scheduled Caste/Scheduled Tribe	0.53	0.50	0.47	0.50	0.50	0.50
Hindu religion	0.68	0.47	0.69	0.46	0.69	0.46
Age at first birth	20.47	3.80	20.62	3.77	20.56	3.79
Wealth Index (1-5)	1.98	0.98	1.96	0.97	1.97	0.98
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	

Notes: 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)	(2)	(3)	(4)	(5)
	Urban	Hindu	Age	# of Births (last 5 years)	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)	(2)	(3)	(4)	(5)
	Owns House	Owns Land	Husband Education (Years)	Female Child	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)	(2)	(3)	(4)	(5)
	Electricity	Piped Drinking Water	Toilet Facility	Household Assets Index	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)	(2)	(3)	(4)	(5)
	Females	Hindu	Health Centres	Cultivators	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

Notes: 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: 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

Notes: 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 4: 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

Notes: 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 5: 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

Notes: 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 6: 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

Notes: 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 7: Placebo Test for Mothers with Higher-education (not eligible for SBM)

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

Notes: 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 8: 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

Notes: 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.

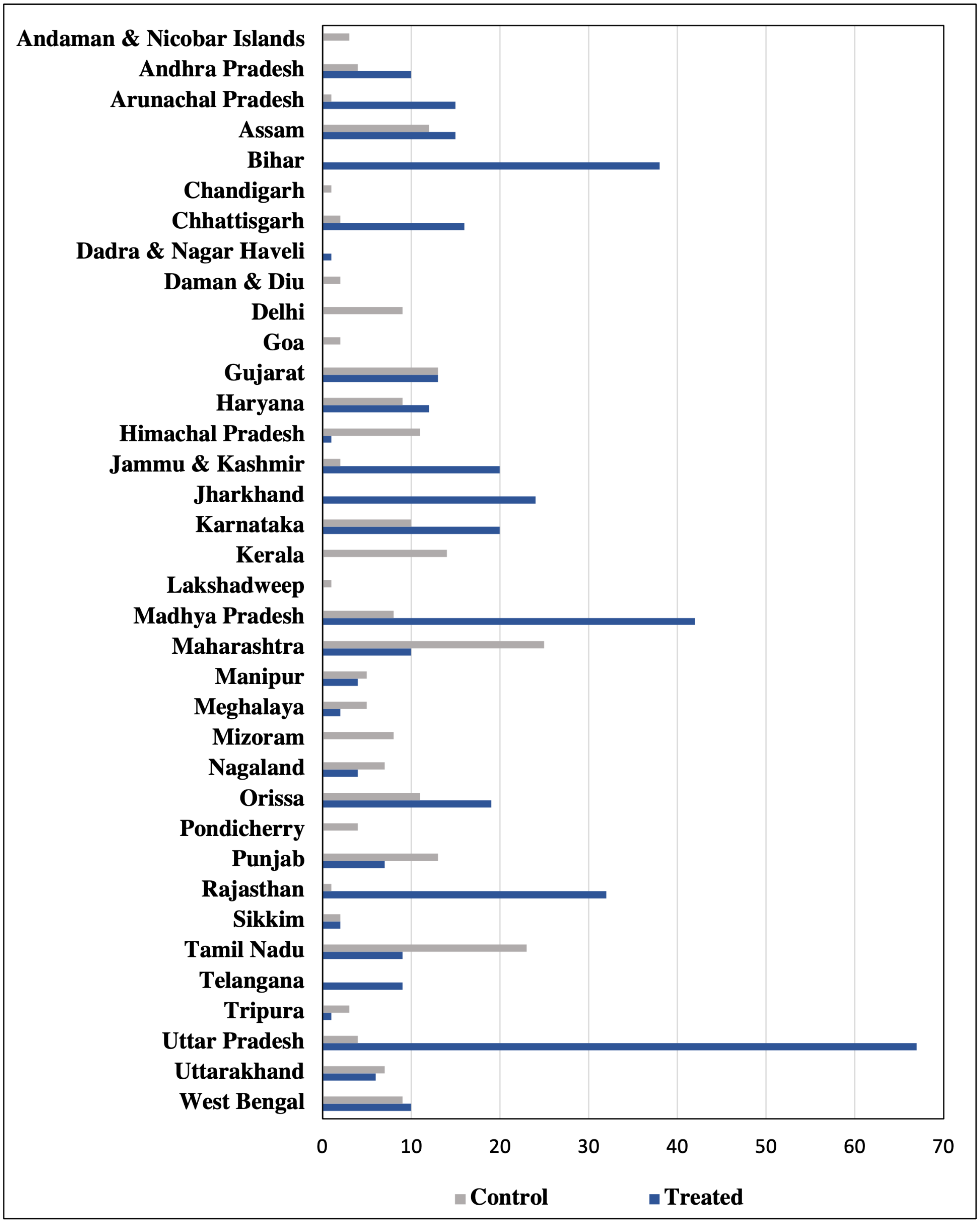
Table 9: Mechanisms - Effects of SBM on Diet Diversity and Healthcare Services Utilization

	(1) Minimum Dietary Diversity Index	(2) Can Read a Sentence	(3) Labor Force Participation (Last 12 months)	(4) Prenatal Care Initiated in First Trimester
SBM Eligible	0.186**	-0.038	0.178**	0.018
	(0.087)	(0.040)	(0.089)	(0.053)
Sample size	5,801	5,098	842	3,989
Mean	0.00	0.185	0.316	0.638
	(5) Prenatal Visits 4+	(6) Received Advice Index	(7) Received Benefits During Pregnancy Index	(8) Received Benefits While Breastfeeding Index
SBM Eligible	0.093	0.177	0.133	0.057
	(0.093)	(0.166)	(0.171)	(0.154)
Sample size	4,845	2,627	3,282	2,959
Mean	0.375	0.00	0.00	0.00

Notes: 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 (6) to (8) 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



Notes: 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

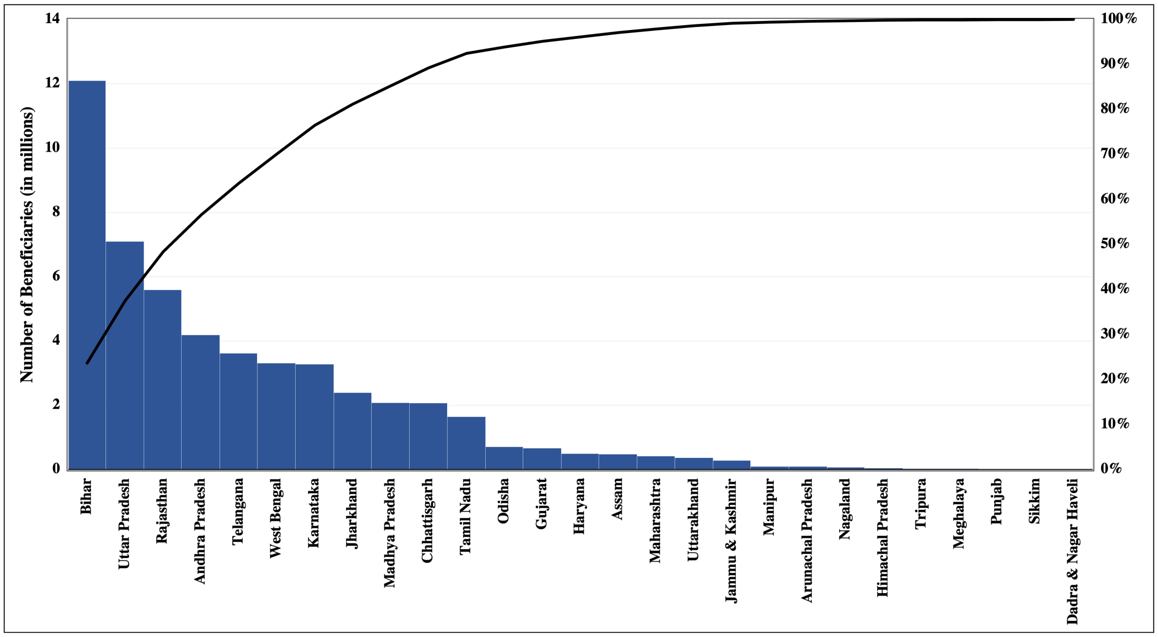
Picture credits: orissadiary.com Link to Section 2.2.

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

Notes: The figure above presents information about infrastructural build-up for implementation of the 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

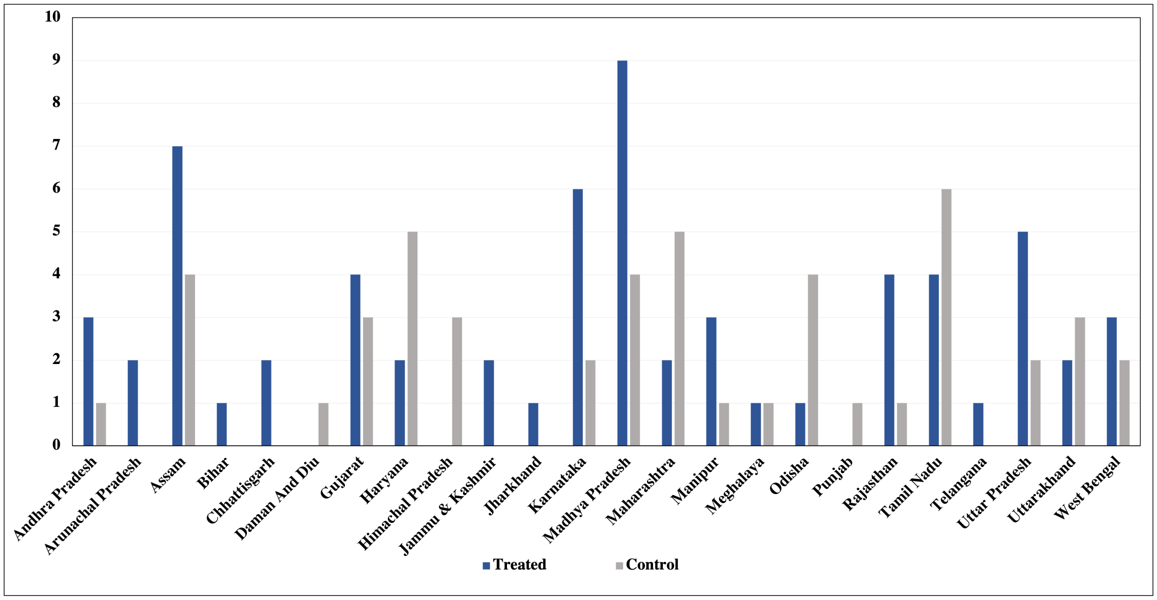


Notes: The Pareto chart shows the state-wise ordered frequency of female beneficiaries (left y-axis). The right y-axis shows the cumulative percentage of female beneficiaries. The x-axis labels the states of India. The total number of successful female learners under the adult literacy program (SBM) was 52 million.

Data source: Ministry of Human Resource and Development (2018)

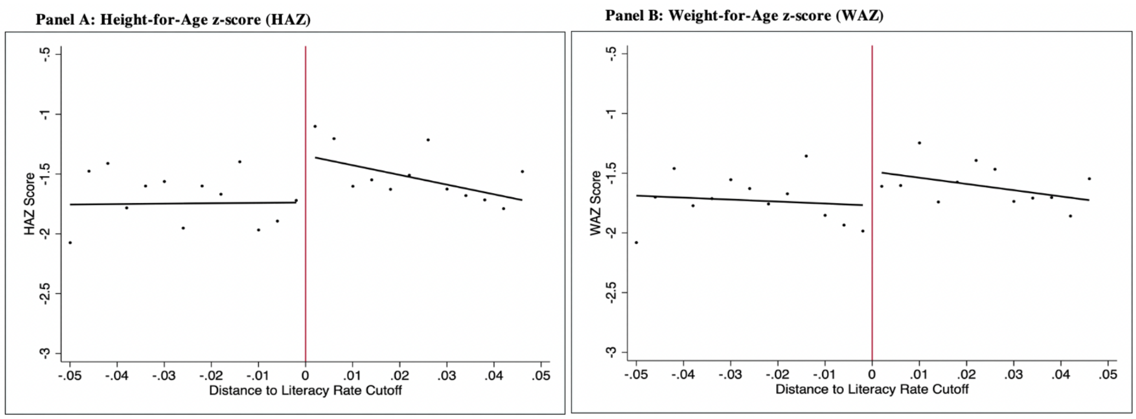
Link to Section 2.3.

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



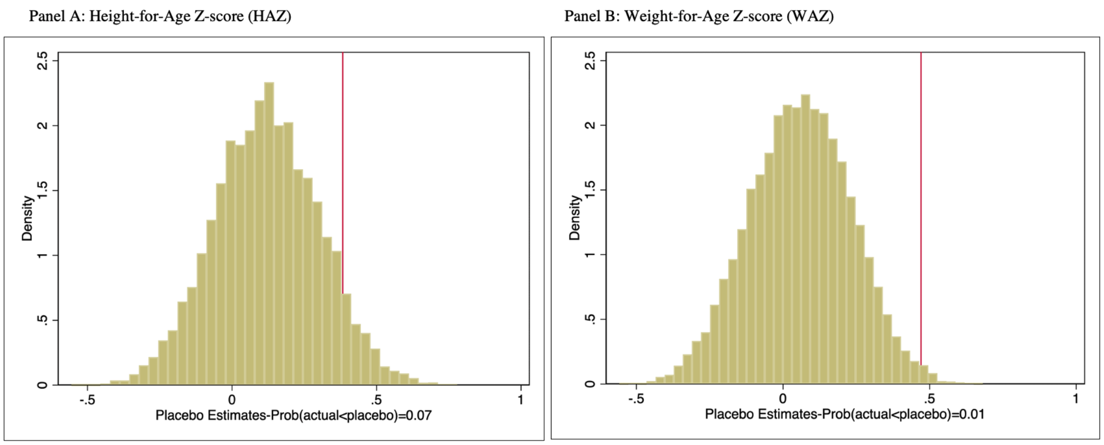
Notes: Note: The figure plots the state-wise frequency of districts included in the RD analysis sample. The x-axis labels the states of India. Link to Section 3.3.

Figure A-6: RD Graphs (Zoomed in)



Notes: 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.

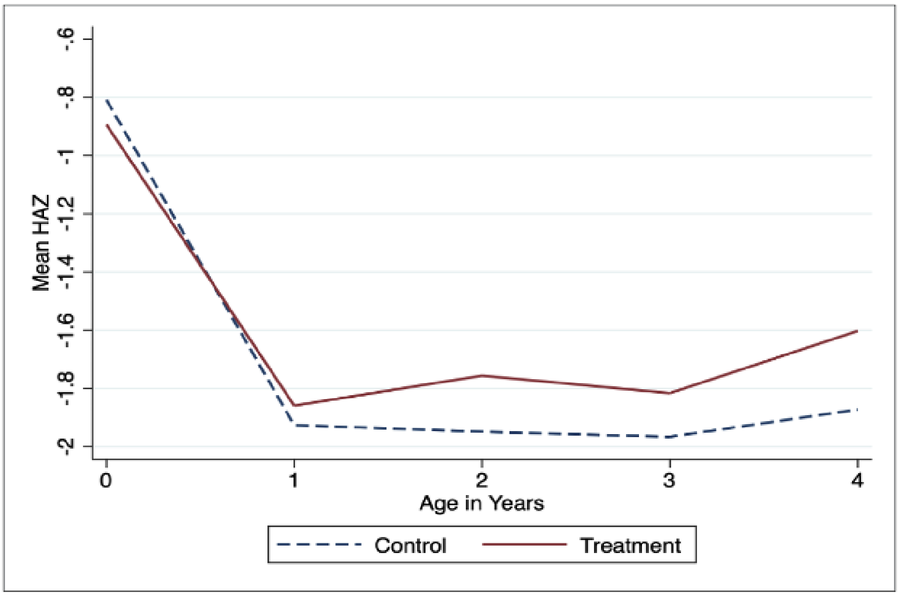
Figure A-7: Placebo Treatment Effects (False Program Implementation Dates)



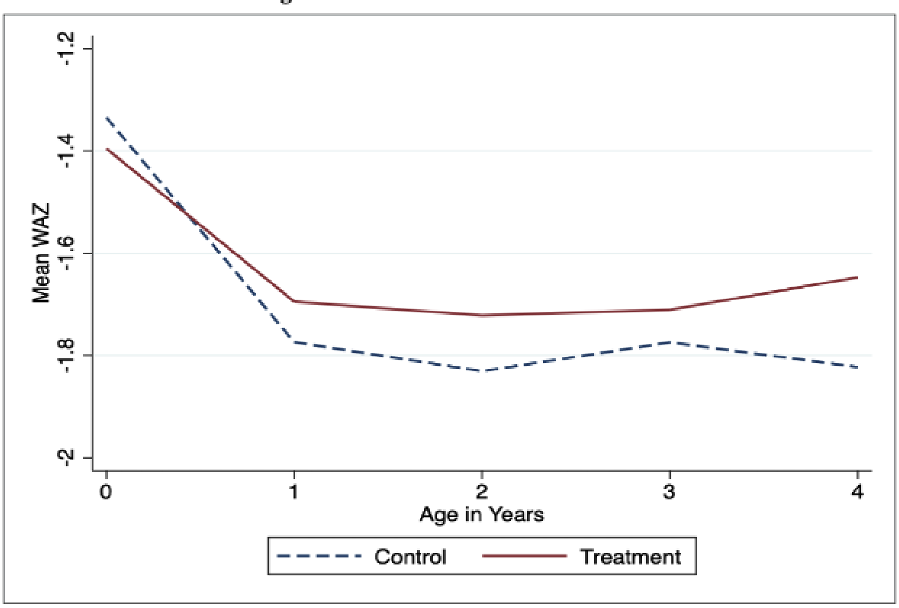
Notes: Distribution of estimated placebo treatment effects resulting from 10,000 random assignments of districts to treatment status. The placebo treatment effect estimates correspond to randomly assigned SBM implementation dates to districts with the dates drawn from the actual set of implementation 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

Panel A: Mean HAZ Age Profile

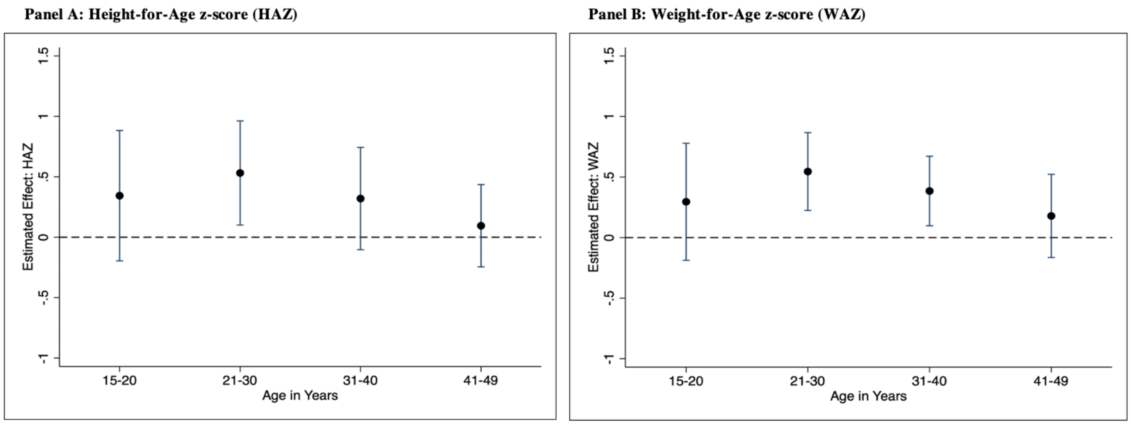


Panel B: Mean WAZ Age Profile



Notes: 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



Notes: 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

Notes: 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.