



Does early childhood adversities affect physical, cognitive and language development in indian children? Evidence from a panel study

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ARTICLE INFO

Keywords:

Early childhood adversities
Physical development
Cognitive development
Language development
India

ABSTRACT

Early childhood adversities are known to impair the development potential of children, however, there is limited evidence for the same in the Indian context. This study provides evidence of the effect of relevant biological and social risk factors during early childhood on the physical, cognitive and language development of Indian children. Panel data from two rounds of the India Human Development Survey (IHDS) was used to examine these associations among the Indian children. Using multivariable ordered logistic regression models, our study examined the association between the risk factors and the four indicators of development potential – stunting status, mathematical skill, reading skill, and writing skill. The results show that malnutrition and hostile community environment during early childhood impairs the physical development of children. The results also reveal that malnutrition, indoor air pollution, poor household sanitation condition, hostile community environment, lack of education among household adults, domestic violence on women in the community, and lack of autonomy among women in the household are the major biological and social risk factors that affect the cognitive and language development of Indian children.

Introduction

Early childhood development refers to the process through which a child develops by growing and learning new skills within a time interval that spans from the prenatal period up to eight years of age (Shonkoff et al., 2012). This period is characterized by rapid growth in the brain's size and complexity, as exposure to new experiences leads to the formation of neural connections between the brain cells. These neural connections shape how the child thinks, feels and behaves throughout his/her life. From the time of birth, every experience that a child takes in with the help of his or her five senses helps build the neural architecture that guides his/her development throughout life (NSCDC, 2008). Positive experiences, such as stable and responsive relationship with the primary caregiver, safe and supportive environment, appropriate nutrition and others, during this developmental period, lays the pedestal for healthy development in children. On the other hand, negative experiences during this period, such as poverty, physical maltreatment, emotional maltreatment, neglect of child's needs such as not having access to proper nutrition and medical care and others, weaken the development in children (Grantham-McGregor et al., 2007). Early childhood adversity is defined as the negative experiences that lead to

toxic stress during the early childhood period (NSCDC, 2005). Exposure to toxic stress during early childhood derails the healthy development by excessive or prolonged activation of stress response systems inside the body and nervous system (NSCDC, 2005). The body diverts its available resources for coping up with this stress, which otherwise would have been used for healthy growth and development. These experiences make the early childhood period the most crucial interval for development in humans. Development is generally classified into four domains – physical, cognitive, language and social-emotional and each of these domains are interrelated (Shonkoff & Phillips, 2000). Each of these domains has its sensitive period of maturity, and the majority of brain development takes place during the early childhood period which is by 8 years from birth (NSCDC, 2005, 2008; Shonkoff & Phillips, 2000).

A recent report by the World Health Organization (WHO) suggests that more than 250 million or 43% of children age 5 years or less in the low and middle -income countries could not realize their full development potential as a result of adverse experiences faced by them during early childhood (WHO, 2016). Delay or loss in development results in the children lagging in one or a combination of the physical, cognitive, language and socio-emotional developmental domains that subsequently leads to adverse outcomes later in their life (Blair & Raver,

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2012; Richards & Wadsworth, 2004). Children suffering from delay or loss in development potential are likely to perform poorer in school and have a low income as an adult, which in turn translates to a loss in human capital formation. Besides, in future, these children are more likely to have children at an early age and are more likely to provide poor health care, nutrition, and stimulation to their children resulting in the loss of development potential of their children. This contributes to the intergenerational transmission of poverty and poor development (Grantham-McGregor et al., 2007).

Early childhood adversity poses a serious threat to the development potential of children from both developed and developing countries (CDC, 2007; Shonkoff & Phillips, 2000). However, the burden of such adversities and its consequences could be particularly high in developing countries like India. According to a systematic review by Walker et al. (2007), the major adversities that derail development potential of children from developing countries are – inadequate cognitive stimulation, stunting, iodine and iron deficiency, malaria, maternal depressive symptoms, violence, intrauterine growth restriction and exposure to metals like lead, arsenic. Recent data from India suggests that a majority of Indian children under-five years are exposed to adverse experiences during childhood (IIPS and ICF, 2017). A little less than two-fifths (38%) of Indian children under-five years were stunted and a little less than three-fifths (58%) of children between 6 and 59 months suffered from anaemia. Moreover, 62% and 52% of Indian households drink untreated water and have no access to improved sanitation facilities respectively. Additionally, only 44% of households use clean cooking fuel. Further, 39% of Indian households are Below Poverty Line (BPL). Therefore, the effect of early childhood adversities on the loss of development potential in a country like India becomes an important topic for research with broad policy implications.

Only a few studies have documented the association between early childhood adversities and child development in developed and developing countries. In a panel study of British people, Richards and Wadsworth (2004) found that early childhood adverse experiences affected the cognitive development of children in long-term. A couple of studies from other developed countries show that increased household food security improved cognitive development in children (Rose-Jacobs et al., 2008; Stormer & Harrison, 2003). Another couple of studies based on panel data, from Finland and United Kingdom, have shown that children born with low birth-size and weight have a higher chance of suffering from cognitive deficits and poor academic performance during late childhood compared with their counterparts (Kallankari et al., 2015; Strauss, 2000). Midouhas et al. (2018) provided evidence of the effect of exposure to indoor air pollution on cognitive deficits in British children.

A few studies from developing countries have shown that exposure to unimproved WASH practices during early childhood is associated with loss of development potential in children (Ngure et al., 2014; Spears & Lamba, 2013). A study from India showed that children from households having average or poor sanitation were less likely to achieve Mathematics Achievement Test (MAT) scores that are comparable to those of children from households having good sanitation (Singh et al., 2017). Exposure to violence in any form during childhood negatively influenced the development of children in long term in a study by Walker et al. (2007). Television viewing was found to affect the mental development of Indian children in a study by Singh and Gaurav (2013). In addition, studies have shown that Indian children from female-headed households had higher reading, mathematical and writing skills compared with children from male-headed households (Singh et al., 2013). A few other studies have found a positive association between parental education and development potential of children in developing countries (Bangirana et al., 2009; Johnson & Nagoshi, 1985; Jones & Schoon, 2008).

Literature providing evidence of the association of specific biological and social risk factors with the development of Indian children is limited (Acharya et al., 2019; Kingdon, 2010; Singh et al., 2017, 2013; Singh &

Gaurav, 2013; Spears, 2012; Spears & Lamba, 2013). Acharya et al. (2019) provided evidence of the association of malnutrition with cognitive development and educational attainment among rural children aged 8–11 years from the south Indian state of Tamil Nadu. Kingdon (2010) found a positive association between height-for-age (stunting) and academic achievement among rural children from two populous northern states of Uttar Pradesh and Bihar. A key limitation of a majority of the Indian studies is that they are cross-sectional in nature, and hence cannot establish causality. Moreover, they lack generalizability as a majority of those focuses on a sub-set of Indian population. In addition, a majority of the Indian studies take a narrow look at the Indian children's development potential. Our study aims to fill these research gaps by using two rounds of India Human Development Survey (IHDS). A key objective of our study is to investigate whether exposure to early childhood adversities in Round-I causes loss or delay in the development of children in Round-II of IHDS. Our study focuses on physical, cognitive and language development of children. It excludes socio-emotional development of children because of unavailability of related data in IHDS. Early childhood adversities are generally classified into biological, social, and genetic risk factors that can compromise development potential in children (Wachs, 2000; Walker et al., 2007). Our study focuses only on the biological and social risk factors, as data on genetic factors are not available in IHDS.

DATA, VARIABLES and METHODS

Data

Our study uses data from the India Human Development Survey (IHDS) Rounds I and II. IHDS Round-I, conducted during 2004–05, is a nationally representative multi-topic survey of 215,754 individuals from 41,554 households across India (Desai et al., 2008). Round-II, conducted during 2011–12, is a multi-topic panel survey of 204,569 individuals from 42,152 across India (Desai & Vanneman, 2015). National Council of Applied Economics Research (NCAER) in collaboration with the University of Maryland conducted the two IHDS rounds in all the states and union territories of India (except for Andaman and Nicobar Islands and Lakshadweep). Samples were drawn using stratified random sampling. IHDS Round-II re-interviewed 83% of the original households as well as split households residing within the same village from Round-I. Details regarding sample selection and sampling in Rounds I and II of IHDS can be obtained elsewhere (Desai et al., 2010; Desai et al., 2015).

Our study uses data for children age 1–4 during Round-I who became 8–11 years old in Round-II. There were 16,404 children age 1–4 in Round-I among whom 164 were not alive, 3,242 children migrated and 3,216 children were untraceable during Round-II. Therefore, information from 9,782 children was obtained in Round-II when they became 8–11 years old. Further, we excluded 1,171 children as they had missing information in all the four outcome variables of development potential used in this study. Furthermore, we found that the four individual outcome variables of stunting, mathematical skill, reading skill and writing skill had 407, 701, 670 and 760 records with missing information respectively. Therefore, the analytical sample size for investigating the relationship between early childhood adversities and the four outcome variables, stunting, mathematical skill, reading skill and writing skill are 8204, 7910, 7941 and 7851 children respectively.

Ethics statement

Our study is based on a publicly available secondary data with no identifiable information on survey respondents. Hence, no ethical approval was needed for this study. The data used in our study can be downloaded from the IHDS website (Desai et al., 2008; Desai & Vanneman, 2015). Details regarding research project approval, respondent approval, and data collection procedures are available in the IHDS user guides (Desai et al., 2015, 2010).

Dependent variables

We used four dependent variables – stunting, mathematical skill, reading skill, and writing skill – to measure the physical-, cognitive-, and language-development of children. We used stunting as a measure of the physical development of children. Stunting is categorized into “not stunted”, “moderately stunted” and “severely stunted”. We used mathematical skill as a measure of cognitive development of children. Mathematical skill is categorized into “cannot read numbers”, “can recognize numbers but cannot do any arithmetic operations”, “can subtract a two-digit number from another number”, and “can divide a three-digit number by a one-digit number”. Likewise, we used reading- and writing-skills as measures of language development of children. Reading skill is categorized into “cannot read at all”, “can read alphabets not words”, “can read words but cannot read full sentences”, “can read a short paragraph of 2–3 sentences but cannot read a full story”, and “can read a full story”; Writing skill is categorized into “cannot write at all”, “can write a sentence with two or fewer mistakes”, and “can write a sentence with no mistakes”.

Stunting occurs when children become too short for their age. Stunting is an indicator of chronic growth deficit (De Onis & Branca, 2016). Unfortunately, IHDS does not provide a readymade height-for-age z-score (HAZ). We estimated HAZ score for the panel of children aged 8–11 years in Round-II using the WHO AnthroPlus 3.2.2 software and anthropometric data of children provided in Round-II (WHO AnthroPlus, 2010). Estimated observations with HAZ values below -6 and above $+6$ were recoded as missing cases for the reason of erroneous measurement (de Onis et al., 2006). We coded the HAZ into three categories based on the z-score – not stunted ($HAZ \geq -2$), moderately stunted ($-2 > HAZ \geq -3$), and severely stunted ($HAZ < -3$). The mathematical skill, reading skill and writing skill variables were developed from short mathematical, reading and writing tests of any two children aged 8–11 years in the households surveyed in IHDS. IHDS researchers developed and administered these tests in collaboration with Pratham, an Indian NGO. All these tests were pre-tested to ensure similar difficulty level across 13 other Indian languages (Desai et al., 2015, 2010). Only children aged 8–11 years were administered these tests in both rounds of IHDS, as by this age, children are supposed to have developed the basic reading, mathematical and writing skills (NSCDC, 2005).

Independent variables

The extant literature provides a number of independent variables that are associated with the development potential of children. We classified these variables into two broad domains –biological and social. Only the variables measured for children aged 1–4 years in Round-I were included in the two broad domains. The variables included in biological domain are age of the children (in years), sex of the children (male, female), stunting status of children (stunted, not stunted), place of cooking in household (in living area, not in living area), type of cooking fuel (solid fuel, clean fuel), household sanitation condition (poor, average, good), and water purified in household (no, yes). Place of cooking in household and type of cooking fuel are indicators of indoor pollution whereas household sanitation condition and water purified in household measure household water, sanitation and hygiene (WASH) practices. Exposure to indoor pollution and inferior WASH practices in household are known to harm the health of children and hence have been included in the biological domain (Walker et al., 2007).

Household sanitation condition was determined using three variables – household source of drinking water, type of sanitation facility and number of people per room (WHO-UNICEF, 2004). During Round-I, respondents were asked about the source of drinking water. We recoded the source of drinking water into two categories – “unimproved” (consisting of “dug, open well”, “river”, “pond”, “truck” and “bottled” categories from the original variable) and “improved” (consisting of “piped”,

“tube well”, “hand pump”, “covered well” and “rainwater” categories from the original variable). Similarly, we categorized sanitation facility into two categories – “unimproved” (consisting of “defecation in open fields” and “traditional pit latrine” categories from the original variable) and “improved” (consisting of “ventilated improved pit latrine” and “flush toilet” categories from the original variable). Households drinking from unimproved and improved source of water were coded as “0” and “1” respectively. Households using unimproved and improved sanitation facility were coded as “0” and “1” respectively. Similarly, households having less than three members per room were coded as “1” and those with three or more members were coded as “0”. The above three variables were added to obtain a score. Households with a score of 3, 2, and less than 2 were categorized as having “good”, “average” and “poor” sanitation condition respectively.

HAZ values for determining the stunting status of children in Round-I were calculated using the WHO Anthro software (WHO Anthro, 2010) and anthropometric data provided in IHDS. Children having HAZ values less than -2 standard deviations were classified as “Stunted” and otherwise they were classified as “Not stunted”.

The variables included in social domain are wealth quintiles (poorest, poor, medium, rich, richest), below poverty line (BPL) status of household (yes, no), gender of the household head (male, female), caste of the household head (scheduled tribes (ST), scheduled castes (SC), other backward class (OBC), others), religion of the household head (Hindu, Muslim, others), type of community (rural, urban), attack/threat on any household member from the community (yes, no), solving community problem together (each family individually, families come together), highest educational level of male adult in the household (no formal schooling, up to 5 years of schooling, 6–10 years of schooling, more than 10 years of schooling), highest educational level of female adult in the household (no formal schooling, up to 5 years of schooling, 6–10 years of schooling, more than 10 years of schooling), number of forms of media a child is exposed to in the household (none, one, two or more), domestic violence on women in the community (yes, no), and women have autonomy regarding healthcare of children in household (no, yes). Additionally, two variables measured in Round-II, type of school attended by the children (public school, private school) and children taking private tuition (no, yes) were included in the social domain.

Wealth quintiles were estimated in IHDS Round-I using principal component analysis (Filmer & Scott, 2008). Wealth scores were generated from data on household asset ownership, livestock owned, and household material type. Based on the wealth scores households were classified into five categories (poorest, poor, middle, rich, and richest).

IHDS Round-I provided data on the educational attainment of adult males and females in a household. Adults were defined as people who are aged 21 years or older. We reclassified the variables for adult males and adult females respectively, into four categories based on general milestones in the Indian education system – no formal schooling, up to 5 years of schooling, 6–10 years of schooling, and more than 10 years of schooling.

IHDS Round-I also collected information from a one woman (between 15 and 49 years) from each interviewed household regarding whether husbands in the community beat their wives if she – “goes out without telling him”, “neglects the house or the children”, “does not cook food properly”, “is suspected of having relationship with other men” and “if her natal family does not provide money, jewelry and other items”. The five binary variables (coded as “yes” or “no”) formed from each of the above enquiries were used to prepare the binary indicator for domestic violence on women in community. If a woman responded “yes” in any of the five original variables then we classified the record in the study variable as a “Yes” or a “No” otherwise.

Statistical methods

As the dependent variables are ordinal, we estimated multivariable

ordinal logistic regression models to examine the association of biological and social variables measured in Round-I with the dependent variables measured in Round-II. Ordinal logistic regression model, also known as the cumulative logit model, gives cumulative odds ratio. Cumulative odds ratio is the odds of an individual being in any higher category of the dependent variable in comparison to all other categories below it, given the effect of all the other variables in the model remains constant (Cameron & Trivedi, 2005).

All the statistical estimations were done using STATA 13.0 (Stata-Corp, 2013).

Results

Distribution of children by relevant demographic and socio-economic characteristics in Round-I

Table 1 presents the percentage distribution of study sample by relevant social, demographic and economic characteristics of children

Table 1

Absolute (N) and percentage (%) distribution of children by relevant demographic and socio-economic characteristics across the cross-sectional and panel datasets for children aged 1–4 years in IHDS Round-I.

Characteristics	Children aged 1–4 years				Absolute Difference (%)
	Cross-sectional Dataset		Panel Dataset		
	N	%	N	%	
Age of the child (in years)					
1	3,502	21.3	1,496	17.4	3.9
2	4,215	25.7	2,474	28.7	3.0
3	4,499	27.4	2,671	31.0	3.6
4	4,188	25.5	1,970	22.9	2.6
Sex of the child					
Male	8,531	52.0	4,529	52.6	0.6
Female	7,873	48.0	4,082	47.4	0.6
Type of community					
Rural	11,492	70.1	6,330	73.5	3.4
Urban	4,912	29.9	2,281	26.5	3.4
Caste of the household head					
ST	1,486	9.1	737	8.6	0.5
SC	3,578	21.8	1,955	22.7	0.9
OBC	6,799	41.4	3,557	41.3	0.1
Other	4,541	27.7	2,362	27.4	0.3
Religion of the household head					
Hindu	12,860	78.4	6,791	78.9	0.5
Muslim	2,490	15.2	1,293	15.0	0.2
Others	1,054	6.4	527	6.1	0.3
Household below poverty line					
Yes	5,258	32.1	2,782	32.3	0.2
No	11,146	67.9	5,829	67.7	0.2
Wealth quintile					
Poorest	3,424	20.9	1,884	21.9	1.0
Poor	3,161	19.3	1,694	19.7	0.4
Medium	3,251	19.8	1,719	20.0	0.2
Rich	3,393	20.7	1,759	20.4	0.3
Richest	3,175	19.4	1,555	18.1	1.3
Highest educational level of male adult (21+ years)					
No formal schooling	3,485	21.7	1,989	23.1	1.4
Upto 5 years of schooling	2,508	15.6	1,343	15.6	0.0
6–10 years of schooling	4,276	26.6	2,307	26.8	0.2
More than 10 years of schooling	5,791	36.1	2,972	34.5	1.6
Highest educational level of female adult (21+ years)					
No formal schooling	7,260	44.5	3,893	45.2	0.7
Upto 5 years of schooling	2,325	14.2	1,273	14.8	0.6
6–10 years of schooling	3,264	20.0	1,727	20.1	0.1
More than 10 years of schooling	3,467	21.2	1,718	20.0	1.2
Overall	16,404	100	8,611	100	0

age 1–4 in IHDS Round-I (cross-sectional) and the panel dataset created for this study. Additionally, we show the absolute differences of the distribution across each category of all the aforementioned variables for both datasets. In the panel dataset, 53% are male and 47% are female. Further, 74% belonged to a rural household and 79% of children belonged to a Hindu household. The results also show that 23% and 9% of children belonged to SC and ST households respectively whereas 32% of children belonged to households that were below poverty line. Moreover, 23% and 45% of children came from households in which adult males and females had no formal schooling respectively. The percentage distributions of children across the selected characteristics were indeed similar in the cross-sectional and panel datasets. Only percentage distribution by urban-rural residence and age of the children (in years) differed by more than 3% points between the two datasets.

Bivariate association of biological- and social-variables measured in Round-I with the physical, cognitive, and language development measured in Round-II

Table 2 shows the association between biological variables measured in Round-I with the indicators of physical, cognitive and language development measured in Round-II. Children who were not stunted in Round-I had higher physical, cognitive, and language development in Round-II compared with stunted children. Children from households using clean cooking fuel and not cooking food in the living area had higher physical, cognitive, and language development in Round-II compared with their counterparts. Likewise, children from households having good sanitation and using purified drinking water had higher physical, cognitive, and language development in Round-II compared with their counterparts.

The association between the social variables measured in Round-I and the indicators of physical, cognitive and language development measured in Round-II are shown in Table 3. Children coming from households belonging to richest wealth quintiles in Round-I had best physical, cognitive and language development in Round-II respectively. Results also indicate improvements in physical, cognitive, and language development in Round-II with an improvement in wealth status of households in Round-I. Children belonging to BPL households in Round-I had poorer physical, cognitive, and language development in Round-II compared with children from above poverty line households in Round-I. Further, children belonging to households with female household head, facing no attack/threat from community, having at least a male adult with 10 or more years of schooling, having at least a female adult with 10 or more years of schooling, exposed to two or more forms of media, and women having autonomy regarding healthcare decision of children had higher physical, cognitive and language development in Round-II compared with their counterparts. Moreover, children from communities in which women do not face domestic violence had higher physical, cognitive and language development in Round-II compared with children from communities in which women faced domestic violence. Children going to private school and taking private tuitions had best physical, cognitive, and language development in Round-II.

Multivariable ordinal regression results showing the association of biological- and social-variables measured in Round-I with the physical, cognitive, and language development measured in Round-II

Multivariable ordinal regression results are shown in Table 4. The direction of association between the independent variables and physical, cognitive, and language development in the multivariable models were similar to those observed in the descriptive analyses. Female children had 0.80 and 0.89 times lower odds of attaining a better level of physical and cognitive development in Round-II in comparison to their male counterparts. Compared with stunted children, children age 1–4 who were not stunted in Round-I were more likely to attain higher physical development, mathematical-, and reading- and writing-skill at age 8–11

Table 2
Bivariate association between biological independent variables measured in Round-I with the physical, cognitive, and language development measured in Round-II.

Characteristics	Physical development				Cognitive development					Language development									
	Stunting status ^(a)				Mathematical skill ^(b)					Reading skill ^(c)					Writing skill ^(d)				
	(1)	(2)	(3)	Total	(1)	(2)	(3)	(4)	Total	(1)	(2)	(3)	(4)	(5)	Total	(1)	(2)	(3)	Total
Age of the children (in years)																			
1	15.7	18.4	65.9	1,424	20.3	42.1	27.8	9.9	1,367	14.4	19.1	25.2	17.2	24.1	1,370	31.4	35.1	33.5	1,352
2	12.4	18.5	69.1	2,355	17.0	38.4	30.4	14.2	2,287	11.0	15.0	23.2	20.5	30.3	2,300	26.8	37.4	35.8	2,274
3	12.3	16.9	70.8	2,550	13.9	34.5	31.7	19.9	2,450	9.9	13.5	18.4	19.6	38.6	2,461	23.3	36.5	40.1	2,434
4	10.6	14.2	75.2	1,875	12.7	31.8	31.0	24.6	1,806	8.7	10.9	17.6	19.7	43.1	1,810	21.7	37.2	41.2	1,791
Sex of the children																			
Male	11.7	14.9	73.4	4,309	13.8	36.7	30.5	19.0	4,150	10.4	13.4	21.3	20.0	34.8	4,165	24.6	37.6	37.9	4,122
Female	13.4	19.3	67.3	3,895	17.6	35.9	30.4	16.1	3,760	11.0	15.3	20.2	18.9	34.6	3,776	26.2	35.7	38.1	3,729
Stunting status of children																			
Stunted	14.6	21.9	63.4	3,803	19.2	39.7	27.0	14.1	3,626	13.0	16.9	21.9	17.5	30.6	3,635	30.7	37.0	32.3	3,588
Not stunted	10.7	12.7	76.6	4,401	12.6	33.5	33.5	20.5	4,284	8.8	12.1	19.8	21.2	38.2	4,306	20.8	36.4	42.8	4,263
Place of cooking in household																			
In living area	13.7	19.9	66.4	1,802	20.8	39.0	27.1	13.0	1,718	14.6	16.5	21.2	20.1	27.7	1,724	31.7	36.4	31.9	1,702
Not in living area	12.2	16.2	71.6	6,402	14.2	35.6	31.4	18.8	6,192	9.7	13.7	20.7	19.3	36.7	6,217	23.6	36.8	39.6	6,149
Type of cooking fuel in household																			
Solid fuel	12.5	17.9	69.5	7,085	17.4	37.9	29.1	15.6	6,801	12.0	15.2	21.6	18.7	32.4	6,825	27.9	37.3	34.8	6,757
Clean fuel	12.3	11.1	76.6	1,119	4.4	26.7	39.0	29.9	1,109	2.7	8.6	15.9	24.2	48.7	1,116	9.8	32.9	57.3	1,094
Household sanitation condition																			
Poor	12.9	19.6	67.5	4,330	21.4	40.7	26.3	11.5	4,156	14.8	16.7	23.3	17.8	27.4	4,168	32.6	36.2	31.2	4,136
Average	12.2	15.3	72.5	2,760	11.9	34.2	33.3	20.5	2,663	7.8	13.6	19.4	21.1	38.1	2,674	20.4	39.1	40.5	2,638
Good	11.7	11.1	77.2	1,114	2.7	24.6	39.4	33.4	1,091	2.5	7.0	14.5	22.0	54.0	1,099	9.4	32.7	57.9	1,077
Water purified in household																			
No	11.9	18.1	70.0	5,865	18.4	37.2	28.3	16.1	5,642	12.6	14.9	21.1	18.4	33.1	5,667	28.5	35.7	35.9	5,623
Yes	14.0	14.2	71.8	2,339	8.6	34.1	35.8	21.4	2,268	6.1	12.8	20.1	22.3	38.7	2,274	17.5	39.3	43.3	2,228
Overall	12.5	17.0	70.5	8,204	15.6	36.3	30.5	17.6	7,910	10.7	14.3	20.8	19.5	34.7	7,941	25.3	36.7	38.0	7,851

Note – (a) the categories of stunting status are – (1) severely stunted, (2) moderately stunted, (3) not stunted; (b) the categories of mathematical skill are – (1) cannot recognize numbers, (2) can recognize numbers, (3) can do subtraction, (4) can do division; (c) the categories of reading skill are – (1) cannot read letters, (3) can read letters, (3) can read words, (4) can read paragraph, (5) can read story; (d) the categories of writing skill are – (1) cannot write, (2) can write with 1–2 mistakes, (3) can write with no mistakes.

Table 3

Bivariate association between social independent variables measured in Round-I with the physical, cognitive, and language development measured in Round-II.

Characteristics	Physical development				Cognitive development					Language development									
	Stunting status ^(a)				Mathematical skill ^(b)					Reading skill ^(c)					Writing skill ^(d)				
	(1)	(2)	(3)	Total	(1)	(2)	(3)	(4)	Total	(1)	(2)	(3)	(4)	(5)	Total	(1)	(2)	(3)	Total
Wealth quintile of household																			
Poorest	13.9	23.3	62.8	1,807	30.9	43.8	18.3	7.1	1,714	21.9	21.4	21.6	13.1	21.9	1,714	44.3	33.0	22.6	1,707
Poor	13.4	19.8	66.8	1,610	22.7	40.7	25.1	11.5	1,538	15.5	16.3	23.0	16.6	28.6	1,545	31.9	37.7	30.4	1,530
Medium	11.9	17.0	71.1	1,628	12.2	37.8	33.8	16.2	1,578	7.7	15.0	23.3	22.3	31.8	1,591	22.5	40.3	37.2	1,571
Rich	12.2	14.1	73.6	1,668	7.9	34.9	35.9	21.3	1,640	5.2	10.4	21.7	22.3	40.3	1,647	16.5	39.1	44.4	1,625
Richest	10.7	9.6	79.7	1,491	2.4	22.7	41.0	34.0	1,440	1.9	7.4	13.6	23.7	53.3	1,444	8.6	33.2	58.2	1,418
Household below poverty line																			
Yes	13.0	19.6	67.4	2,661	23.5	42.4	24.4	9.7	2,569	17.0	18.1	21.9	16.6	26.5	2,576	34.6	36.3	29.0	2,556
No	12.3	15.7	72.0	5,543	11.8	33.4	33.4	21.4	5,341	7.7	12.5	20.2	20.9	38.7	5,365	20.8	36.9	42.3	5,295
Gender of household head																			
Male	12.5	17.2	70.3	7,701	15.9	36.5	30.1	17.5	7,418	10.9	14.4	20.8	19.5	34.5	7,449	25.4	36.9	37.7	7,364
Female	13.3	13.3	73.4	503	11.2	34.1	35.8	18.9	492	8.5	12.2	21.1	19.9	38.2	492	24.4	33.1	42.5	487
Caste of the household head																			
SC	11.3	19.4	69.3	1,883	18.6	38.1	26.9	16.4	1,796	13.4	16.1	21.6	17.8	31.1	1,803	29.3	36.1	34.5	1,789
ST	14.1	21.4	64.6	683	26.5	44.2	20.8	8.5	672	17.9	20.7	22.2	17.3	21.9	676	38.7	36.8	24.5	669
OBC	13.0	17.3	69.8	3,405	15.7	37.2	31.3	15.8	3,269	10.2	14.7	20.6	19.7	34.8	3,277	25.3	38.8	35.9	3,231
Others	12.4	13.2	74.4	2,233	9.6	31.1	35.1	24.2	2,173	7.1	10.3	20.0	21.1	41.5	2,185	18.0	34.0	48.1	2,162
Religion of the household head																			
Hindu	11.6	17.4	71.0	6,494	15.1	36.1	30.2	18.6	6,252	9.8	14.5	20.3	19.2	36.1	6,279	24.6	36.7	38.7	6,206
Muslim	17.1	17.0	66.0	1,214	21.1	39.2	28.8	10.9	1,168	16.5	14.5	23.9	19.4	25.7	1,173	32.5	36.2	31.2	1,159
Others	13.3	12.3	74.4	496	9.0	32.9	37.8	20.4	490	8.6	10.8	19.4	22.7	38.4	489	17.9	37.2	44.9	486
Type of community																			
Rural	12.6	18.2	69.2	6,034	18.3	38.4	27.6	15.6	5,805	12.5	15.8	21.8	17.8	32.1	5,825	28.3	37.2	34.5	5,763
Urban	12.1	13.8	74.1	2,170	8.1	30.6	38.3	23.0	2,105	5.8	10.2	18.0	24.0	42.0	2,116	17.0	35.3	47.7	2,088
Attack/threat on household																			
Yes	12.8	17.4	69.7	218	27.1	42.2	18.6	12.1	199	19.8	15.3	22.3	15.3	27.2	202	41.8	32.3	25.9	201
No	12.5	17.0	70.5	7,986	15.3	36.2	30.8	17.7	7,711	10.5	14.3	20.7	19.6	34.9	7,739	24.9	36.8	38.3	7,650
Solving community problem																			
Each family individually	11.6	17.2	71.1	3,427	17.0	36.6	29.5	16.9	3,286	12.1	14.5	19.1	18.7	35.5	3,294	26.3	37.6	36.0	3,265
Families come together	13.1	16.8	70.0	4,777	14.6	36.1	31.2	18.1	4,624	9.7	14.1	21.9	20.0	34.2	4,647	24.6	36.0	39.3	4,586
Highest educational level of male adult (21+ years)																			
No formal schooling	13.7	20.3	66.0	1,896	29.6	42.1	19.9	8.4	1,777	23.2	19.6	22.6	14.0	20.6	1,784	42.7	33.7	23.6	1,767
Upto 5 years of schooling	14.5	19.4	66.1	1,276	19.5	43.7	26.0	10.8	1,235	13.5	16.3	25.1	18.1	27.0	1,243	31.6	39.3	29.0	1,233
6–10 years of schooling	12.4	17.8	69.8	2,194	13.3	38.0	32.5	16.1	2,154	8.0	15.2	21.3	20.6	35.0	2,157	23.0	38.3	38.7	2,136
More than 10 years of schooling	10.9	13.1	76.0	2,838	6.6	27.9	37.8	27.7	2,744	3.5	9.3	17.2	22.8	47.1	2,757	13.0	36.2	50.8	2,715
Highest educational level of female adult (21+ years)																			
No formal schooling	13.3	20.5	66.2	3,719	26.2	41.4	22.4	10.0	3,536	18.9	19.4	23.0	14.9	23.8	3,548	38.8	34.1	27.1	3,527
Upto 5 years of schooling	11.3	17.9	70.7	1,217	11.0	43.0	30.7	15.3	1,184	7.2	12.6	22.4	20.8	37.0	1,190	20.6	42.7	36.8	1,177
6–10 years of schooling	12.1	14.2	73.7	1,645	7.8	33.3	38.2	20.7	1,617	3.7	10.9	19.4	24.4	41.7	1,622	15.0	40.5	44.5	1,601
More than 10 years of schooling	12.0	11.2	76.8	1,623	3.3	23.0	40.5	33.2	1,573	2.1	7.8	16.1	23.7	50.3	1,581	9.1	34.1	56.9	1,546
Forms of mass media a child is exposed																			
None	13.4	19.1	67.4	3,244	20.8	39.8	26.9	12.5	3,106	14.7	16.3	22.3	17.2	29.5	3,115	31.6	36.3	32.1	3,090
One	11.8	16.0	72.2	3,001	13.2	35.2	32.0	19.6	2,912	8.8	13.7	19.7	21.0	36.8	2,921	22.5	37.7	39.8	2,884
Two or more	12.0	15.1	72.9	1,959	10.9	32.3	34.1	22.7	1,892	7.2	12.0	19.9	20.8	40.0	1,905	19.3	35.8	44.9	1,877
Domestic violence on women in community																			
Yes	12.2	17.2	70.6	6,895	16.2	37.0	29.8	17.0	6,640	11.4	14.5	20.9	19.1	34.1	6,661	26.1	37.2	36.7	6,594
No	14.1	15.9	70.1	1,309	12.6	32.8	34.1	20.5	1,270	7.3	13.4	20.3	21.3	37.7	1,280	21.3	34.2	44.5	1,257
Women autonomy in healthcare of children in household																			
No	12.5	17.6	69.9	5,807	17.3	37.5	29.2	16.1	5,593	11.5	14.9	20.7	18.9	34.0	5,616	26.7	37.1	36.2	5,572
Yes	12.6	15.5	71.9	2,397	11.6	33.5	33.6	21.3	2,317	8.8	12.8	21.1	20.9	36.4	2,325	21.9	35.8	42.3	2,279
Type of school attended in Round II																			
Public school	13.9	19.1	67.0	5,207	19.8	39.3	27.4	13.5	5,002	13.7	16.4	22.5	19.4	28.1	5,023	30.8	37.4	31.8	4,969
Private school	10.1	13.3	76.5	2,997	8.4	31.2	35.8	24.6	2,908	5.6	10.7	17.9	19.7	46.1	2,918	15.9	35.4	48.7	2,882
Takes private tuition in Round II																			
No	13.1	17.8	69.1	6,301	18.4	38.6	28.0	15.0	6,047	12.8	15.9	21.6	18.2	31.5	6,075	28.8	36.3	34.9	6,005
Yes	10.5	14.2	75.2	1,903	6.6	28.8	38.6	25.9	1,863	4.1	9.2	18.0	23.6	45.2	1,866	14.0	38.1	47.9	1,846
Overall	12.5	17.0	70.5	8,204	15.6	36.3	30.5	17.6	7,910	10.7	14.3	20.8	19.5	34.7	7,941	25.3	36.7	38.0	7,851

Note – (a) the categories of stunting status are – (1) severely stunted, (2) moderately stunted, (3) not stunted; (b) the categories of mathematical skill are – (1) cannot recognize numbers, (2) can recognize numbers, (3) can do subtraction, (4) can do division; (c) the categories of reading skill are – (1) cannot read letters, (2) can read letters, (3) can read words, (4) can read paragraph, (5) can read story; (d) the categories of writing skill are – (1) cannot write, (2) can write with 1–2 mistakes, (3) can write with no mistake.

Table 4

Odds ratio from multivariable ordinal regression models showing the association of biological- and social-independent variables measured in Round-I with the physical, cognitive and language development measured in Round-II.

Characteristics	Physical development		Cognitive development		Language development			
	Stunting status ^(c)		Mathematical skill ^(d)		Reading skill ^(e)		Writing skill ^(f)	
	Odds ratio	95% CI	Odds ratio	95% CI	Odds ratio	95% CI	Odds ratio	95% CI
Age of the children (in years)								
1 ^(g)								
2	1.32*	(1.14–1.52)	1.54*	(1.36–1.74)	1.57*	(1.40–1.78)	1.32*	(1.16–1.50)
3	1.39*	(1.21–1.60)	2.21*	(1.95–2.50)	2.17*	(1.92–2.45)	1.62*	(1.42–1.84)
4	1.74*	(1.49–2.03)	2.91*	(2.55–3.33)	2.92*	(2.56–3.33)	1.84*	(1.60–2.11)
Sex of the children								
Male ^(g)								
Female	0.80*	(0.73–0.88)	0.89*	(0.82–0.97)	1.03	(0.95–1.12)	1.05	(0.97–1.15)
Stunting status of children								
Stunted ^(g)								
Not stunted	1.75*	(1.59–1.93)	1.36*	(1.25–1.48)	1.30*	(1.19–1.41)	1.36*	(1.25–1.48)
Place of cooking in household								
In living area ^(g)								
Not in living area	1.06	(0.95–1.19)	0.99	(0.89–1.10)	1.04	(0.94–1.15)	1.03	(0.93–1.15)
Type of cooking fuel in household								
Solid fuel ^(g)								
Clean fuel	0.89	(0.73–1.07)	0.84*	(0.72–0.98)	0.87	(0.74–1.01)	1.19*	(1.01–1.40)
Household sanitation condition								
Poor ^(g)								
Average	1.02	(0.91–1.14)	1.19*	(1.08–1.32)	1.13*	(1.03–1.25)	1.08	(0.98–1.20)
Good	0.99	(0.82–1.20)	1.47*	(1.26–1.71)	1.48*	(1.27–1.73)	1.33*	(1.13–1.56)
Water purified in household								
No ^(g)								
Yes	0.94	(0.84–1.06)	1.18*	(1.07–1.30)	1.05	(0.95–1.15)	1.10	(1.00–1.22)
Wealth quintile of household								
Poorest ^(g)								
Poor	1.09	(0.94–1.26)	1.28*	(1.11–1.46)	1.21*	(1.06–1.38)	1.31*	(1.14–1.50)
Medium	1.28*	(1.09–1.50)	1.88*	(1.63–2.17)	1.45*	(1.26–1.66)	1.63*	(1.41–1.88)
Rich	1.34*	(1.11–1.61)	1.88*	(1.60–2.22)	1.56*	(1.33–1.82)	1.63*	(1.38–1.92)
Richest	1.70*	(1.33–2.17)	2.45*	(1.99–3.00)	1.82*	(1.49–2.23)	1.80*	(1.46–2.23)
Household below poverty line								
Yes ^(g)								
No	0.91	(0.81–1.02)	1.20*	(1.08–1.33)	1.14*	(1.03–1.25)	1.05	(0.95–1.16)
Gender of household head								
Male ^(g)								
Female	1.07	(0.86–1.31)	1.08	(0.91–1.28)	1.11	(0.94–1.32)	1.01	(0.84–1.21)
Caste of the household head								
ST ^(g)								
SC	1.03	(0.85–1.24)	1.19*	(1.01–1.40)	1.19*	(1.02–1.40)	1.20*	(1.01–1.42)
OBC	1.08	(0.89–1.31)	1.20*	(1.01–1.43)	1.10	(0.93–1.30)	1.20*	(1.01–1.43)
Others	1.18	(0.96–1.45)	1.43*	(1.19–1.71)	1.31*	(1.10–1.56)	1.49*	(1.24–1.79)
Religion of the household head								
Hindu ^(g)								
Muslim	0.71*	(0.62–0.82)	0.56*	(0.49–0.63)	0.58*	(0.51–0.65)	0.63*	(0.55–0.72)
Others	0.99	(0.79–1.23)	1.02	(0.85–1.22)	1.00	(0.84–1.19)	1.11	(0.92–1.34)
Type of community								
Rural ^(g)								
Urban	0.94	(0.81–1.09)	0.98	(0.87–1.11)	0.99	(0.88–1.11)	0.91	(0.80–1.03)
Attack/threat on household								
Yes ^(g)								
No	0.99	(0.74–1.33)	1.59*	(1.22–2.09)	1.36*	(1.05–1.76)	1.65*	(1.26–2.16)
Solving community problem								
Each family individually ^(g)								
Families come together	0.93	(0.84–1.03)	1.12*	(1.03–1.22)	1.03	(0.94–1.11)	1.11*	(1.02–1.21)
Highest educational level of male adult (21+ years)								
No formal schooling ^(g)								
Upto 5 years of schooling	0.92	(0.79–1.07)	1.29*	(1.12–1.48)	1.39*	(1.22–1.59)	1.24*	(1.08–1.43)
6–10 years of schooling	0.96	(0.83–1.11)	1.45*	(1.27–1.65)	1.58*	(1.39–1.79)	1.46*	(1.28–1.66)
More than 10 years of schooling	1.05	(0.89–1.23)	1.66*	(1.44–1.92)	1.86*	(1.62–2.14)	1.58*	(1.37–1.83)
Highest educational level of female adult (21+ years)								
No formal schooling ^(g)								
Upto 5 years of schooling	1.09	(0.94–1.26)	1.38*	(1.21–1.57)	1.63*	(1.43–1.84)	1.41*	(1.24–1.60)
6–10 years of schooling	1.08	(0.94–1.25)	1.67*	(1.48–1.89)	1.75*	(1.55–1.97)	1.57*	(1.38–1.78)
More than 10 years of schooling	0.99	(0.83–1.19)	2.02*	(1.74–2.35)	1.62*	(1.40–1.88)	1.69*	(1.45–1.97)
Forms of mass media a child is exposed								
None ^(g)								
One	1.05	(0.94–1.17)	1.05	(0.95–1.16)	1.01	(0.91–1.11)	1.00	(0.90–1.10)
Two or more	0.97	(0.85–1.11)	1.08	(0.97–1.21)	0.98	(0.88–1.10)	1.06	(0.94–1.19)
Domestic violence on women in community								
Yes ^(g)								

(continued on next page)

Table 4 (continued)

Characteristics	Physical development		Cognitive development		Language development			
	Stunting status ^(c)		Mathematical skill ^(d)		Reading skill ^(e)		Writing skill ^(f)	
	Odds ratio	95% CI	Odds ratio	95% CI	Odds ratio	95% CI	Odds ratio	95% CI
No	0.86*	(0.76–0.99)	1.17*	(1.05–1.32)	1.13*	(1.01–1.27)	1.23*	(1.09–1.39)
Women autonomy in healthcare of children in household								
No ^(b)								
Yes	1.01	(0.91–1.13)	1.20*	(1.10–1.32)	1.00	(0.92–1.10)	1.08	(0.98–1.19)
Type of school attended in Round-II								
Public school								
Private school	1.32*	(1.18–1.48)	1.22*	(1.11–1.35)	1.41*	(1.28–1.55)	1.35*	(1.22–1.49)
Takes private tuition in Round-II								
No								
Yes	1.16*	(1.03–1.32)	1.58*	(1.43–1.75)	1.48*	(1.34–1.64)	1.34*	(1.21–1.49)
Number of children	8,204		7,910		7,941		7,851	

Note – (a) Statistical significance is denoted by asterisks where * $p < 0.05$; (b) ® denotes reference category; (c) the categories of stunting status are – severely stunted, moderately stunted, not stunted; (d) the categories of mathematical skill are – cannot recognize numbers, can recognize numbers, can do subtraction, can do division; (e) the categories of reading skill are – cannot read letters, can read letters, can read words, can read paragraph, can read story; (f) the categories of writing skill are – cannot write, can write with 1–2 mistakes, can write with no mistakes.

in Round-II. Better household sanitation in Round-I was also associated with higher cognitive and language development in children in Round-II. Children from households with good sanitation condition had 1.47, 1.48 and 1.33 times higher odds of attaining higher mathematical, reading, and writing skills respectively compared with children from households with poor sanitation.

Children from higher wealth quintiles households in Round-I had higher odds of attaining higher levels of physical, cognitive, and language development in Round-II. Children from richest quintile households had 1.70, 2.45, 1.82, and 1.80 times higher odds of not being stunted and attaining higher mathematical-, and reading- and writing-skill compared with children from poorest quintile households respectively. Children from non-BPL households had higher odds of attaining higher mathematical, reading, and writing skills. Children from households whose members did not face attacks or threats from community during Round-I had 1.59, 1.36 and 1.65 times greater odds of attaining a higher-level of mathematical-, reading-, and writing-skill respectively in Round-II compared with their counterparts. Children from households, where at least one of the male adults had 10 or more years of schooling had 1.66, 1.86 and 1.58 times greater odds of achieving a higher mathematical-, reading-, and writing-skill respectively in comparison with children from households in which adult male members had no formal schooling. Similarly, children from households in which one or more of adult female members had 10 or more years of schooling had 2.02, 1.62 and 1.69 times greater odds of achieving a higher level of mathematical-, reading-, and writing-skill respectively compared with children from households in which adult female members had no formal schooling. Further, children going to private school in Round-II were 1.32 times more likely of not being stunted and 1.22, 1.41 and 1.35 times greater odds of achieving a higher mathematical-, reading-, and writing-skill respectively compared with their public school counterparts. Likewise, children taking private tuitions in Round-II were highly likely of having better mathematical-, reading-, and writing-skill respectively in comparison to their peers.

Discussion

The current study uses IHDS panel dataset to examine causal association between exposure to early childhood adverse experiences (measured in Round-I) and deficiencies in the development potential (measured in Round-II) in Indian children. Findings indeed show that exposure to early childhood adverse experiences lead to deficiencies in the development potential in Indian children. Our study shows that undernutrition, poverty and hostile community environment are major risk factors that arrest the physical development in Indian children. Similarly, the prominent risk factors preventing the cognitive

development in Indian children are undernutrition, poor household sanitation condition, poverty, hostile community environment, lack of schooling among adults of household, domestic violence on women in the community, and lack of autonomy among women in the household. Likewise, we find that language development of Indian children is deterred by occurrence of undernutrition, poor household sanitation condition, poverty, hostile community environment, lack of education among household adults, domestic violence on women in the community, and lack of autonomy among women in the household. Further, our study shows that private schooling and taking private tuition results in better all-round development in children. Furthermore, we find evidence of an existing gender gap, which favored the development of male children over their female counterparts. Moreover, there is compelling evidence of wealth- and caste-based inequalities in the development of Indian children. A few of the existing studies had also shown that undernutrition during childhood deters the cognitive development of Indian children (Acharya et al., 2019; Kingdon, 2010; Spears, 2012). Spears and Lamba (2013) and Singh et al. (2017) also documented the deleterious impact of unsafe household sanitation practices on the cognitive development of Indian children.

However, there are contradictions too. Our study, after adjusting for the effects of relevant biological and social risk factors, did not find association between mass media exposure and the development potential of Indian children which contradicts the finding of Singh and Gaurav (2013). Furthermore, our study did not find any additional benefit of female household headship for the development of Indian children. Female household headship was, however, found to be associated with higher development potential in Indian children in Singh et al. (2013). There are two possible reasons for this contradiction. Firstly, both the studies did not include crucial biological risk factors, such as stunting status of the children, indoor pollution-related indicators, household sanitation condition and water purification procedure of household, in their statistical models. Secondly, both the studies were cross-sectional in nature and the association shown in these studies does not correspond to a cause-effect relationship.

A key strength of our study is the use of panel dataset to determine the effect of adversities faced by the children during early childhood on their development potential at age 8–11. The early childhood period is a highly sensitive interval as the children are more vulnerable to the harmful effects of adversities during this period. The persistent exposure to adversities during this period are likely to reveal its harmful effects on development potential in the long run (Shonkoff & Phillips, 2000). Thus, cross-sectional studies measuring the association of the adversities with the development potential in children during early childhood will misestimate this effect. Moreover, cross-sectional studies that measure this association after early childhood period will be unable to tell if the

children were exposed to the adversities during the early childhood. Even if they do, there is likely to be huge recall bias. Fortunately, in IHDS the information on exposure to early childhood adversities and the level of development in children were collected at appropriate ages in separate rounds. Thus, our estimates do not suffer from selection bias and recall bias. Furthermore, the similar composition of the study population in IHDS Round-I cross-sectional and panel dataset indicates that our estimates are least affected by attrition bias. Additionally, our study uses appropriate and reliable instruments for measuring the cognitive and language development (reading, mathematical and writing skill) in Indian children. To determine whether the study results are affected by the choice of stunting as a measure of undernutrition in Round-I, we performed another set of analysis taking underweight as the indicator of undernutrition. The results from the second set of analysis were indeed similar to the analysis shown in our paper. IHDS, being a nationally representative household survey, allowed us to generalize our results to Indian children as opposed to previous population-specific Indian studies.

The shortcomings of the study should also be noted. Firstly, our study was unable to provide evidence of the effect of the timing of adverse experiences on the development of physical, cognitive and language skill in children due to lack of relevant data in IHDS. Secondly, even though our study adjusted for a majority of relevant demographic and socio-economic characteristics, we could not adjust for exposure to harmful pollutants in environment, relationship of the children with their primary caregiver, breastfeeding, and occurrence of morbidities in our analysis due to the unavailability of data in IHDS. Thirdly, the effects presented here are unweighted due to the non-availability of panel data weights in IHDS. Future studies examining the association between early childhood adversities and development potential may note that some of the explanatory variables may interact with each other. Thus, possible interaction terms supported by proper theoretical justifications may be used. Future rounds of IHDS may also collect information on socio-emotional development of children for better understanding of this domain of development potential in Indian children. Even though we used mathematical skill as an indicator of cognitive development, future studies could use other indicators that measure cognitive development among Indian children in its entirety. Future research may also focus on verbal skills and comprehension, which are often used as language development indicators, to fully understand the language development in Indian children.

Despite these limitations, our study provides additional and conclusive evidence of the effect of adversities during early childhood on development potential in Indian children at later ages. Interestingly, the problem of early childhood adversity is often overlooked, which makes it a devil in disguise. Investments on positive nurturing of children during the early childhood are likely to result in greater dividends in terms of economic and social capital in the future. The findings of our study pinpoint the important role that childcare programmes such as the Integrated Child Development Services (ICDS) can play in improving the development potential in Indian children. Additionally, our estimates highlight the importance of using clean fuel, good household sanitation condition, and safe drinking water for the growth and development of Indian children. These findings lend support to the various Government of India recently sponsored programmes such as the “Swachh Bharat Mission” and clean cooking fuel use programme named “Ujjwala”. Furthermore, public programmes supporting the girl child are crucial for bridging the existing gender gap in development of children. In short, our findings call for swift and effective implementation of such programmes and bring more and more children suffering from the loss of development potential under the aegis of these programmes.

Funding statement

This research received no specific grant from any funding agency, commercial entity or not-for-profit organization.

Author contribution

Ronak Paul (RP) Formal analysis. Writing - original draft conceived the study, did the data analysis, and wrote the first draft of the manuscript; Abhishek Singh (AS) Supervision Formal analysis. supervised the data analysis and revised and edited the manuscript.

Ethical statement

Our study is based on a publicly available secondary data with no identifiable information on survey respondents. Hence, no ethical approval was needed for this study. The data used in our study can be downloaded from the IHDS website (Desai et al., 2008; Desai & Vanneman, 2015). Details regarding research project approval, respondent approval, and data collection procedures are available in the IHDS user guides (Desai et al., 2015, 2010).

Declaration of competing interest

There is no conflict of interest.

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