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Birth Weight and Supplementary Nutrition: An Evaluation of Integrated Child Development Services (ICDS) in India

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ABSTRACT

Despite having a significant public health safety net and steady economic growth, a high percentage of children are born with low birth weight; progress has been relatively sluggish in the past fifteen years in India. Integrated Child Development Services (ICDS) provides supplementary nutrition to pregnant women to improve nutrition during pregnancy and increase birth weight. In this paper, I use data from the Demographic and Health Surveys of 2005-2006, 2015-2016, and 2019-2021 to evaluate the outcomes of supplementary nutrition in reducing the share of low birth weight. I use Propensity Score Matching (PSM) to study whether the share of low birth weight differs between the groups: the group that receives full antenatal care and supplementary nutrition during pregnancy from ICDS versus the group that receives only full antenatal care. I examine the outcomes of supplementary nutrition for the whole sample, five regions (East, North, North East, South, and West), two major religions (Hindu and Muslim), and area of residence (rural and urban). I find a statistically significant result only in the North East in 2005-2006, and the share of low birth weight is lower for the treatment group. In 2015-2016, only East had a statistically significant result, but the share of low birth weight was higher among the treatment group. The treatment group has a statistically significant lower share of low birth weight for the whole sample, in the South and the West, among the Hindus and the people living in rural areas in 2019-2021.

Keywords: Birth Weight, Supplementary Nutrition, Integrated Child Development Services (ICDS), Antenatal Care, India

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1. Introduction

Eighteen percent of Indian children were born with low birth weight[1] in 2019-2021, according to the Demographic and Health Survey (International Institute for Population Sciences 2022). Two factors contribute to low birth weight; preterm birth implying birth before 37th week of gestation and smaller growth for gestational age, implying intrauterine growth retardation (IUGR). IUGR is a major policy concern. Mother's nutrition during pregnancy is one of the most important determinants of gestational growth (Painter, Roseboom, and Bleker 2005) and birth weight (Amarante et al. 2016). The Integrated Child Development Scheme (ICDS) was launched in 1975 to provide various healthcare services to pregnant and nursing women, preschool children, and adolescent girls in India. Providing supplementary nutrition, antenatal checkups, tetanus toxoid injection, nutrition, and health education for pregnant women are major components of this scheme. More than 90.6 million beneficiaries received supplementary nutrition from more than 1.4 million operational ICDS centers in 2021 (Ministry of Women and Child Development 2022). Existing literature examines the effect of SNP on birth outcome in the US, Canada, Bangladesh, Columbia, Mexico and Uruguay. To my knowledge, this is the first paper that examines the effect of SNP on birth weight in India using propensity score matching for the Average Treatment Effect on the Treated (ATET) for pregnant women who received full antenatal care.

ICDS centers provide supplementary nutrition to pregnant women through take-home rations, aiming to reduce the gap between the recommended dietary allowance and the average daily intake. In supplementary nutrition, a woman receives 600 calories and 18-20 grams of protein for 300 days a year. There are no eligibility criteria to enroll in SNP. Women who visit and enroll in ICDS centers are eligible for supplementary nutrition. The state government was fully responsible for providing supplementary nutrition before 2005-2006. However, many state governments were unable to allocate sufficient funds for supplementary nutrition due to budget constraints. From 2005, the responsibility was shared between the central and state governments, where both central and state governments spent 50 percent of the budget. For Northeastern states, the central government provides 90 percent of the cost, and the state governments are responsible for the rest. The allocation of budget and coverage of ICDS has increased steadily over time. The allocated budget for the Supplementary Nutrition Program from the Government of India increased from almost 20 billion to almost 58 billion rupees between 2005 and 2006 (Ministry of Women and Child Development 2006) and 2021 and 2022 (Ministry of Women and Child Development 2022).

[1] Low birth weight is defined as a birth weight of less than 2500 grams by the World Health Organization.

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Smaller growth for gestational age indicates intrauterine growth retardation (IUGR) and IUGR is a major public health policy concern. For some cases, the reason for IUGR is purely medical because the gene affects birth weight, gestational length, and fetal growth (Clausson, Lichtenstein, and Cnattingius 2000). Gene gestation and birth weight vary across ethnic groups (Dearden, Mesnard, and Shaw 2006). Additionally, the mother's anthropometric characteristics strongly predict fetal growth (Warner 1995). However, socioeconomic background, diseases, lifestyle, and environment are other major causes of IUGR. While in developing countries, low pre-pregnancy weight, inadequate gestational growth, malaria, and small stature of the mother are the main causes of IUGR (Kramer 1987, 2003). It is smoking in developed countries (Abrevaya and Dahl 2008; Bache, Dahl, and Kristensen 2013; Kramer 1987). In addition to smoking, air pollution (Currie and Hyson 1999; Currie and Schmieder 2009), fasting during pregnancy (Almond and Mazumder 2011), poor socioeconomic status (Currie 2009), stress (Camacho 2008), marital status (Abrevaya and Dahl 2008) and violence (Aizer 2011) during pregnancy have a negative effect on birth weight.

Food availability during pregnancy, income level, prenatal care, and maternal leave affect birth weight. Mothers who receive food stamps three months before the delivery will have children with higher birth weights, and this increase is the highest for the group with the lowest birth weight (Almond and Mazumder 2011). Earned income tax credit, a refundable tax credit for low-income families with children in the US, increases average birth weight and reduces the occurrence of low birth weight (Hoynes, Miller, and Simon 2015). Micronutrient and macronutrient intake (Murtaugh and Weingart 1995) favorably impact birth weight, but fast food availability has no relationship with child weight (Lhila 2011). Increased prenatal care increases birth weight in Azerbaijan (Habibov and Fan 2011); Bolivia, Brazil, Colombia, and Peru (Jewell 2007); Mexico (Gonzalez and Kumar 2018); and Uruguay (Jewell 2007; Jewell and Rous 2008; Jewell and Triunfo 2006). New York's Prenatal Care Assistance Program (PCAP) increases child birth weight and reduces the incidence of low birth weight (Joyce 1999). The HealthStart Program in New Jersey increases birth weight and lowers the rate of low birth weight for Blacks (Reichman and Florio 1996). An early first-trimester visit can reduce low birth weight, but the difference in the use of prenatal care by race explains only a limited part of black-white racial differences in the rate of low birth weights (Frank et al. 1991). Maternal leave during the third trimester (Del Bono, Ermisch, and Francesconi 2012) has a favorable impact on birth weight.

Children with low birth weight are more susceptible to neonatal death (Black, Devereux, and Salvanes 2007; McCormick 1985). Children born with low birth weight suffer from learning disabilities (Fletcher 2011) are more likely to grade repetition and take special classes (Corman and Chaikind 1998; Fletcher 2011). Birth weight is positively associated with educational attainment (Behrman and Rosenzweig 2004; Black et al. 2007; Currie and Hyson 1999) and

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adult height (Behrman and Rosenzweig 2004; Black et al. 2007). Birth weight also affects labor market outcomes (Behrman and Rosenzweig 2004; Black et al. 2007; Currie and Hyson 1999). A mother's birth weight is associated with birth weight for the next generation (Black et al. 2007; Royer 2009) and pregnancy complications (Royer 2009). In summary, birth weight is an important factor for future human capital formation, growth, and development. As Integrated Child Development Services is the only government-led service in India that provides supplementary nutrition to pregnant women, evaluating its impact is important for Indian policymakers to understand the effectiveness of this program. Additionally, the results can be helpful for countries with similar programs.

Providing supplementary nutrition during pregnancy is an important health policy in various countries. Existing literature investigates the impact of supplementary nutrition on birth outcomes. A significant amount of work is concentrated on the supplementary nutrition program for Women, Infants, and Children (WIC) in the United States. In the WIC program, the federal government provides grants to the state governments for supplementary foods, health referrals, and nutrition education to low-income families. To qualify for WIC, the applicant must satisfy the eligibility criteria. Pregnant women receive food checks or an Electronic Benefit Transfer (EBT) Card and buy nutritious food from stores. Existing studies find mixed results regarding the connection between WIC and birth weight. While some studies find a positive association between WIC participation and birth weight (Hoynes, Page, and Stevens 2011; Kowaleski-Jones and Duncan 2002); other studies find no association (Figlio, Hamersma, and Roth 2009; Gai and Feng 2012; Rossin-Slater 2013). Although WIC has a mixed effect on birth weight, it reduces the probability of low birth weight (Currie and Rajani 2015; Figlio et al. 2009; Gai and Feng 2012; Hoynes et al. 2011; Rossin-Slater 2013). For singletons, there is no association between fetal growth and WIC participation, but a moderate association for Black twins (Joyce, Gibson, and Colman 2005).

Like WIC, the nutritional program in Canada, "*oeuf-lait-orange*" (eggs-milk-oranges) (OLO) provides supplementary food to low-income families. Although WIC and OLO provide supplementary food, the two programs vary regarding the spectrum of food. While women receive milk, orange juice, eggs, and vitamin tablets in specific quantities in OLO, they are allowed to choose a large variety of food in the categories of cereals, cheese, fruits, and vegetables. The OLO program increases the birth weight of the treated group and reduces the likelihood of low birth weight (Haeck and Lefebvre 2016). Another important nutrition program in Canada is the Higgins Nutrition Intervention Method of Assessment and Rehabilitation in the Montreal Diet Dispensary. In this program, each pregnant adolescent is evaluated for the risk of adverse birth outcomes and provided individualized dietary recommendations. Adolescents who participate in this program give birth to babies with higher average birth weights. Additionally,

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the percentages of babies with low birth weight and very low birth weight are lower among the participants (Dubois et al. 1997).

Supplementary nutrition has a favorable impact on birth weight in some countries but may have no effect in other countries. The Colombian *Buen Comienzo* program in Medellín increases birth weight and reduces the occurrence of low birth weight (Cardona-Sosa and Medina 2017). Uruguayan *Plan de Atención Nacional a la Emergencia Social* (*PANES*) reduces low birthweight (Amarante et al. 2016). Mexico's conditional cash transfer program, *Oportunidades* increases birth weight and reduces the percentage of lower birth weight by providing better health care information and support for negotiation (Barber and Gertler 2010). Bangladesh Integrated Nutrition Programme (BINP) fails to provide supplementary nutrition to the required group and, therefore unable to improve the incidence of low birth weight (Nahar, Mascie-Taylor, and Begum 2008).

Selection bias is a significant problem in evaluating a supplementary program's impact because the program participation is non-random. Therefore, evaluation of the program's impact based on the comparison between participants and non-participants can provide a biased estimate. For example, the estimate will have an upward bias if the participants in WIC are more driven and have better health and healthcare facilities compared to the non-participants, and *vice versa* (Hoynes et al. 2011); (Bitler and Currie 2005); (Gai and Feng 2012) fix the problem of selection bias using the instrumental variable method. While Bitler and Currie 2005 use state-level characteristics as instruments, Gai and Feng 2012 use state-level, individual, and zip code-level characteristics as instruments. Joyce et al. 2005 resolve this problem by using a comparison group very similar to the treatment group. They use women who are eligible for participation in WIC but choose not to participate until postpartum as the control group. They also divide the sample into subgroups based on race and pre-pregnancy characteristics. Additionally, they limit the sample to the first birth. They use propensity score matching. ICDS centers are generally located in areas with high malnutrition, which makes their placement endogenous and provision for supplementary nutrition endogenous. Therefore, the program evaluation for ICDS may generate biased results due to the endogenous placement of the ICDS center and/or endogenous provision of supplementary nutrition. I use propensity score matching to control the selection bias. Propensity Score Matching (PSM) matches treated individuals with control individuals based on a conditional probability of treatment participation. It compares the treated group with the control group based on a given set of observables. By controlling the observables, Propensity Score Matching can eliminate the selection bias of endogenous placement of ICDS centers. I use data from the Demographic and Health Surveys of 2005-2006, 2015-2016, and 2019-2021 to evaluate the outcomes of supplementary nutrition on children's birth weight.

The remainder of the paper is organized as follows: Section 2 describes the data sources and econometric specification. Section 3 explains the results. Section 4 discusses the factors that may be responsible for the results, and Section 5 concludes.

2. Data and Econometric Specification

The Demographic and Health Survey started to collect data in India in 1992-1993. The first survey was conducted in 1992-1993, the second in 1998-1999, the third in 2005-2006, the fourth in 2015-2016, and the most recent in 2019-2021. This paper uses data from 2005-2006, 2015-2016, and 2019-2021 to evaluate the effect of the supplementary nutrition program through ICDS on children's birth weight.

2.1. Data and Variables

I use data on child birth weight; mother's full antennal care status during pregnancy consists of at least four antenatal visits, at least one tetanus toxoid injection, and consumption of iron folic acid tablets for at least 100 days; supplementary nutrition from ICDS during pregnancy; mother's characteristics such as her age, education, birth in last five years and media exposure; household characteristics such as availability of improved toilet facility; main floor material, and sources of drinking water from the Children's Data Record/File (KR) of Demographic and Health Survey. (https://dhsprogram.com/data/).

2.2. Econometric Specification and Estimation Method

The evaluation of supplementary nutrition from ICDS during pregnancy on reducing the share of low birth weight may generate biased results due to the endogenous placement of ICDS centers and/or endogenous provision of supplementary nutrition. Non-randomness of policy implementation and utilization of services creates selection bias. Propensity score matching (PSM) is an econometric method that controls selection bias (Kandpal 2011; Lokshin et al. 2005). A propensity score is the conditional probability of receiving treatment given the characteristics of covariates and is expressed as follows:

$$p(x) = prob(D = 1|x) = E(D|x).$$

D is the binary treatment variable equal to one when the woman has full antenatal care from the public health care system[2] and supplementary nutrition from ICDS during pregnancy and equal

[2] The Provision of antenatal care from the public health care system comes from government/municipal hospitals, government dispensaries, Universal Health Care/Urban Health Posts/Urban Family Welfare Centers, Community Health Centers/Rural Hospitals/block Primary Health Care, Primary Health

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to zero when she has only full antenatal care from the public health care system. To evaluate the effectiveness of supplementary nutrition during pregnancy on reducing the share of low birth weight, I use Average Treatment Effect on the Treated (ATET) with propensity score matching. ATET compares the share of low birth weight of children whose mother has full antenatal care from the public health care system and receive supplementary nutrition from ICDS during pregnancy, and those whose mothers have only full antenatal care from the public health care system. After matching the propensity score, this can be expressed as:

$$ATET = E(\Delta|p(x), D = 1) = E(y_1|p(x), D = 1) - E(y_0|p(x), D = 1).$$

y_1 and y_0 represent, respectively, the share of low birth weight of children when the mothers receive supplementary nutrition and when the mothers do not, given the propensity score. Matching can eliminate biases from weak overlap and weak balancing under certain conditions, but it cannot eliminate bias from unobservables (Cerulli 2017). As all individual and family characteristics are not included in the covariates, (x), the selection bias is not completely eliminated from PSM.

2.3. Variables

2.3.1. Outcome Variable

Child Birth Weight: DHS provides data on child birth weight in grams. I modified the data into kilograms. A child with a birth weight of less than 2500 grams or 2.5 kilograms is considered a low birth weight (WHO 2014).

2.3.2. Treatment Variable

Supplementary Nutrition: I use the data on whether the mother received supplementary Nutrition during pregnancy from ICDS among the women who received full antenatal care during pregnancy. DHS provides the data as a binary variable. It is equal to one when a woman receives supplementary Nutrition and zero when she does not. The major limitation of this variable is that it doesn't provide any information on the frequency and/or the number of times a woman receives supplementary Nutrition during pregnancy from ICDS. ICDS promises to provide pregnant women with 600 calories and 18-20 grams of protein daily. However, whether a pregnant woman receives the promised nutrition from ICDS is unavailable from DHS. Additionally, ICDS doesn't deliver any information on whether the pregnant woman consumes the full supplementary Nutrition by herself or shares it with her family members.

Care/additional Primary Health Care, sub-centers, Anganwadi/Integrated Child Development Service Centers, village clinic by Auxiliary Nurse Midwives, and other public.

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Utilization of prenatal care and birth weight are positively associated (Gonzalez and Kumar 2018; Habibov and Fan 2011; Jewell 2007; Jewell and Rous 2008; Jewell and Triunfo 2006). According to the definition of DHS, full antenatal care consists of at least four antenatal check-ups, consumption of iron folic acid tablets or syrup for at least 100 days, and at least one tetanus toxoid injection (Kumar et al. 2019). I use three variables to proxy the mother's health care utilization during pregnancy. To measure whether the woman receives full antenatal care, I use the following three variables:

Antenatal Visits: DHS provides data on the number of antenatal visits during the last pregnancy. I create a binary variable equal to one if the woman has at least four antenatal visits and zero if she has fewer than four.

Consumption of iron folic acid tablet: DHS provides data on the number of days a woman consumes iron folic acid tablet during her last pregnancy. I create a binary variable that is equal to one if the woman consumes the iron-folic acid tablet for at least a hundred days and zero if she consumes less than a hundred days.

Tetanus Toxoid Injection: DHS provides data on the number of tetanus toxoid injections taken before birth. I create a binary variable equal to one if the woman has taken at least one tetanus toxoid injection and zero if she has not. I consider a woman receiving full antenatal care when she has at least four antenatal visits, one tetanus toxoid injection, and consumes iron folic acid tablets for 100 days.

2.3.3. Observables

In Propensity Score Matching (PSM), treated individuals are matched with control individuals based on a conditional probability of treatment participation. PSM compares the treated group with the controlled group based on a given set of observables. By controlling the observables, Propensity Score Matching can eliminate selection bias.

2.3.3.1. Mother's Characteristics

Mother's Education: Mother's education is measured by the number of years of schooling. DHS provides the data on the mother's years of schooling. A mother's education positively impacts birth outcomes (Gage et al. 2013).

Mother's Age: DHS provides data on the mother's age during the interview. Adverse pregnancy outcome risk is higher for women under seventeen years old and over forty years old (Londero et al. 2019).

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Number of children born in the last five years: Lower birth spacing and adverse birth outcomes are associated (Class et al. 2017). DHS provides data on the number of children born in the last five years. A higher number of children born in the last five years may adversely affect the mother's health, leading to adverse birth outcomes.

Mother's Media Exposure: DHS provides data on the mother's frequency of reading newspapers, listening to the radio, and watching television. Data on these three variables are divided into four categories of frequency: almost every day, at least once a week, less than once a week, and not at all. I construct a binary variable named *media exposure*, which takes a value of one if the mother reads the newspaper and/or listens to the radio and/or watches television almost every day, and zero otherwise. I use media exposure as an observable because mother media exposure may provide helpful information regarding nutrition and health care during pregnancy which may have a favorable impact on birth outcome.

2.3.3.3. Household Characteristics:

Socioeconomic characteristics significantly impact child birth weight (Currie 2009). I use the wealth index factor and the availability of improved toilet facilities as proxies for household characteristics.

Wealth Index Factor: Wealth index is an indicator of a household's economic status. Demographic and Health Survey uses several variables and applies Principal Component Analysis to construct the Wealth Index Factor (Rutstein and Johnson 2004).

Improved Toilet Facility: India has the highest level of open defecation in the World. Open defecation is largely influenced by India's cultural preference rather than economic constraints. Open defecation has adverse health effects on women (Saleem, Burdett, and Heaslip 2019), which may lead to adverse birth outcomes. DHS provides the type of toilet facility available for the household. I construct a binary variable equal to one if the household has an improved toilet facility and zero if it doesn't.

3. Results

This section describes the summary statistics, explains the diagrams and discusses the estimation results.

3.1 Stylized Facts

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Table 1. Summary statistics

Variables	Mean 2005-2006	Standard Deviation 2005-2006	Mean 2015-2016	Standard Deviation 2015-2016	Mean 2019-2021	Standard Deviation 2019-2021
Birth Weight (kg)	2.9	0.0	2.9	0.0	2.8	0.0
Birth Weight without Supplementary Nutrition (kg)	2.9	0.0	2.9	0.0	2.9	0.0
Birth Weight with Supplementary Nutrition (kg)	2.8	0.0	2.9	0.0	2.8	0.0
Low Birth Weight (%)	15.6	0.6	14.0	0.2	15.0	0.2
Low Birth Weight without Supplementary Nutrition (%)	14.8	0.6	13.1	0.3	14.3	0.3
Low Birth Weight with Supplementary Nutrition (%)	19.1	1.4	14.5	0.2	15.3	0.2
Full Antenatal Care and Supplementary Nutrition (%)	19.6	0.6	62.2	0.3	78.1	0.2
Mother's Education (years)	10.4	0.1	9.3	0.0	9.2	0.0
Mother's Age (years)	27.5	0.1	27.4	0.0	27.6	0.0
Birth in Last five years	1.2	0.0	1.3	0.0	1.3	0.0
Media Exposure (%)	85.0	0.6	91.6	0.2	83.4	0.2
Improved Toilet (%)	85.9	0.6	74.6	0.2	84.6	0.2

Table 1 provides the summary statistics of birth weight, low birth weight and other observables. The average birth weight was 2.9 kilograms for both 2005-2006 and 2015-2016, and it became 2.8 kilograms in 2019-2021. However, the standard deviations were zero for all periods. Birth weight remained constant and was equal to 2.8 kilograms for all periods for the group who didn't receive supplementary nutrition. The birth weight for the group with supplementary nutrition was the same in 2005-2006 and 2019-2021 and was equal to 2.8 kilograms. It was slightly higher (2.9 Kilograms) in 2015-2016.

In 2005-2006, 15.6 percent of children were born with low birth weight. This percentage decreased to 14 percent in 2015-2016 but increased to 15 percent in 2019-2021. Groups with and without supplementary nutrition followed the same trend; the percentage of children with low birth weight decreased from 14.8 to 13.1 between 2005-2006 and 2015-2016 and increased to 14.3 percent in 2019-2021 who didn't receive supplementary nutrition. For the group who received supplementary nutrition, the percentage of low birth weight decreased by 4.6 percentage points from 19.1 percent to 14.5 percent between 2005-2006 and 2015-2016. However, it increased to 15.3 percent in 2019-2021.

The percentage of women with full antenatal care and supplementary nutrition steadily increased from 19.6 in 2005- 2006 to 62.2 in 2015-206 to 78.1 in 2019-2021. The average years of schooling for mothers decreased from 10.4 years to 9.3 years to 9.2 years in 2005-2006, 2015-2016, and 2019-2021, respectively. The average age of the mother was almost the same for all periods and close to 27.5 years. The number of birth in the last five years increased from 1.2 to 1.3 between 2005-2006 and 2015-2016 and remained at 1.3 in 2019-2021. The percentage of mothers who read a newspaper and/or listened to the radio and/or watched television at least some time per week increased from 85 in 2005-2006 to 91.6 in 2015-2016, but sharply decreased to 83.4 in 2019-2021. The percentage of improved toilet facilities decreased from 85.9 to 74.6 from 2005-2006 to 2015-2016, but increased to 84.6 in 2019-2021. Despite initiatives like Central Rural Sanitation Program in the mid-1980s, the Total Sanitation Campaign (TSC) in the late 1990s, and *Swachh Bharat Abhiyan* (Clean India Mission) in 2014, the availability of improved toilet facilities didn't exist for a significant percentage of the Indian population.

3.2. Diagrams

Fig. 1. Supplementary Nutrition and Low Birth Weight: Total, Rural and Urban Population

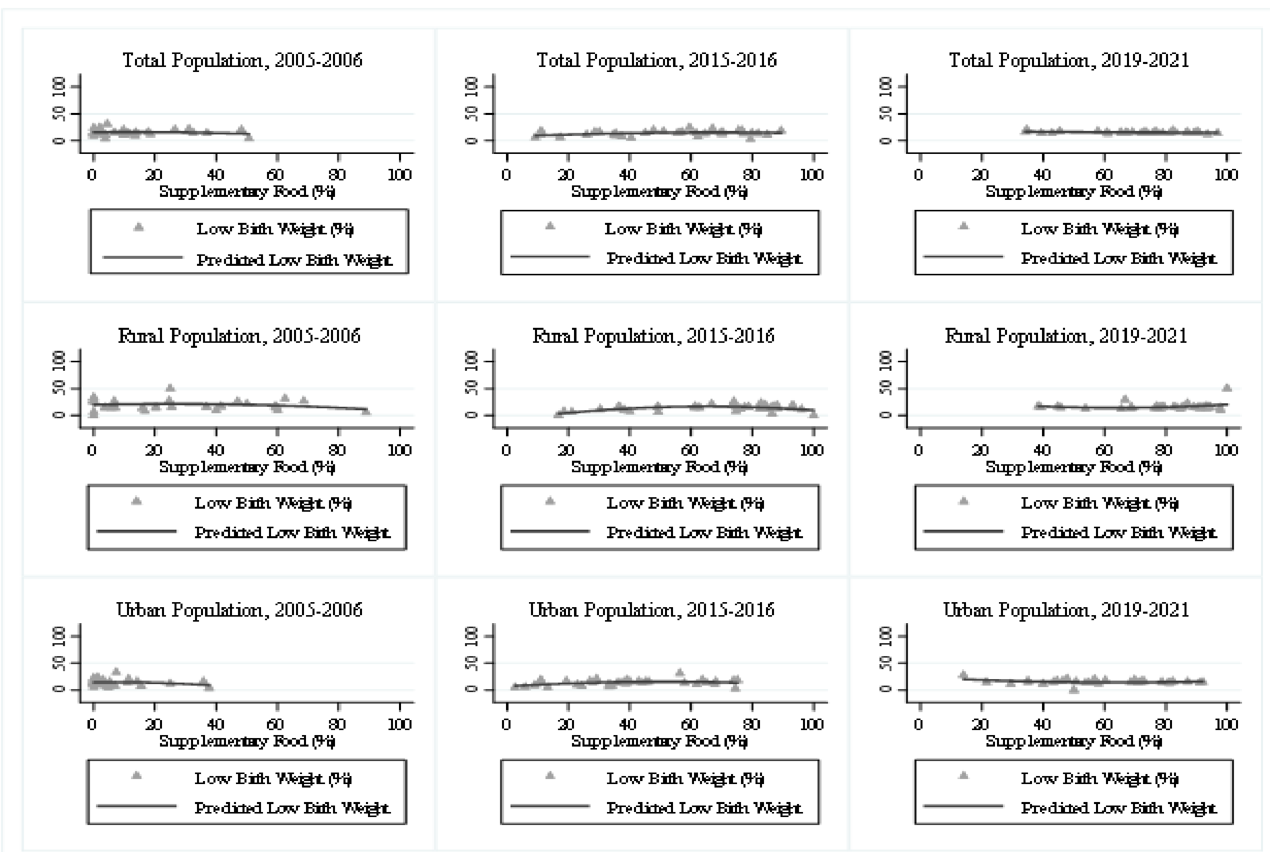

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Fig. 1. shows the percentage of supplementary nutrition and low birth weight by the state for the total, rural, and urban populations. The fitted lines for the total population in 2005-2006 and 2015-2016 were concave to the origin, indicating that with the increase in the percentage of supplementary nutrition, the percentage of low birth weight increased initially but decreased after that. However, for 2019-2021, this trend was downward, indicating a negative relationship between the percentage of supplementary nutrition and low birth weight. For the rural population, the fitted lines were concave to the origin for both 2005-2006 and 2015-2016, implying that with an increase in the percentage of supplementary nutrition, the percentage of low birth weight increased initially but then started to decrease. In 2019-2021, the trend line was convex to the origin, showing that with an increase in the percentage of supplementary nutrition, the percentage of low birth weight decreased first and then increased. I found a similar trend for the urban population as the rural population. The trend lines were concave to the origin in 2005-2006 and 2015-2016 and convex to the origin in 2019-2021.

3.3. Estimation Results

Using 2005-2006, 2015-2016, and 2019-2021 DHS data, I examine whether receiving supplementary nutrition during pregnancy significantly reduces the share of low birth weight. More specifically, I examine whether the share of low birth weight differs between the group that receives supplementary nutrition and those who don't.

Table 2 shows the relationship between the share of low birth weight for the treated and control group in 2005-2006, 2015-2016, and 2019-2021 for unmatched and matched observations. The treatment group comprises women with full antenatal care who receive supplementary nutrition from ICDS during pregnancy. The control group comprises women with full antenatal care who don't receive supplementary nutrition from ICDS during pregnancy.

Table 2. The Estimated Effect of Supplementary Nutrition on Low Birth Weight

	Unmatched				Matched			
	Treatment	Control	Difference	Standard Error	Treatment	Control	Difference	Standard Error
Whole Sample								
2005-2006	0.191	0.148	0.043***	0.016	0.191	0.175	0.016	0.024
2015-2016	0. 145	0.131	0.014***	0.004	0.145	0.144	0.001	0.007
2019-2021	0.149	0.155	-0.005	0.004	0.149	0.159	-0.010*	0.006
East								
2005-2006	0.192	0.167	0.026	0.059	0.192	0.288	-0.096	0.098
2015-2016	0.168	0.130	0.038***	0.012	0.168	0.120	0.048**	0.021
2019-2021	0.170	0.157	0.013	0.011	0.170	0.183	-0.013	0.019

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North								
2005-2006	0.281	0.195	0.086	0.062	0.281	0.175	0.105	0.083
2015-2016	0.149	0.144	0.005	0.007	0.149	0.167	-0.018	0.013
2019-2021	0.161	0.158	0.003	0.008	0.161	0.172	-0.011	0.011
North East								
2005-2006	0.036	0.115	-0.079**	0.031	0.036	0.164	-0.127*	0.070
2015-2016	0.079	0.080	-0.001	0.008	0.079	0.082	-0.003	0.011
2019-2021	0.105	0.086	0.019**	0.008	0.105	0.096	0.009	0.011
South								
2005-2006	0.172	0.118	0.054**	0.023	0.172	0.141	0.032	0.032
2015-2016	0.145	0.131	0.014*	0.008	0.145	0.160	-0.016	0.013
2019-2021	0.142	0.155	-0.013	0.009	0.142	0.173	-0.031*	0.016
West								
2005-2006	0.230	0.152	0.078**	0.030	0.230	0.222	0.008	0.054
2015-2016	0.186	0.159	0.027**	0.011	0.186	0.191	-0.005	0.017
2019-2021	0.165	0.161	0.004	0.009	0.165	0.192	-0.027*	0.015
Hindu								
2005-2006	0.220	0.152	0.068***	0.019	0.220	0.215	0.005	0.029
2015-2016	0.157	0.139	0.017***	0.005	0.157	0.157	-0.001	0.008
2019-2021	0.158	0.156	0.003	0.005	0.158	0.175	-0.017**	0.008
Muslim								
2005-2006	0.133	0.150	-0.016	0.043	0.133	0.160	-0.027	0.070
2015-2016	0.139	0.136	0.003	0.011	0.139	0.144	-0.005	0.015
2019-2021	0.144	0.137	0.007	0.010	0.144	0.140	0.004	0.014
Rural								
2005-2006	0.211	0.171	0.040*	0.022	0.211	0.185	0.026	0.032
2015-2016	0.148	0.129	0.019***	0.005	0.148	0.140	0.008	0.008
2019-2021	0.155	0.144	0.011**	0.005	0.155	0.151	0.004	0.007
Urban								
2005-2006	0.155	0.139	0.016	0.023	0.155	0.144	0.011	0.032
2015-2016	0.138	0.132	0.006	0.006	0.138	0.144	-0.006	0.009
2019-2021	0.143	0.141	0.001	0.006	0.143	0.159	-0.016*	0.009

***, **, * represents significance at 99%, 95% and 90% level respectively.

The results show that the share of low birth weight is higher in the treatment group for the unmatched observations over the whole sample in 2005-2006 and 2015-2016 and the results are statistically significant. The share of low birth is lower for the treatment group in 2019-2021. However, the result is not statistically significant.

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The share of low birth weight is higher for the treatment group in East, North East and West for all periods for unmatched observations. However, the results are statistically significant in 2005-2006 for the West and 2015-2016 for the East and West. The share of low birth weight is lower for the treatment group in North East in 2005-2006, and the result is statistically significant. However, in 2019-2021 the result reverses and the share of low birth becomes higher for the treatment group in the North East, which is statistically significant. For the South, the share of low birth weights is higher for the treatment group in 2005-2006 and 2015-2016, and the results are statistically significant. It is lower for the treatment group in 2019-2021, but the result is not statistically significant.

The treatment group has a higher share of low birth weight for the population that practices the Hindu religion for all periods. However, the results are statistically significant only in 2005-2006 and 2015- 2016. The results are not statistically significant for the Muslim population for all periods.

The share of low birth weight in the rural population was higher and statistically significant in 2005-2006, 2015-2016, and 2019-2021. For the urban population, there was no statistically significant difference in the share of low birth weight between treatment and control groups for all periods.

The difference in the share of low birth weight between those who receive supplementary nutrition during pregnancy from the ICDS and those who don't may result from the mother's characteristics and the socioeconomic difference between these two groups. To understand whether the difference reflects the effect of supplementary nutrition, I compare the women who receive supplementary nutrition with a comparison group with similar mothers' characteristics and socioeconomic background. Each woman who receives the supplementary nutrition (treated) is matched with another woman who doesn't receive (control) it. The two women have similar observables, including the mother's age, education, number of births in the last five years, media exposure, family's wealth index factor, and availability of improved toilet facilities. I then test whether there is any difference between the treated and the matched control groups using propensity score matching.

For the matched observations, the share of low birth weight is higher for the treatment group in 2005-2006 and 2015-2016 for the whole sample. However, the results are not statistically significant. In 2019-2021, the share of low birth weight is lower for the treatment group and the result is statistically significant.

Among all regions, the result is statistically significant only in the North East in 2005-2006. The share of low birth weight is lower in the treatment group than in this region's control group. The share of low birth weight is higher in the treatment group for the East in 2015-2016, and the result is statistically significant. The results are not statistically significant for all other regions in this period. In 2019-2021, there is a statistically significant difference in the share of low birth weight in the South and West. The share of low birth weight is lower within the treatment group for both regions.

The difference is negative and statistically significant for the Hindu population in 2019-2021, which indicates that the share of low birth weight is lower among the treatment group. For Muslims, the results are not statistically significant for all the periods.

There is no statistically significant difference in the share of low birth weight between the treatment and the control groups for the rural population. It is only statistically significant in 2019-2021 for the urban population and indicates that the share of low birth weight is lower among the treatment group than the control group.

In summary, for the unmatched observations, the share of low birth weight is higher and statistically significant for the whole sample, in the South and the West regions, among the people who practice the Hindu religion, and the people who live in rural areas in 2005-2006. The share of birth weight is lower among the treatment group and statistically significant only in the North East for this period. In 2015-2016, the share of low birth weight was higher among the treatment group for the whole sample, in the East, South, and West, among Hindus, and the rural population. The share of low birth weight is higher and statistically significant in the North East and rural population in 2019-2021.

For the matched observations, I find a statistically significant result only in the North East in 2005-2006, and the share of low birth weight is lower for the treatment group. In 2015-2016, only East had a statistically significant result, and the share of low birth weight was higher among the treatment group. The treatment group has a statistically significant lower share of low birth weight for the whole sample, in the South and the West, among the Hindus and the people living in rural areas in 2019-2021.

4. Discussion

The existing literature finds mixed results, some studies find a negative association between supplementary nutrition and low birth weight (Amarante et al. 2016; Barber and Gertler 2010; Cardona-Sosa and Medina 2017; Currie and Rajani 2015; Dubois et al. 1997; Figlio et al. 2009; Gai and Feng 2012; Haeck and Lefebvre 2016; Hoynes et al. 2011; Rossin-Slater 2013) and others find no association (Nahar et al. 2008). My results are mixed, too. I find no statistically significant difference in the share of low birth weight among the treatment and control groups in

2005-2006 and 2015-2016 for the whole sample. I find the share of low birth weight is lower among the treatment group compared to the control group in 2019-2021.

Several factors may be responsible for this. The Demographic and Health Survey (DHS) provides data on whether a woman receives supplementary nutrition during pregnancy from ICDS. There are three major flaws in this information. First, DHS provided data on the frequency of receiving supplementary nutrition from ICDS during pregnancy, but most observations had no information. For example, in 2005-2006, only twenty percent of observations contained information. It increased to sixty-two percent in 2015-2016 but decreased to fifty-six percent in 2019-2021. The effect will be different when a woman receives supplementary nutrition occasionally versus when she receives it regularly during pregnancy. Second, according to the Indian government, pregnant women will receive 600 calories and 18-20 grams of protein daily as supplementary nutrition. However, DHS didn’t inform us about the promised calories and protein from ICDS. Third, DHS failed to give information on the usage of supplementary nutrition. Women received take-home rations from ICDS. There was no guarantee that she consumed the full supplementary food by herself. She might distribute the food among family members and/or substitute her consumption of food from home with supplementary food.

5. Conclusion

Integrated Child Development Services provides supplementary nutrition to pregnant women, aiming to improve nutrition during pregnancy and reduce the share of low birth weight. In this paper, I use data from the Demographic and Health Surveys of 2005-2006, 2015-2016, and 2019-2021 to evaluate the outcomes of supplementary nutrition in reducing children’s low birth weight. I use Propensity Score Matching (PSM) to study whether the share of low birth weight differs between two groups: one whose mother receives supplementary nutrition during pregnancy from ICDS and the other who doesn’t. I find no statistically significant difference between the treatment and the control group for the whole sample; in the East, South, North,, and West; for the Hindus and Muslims, and rural and urban populations,, except in the North East in 2005-2006. The share of low birth weight is lower for the treatment group in the North East. I find only statistically significant results in the East in 2015-2016, and the share of low birth weight is higher among the treatment group. I find the share of low birth weight is lower for the treatment group and statistically significant for the whole sample, in the South and the West, among the Hindus, and the people living in rural areas in 2019-2021.

Existing literature finds positive or no effect of supplementary nutrition on reducing low birth weight. My findings are mixed compared to the existing literature. Several factors, such as interrupted distribution and/or consumption of supplementary nutrition during pregnancy,

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distribution of calories and protein lower than the promised amounts, inability to consume full supplementary food due to its distribution among family members, the substitution of regular consumption of food by supplementary food may lead to disappointing results of supplementary nutrition in 2005-2006 and 2015-2016.

The results in 2019-2021 are more promising. However, we need to study future surveys to investigate whether these promises are consistent. DHS provides the data on whether a woman receives supplementary nutrition during pregnancy, but fails to provide complete information on the frequency of receipt for most of the observations, dietary content, and full consumption of supplementary nutrition during pregnancy. DHS should consider including these important variables in future surveys to provide more comprehensive information on supplementary nutrition during pregnancy. There are no eligibility criteria to receive supplementary nutrition from ICDS. Many states face budget constraints for supplementary nutrition, affecting the distribution frequency and dietary amount of supplementary nutrition. To distribute supplementary nutrition to the most needed population without interruption and with promised calories and proteins, the Indian government should impose income/wealth criteria to qualify for it. Lastly, India's economic history and problems with hunger led to the distribution of free or subsidized food that is cheap and helps to fight hunger. This policy leads to the design of menus of supplementary nutrition, which predominantly contain cereals rather than a balanced combination of grains, vegetables, fruits, milk and non-vegetable items. The Indian government needs to redesign the menu of supplementary nutrition, which is balanced and provides micro and macronutrients.

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