Learning deficits and early school leaving: Evidence from a longitudinal study in India

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Abstract

Although the relationship between learning deficits (LD) and early school leaving (ESL) is extensively acknowledged in studies from the Global North, fewer studies from the Global South have examined this relationship. We examined the levels and patterns of ESL among adolescents, relationship between LD and ESL and the gender dimensions, if any, in this relationship in India.

We used data from a state-representative longitudinal study of adolescents aged 10-19 in Bihar and Uttar Pradesh states of India, conducted in 2015-16 and 2018-19. Descriptive analysis drew on data from adolescents ever enrolled in school (N=11,476) and multivariate analyses used data from adolescents enrolled in school at wave 1 (N=9,169). We used discrete-time hazard and fixed effects regression models to examine the relationship between LD and ESL.

The probability of ESL was 39%, with a higher probability for girls (42%) than boys (38%). Although learning levels improved over time, 53% of adolescents displayed moderate or severe LD. Discrete-time hazard models show that LD influenced the probability of ESL (β =1.959, p<0.001 for those with severe LD and β =0.568, p<0.001 for those with moderate LD). Learning deficits equally affected the probability of ESL among girls and boys. Fixed-effects regression models reiterate these findings.

Investment in improving foundational skills is paramount for preventing early school leaving for girls and boys. However, the potential benefits will only be fully realised with accompanying measures which address gendered beliefs and practices and premature transition to adult roles, enhance parental engagement and improve education systems.

1. Introduction

Early school leaving and extensive learning deficits remain critical challenges in global education, with significant implications for youth development and societal progress. Despite notable advances in expanding access to education, completion rates in 2023 remained far below SDG targets, with 85% of children completing primary school, 78% completing lower secondary school and only 59% completing upper secondary school worldwide (United Nations, 2024). Moreover, 42% of youth aged 21-24 globally were classified as early school leavers, that is, they left schooling without completing 12 years of education (UNESCO, OECD and the Commonwealth Secretariat, 2024). Learning outcomes are equally concerning, with an estimated 70% of children in learning poverty (i.e., being unable to read and understand a simple text by age 10) in low- and middle-income countries in 2022 (World Bank, 2022).

The economic costs of early school leaving and learning deficits are massive. It is estimated that the current level of early school leaving and basic skills deficits will cost households globally USD 6.3 trillion (11% of global GDP) and USD 9. 2 trillion (17% of global GDP), respectively, in 2030 (UNESCO, OECD and the Commonwealth Secretariat, 2024). The corresponding costs to governments will amount to USD 1.1 trillion and USD 3.3 trillion, respectively. Early school leaving and learning deficits also have substantial social and health consequences, including the risk of early marriage and childbearing, poor mental health, homicides and other forms of violence (Esch et al., 2014; Lansford et al., 2016). For example, it is estimated that early school leaving and basic skills deficits in girls are associated globally with a 59% and 69% increase in early pregnancies, respectively (UNESCO, OECD and the Commonwealth Secretariat, 2024).

The relationship between learning deficits and early school leaving is extensively acknowledged in the global literature, particularly in studies from the Global North (Rumberger and Lim, 2008; Sabates et al., 2010; Lyche, 2010; González-Rodríguez et al., 2019; Gubbels et al., 2019; De Witte et al., 2023). Poor academic performance, although defined and measured differently, for example, low academic achievement, grade repetition, lack of interest in classes, low learning skills, low IQ or learning difficulties among others, is found to be a strong predictor of school discontinuation. However, studies that explored this relationship, particularly the causal relationship, are few and far between in the Global South. This is partially because of limited availability of studies that used panel designs that are a better fit for exploring school discontinuation as a longer process of disengagement (Bridgeland et al., 2006) and few studies that measured learning deficits objectively. Moreover, endogeneity issues arising from simultaneity because factors found to improve learning are also found to improve school attendance, omitted variables and measurement errors complicate assessing this relationship (Nakajima et al., 2018).

The gendered dimension of factors underlying school participation and performance is documented in a few studies in the Global South. For example, a study that explored the effects of primary school quality on school discontinuation among Kenyan girls and boys found that the quality of the school environment had a larger impact on discontinuation among girls than boys (Lloyd et al., 2000). The study reported that girls attending schools in which boys were favoured, where teachers gave lesser importance of hard subjects for girls and where boys were not restrained from harassing girls had higher odds of discontinuing school than boys. Another study in Ethiopia and Guinea observed that adverse cultural practices operating at the household, school, labour market and societal levels affected the enrolment and performance of girls more than boys (Colclough et al., 2000). Similarly, a study from India reported that positive classroom dynamics was correlated with academic

performance of girls more than boys (Santhya et al., 2015). However, whether learning deficits have similar or differential impact on early school leaving among girls and boys is less researched in the Global South.

Drawing on data from a unique state-representative longitudinal study of adolescents aged 10-19 in the two poorest and most populous states of India – Bihar and Uttar Pradesh, this paper extends the literature on the relationship between learning deficits and early school leaving. Specifically, it examines the levels and patterns of early school leaving among adolescents, the relationship between learning deficits and early school leaving and the gender dimensions, if any, of this relationship.

1.1 Education participation and performance in India

Policy and programme initiatives to improve school participation and completion and learning outcomes have increased significantly over the last two decades in India. Some notable examples of these initiatives include the Right of Children to Free and Compulsory Education Act 2009, the National Education Policy 2020 and the *Samagra Shiksha.* Correspondingly, the enrolment of children in school increased significantly since the early 2000s; data from nationally representative sample surveys show that the proportion of children aged 5-17 years enrolled in school increased from 77% in 2004/05 to 94% in 2023/24 (National Sample Survey Office, 2006; National Statistical Office, 2024). Several challenges, however, remain. For example, data from multiple sources indicate that early school leaving is a major issue in India. Education system data show that while the dropout rate was negligible at the primary level (2% for grades 1-5 and 3% for grades 6-8), it was as high as 13% in secondary school (grades 9-10) in 2021-22 (Department of School Education and Literacy, 2022). Although not exactly comparable, higher levels of dropout rates are reported in population-based sample surveys. A 2017-18 nation-wide survey on education by the National Statistical Office reports that while dropout rate was 10% for grades 1-5, it was as high as 18% for grades 6-8 and 20% for grades 9-10 (National Statistical Office, 2020). The Annual Status of Education Report (ASER) survey reports that 24% of adolescents aged 17-18 discontinued schooling and of these, 75% discontinued before completing grade 12 in rural India in 2023 (ASER Centre, 2024).

Poor learning levels among children and adolescents are widely documented in India. Some 56% of children were in learning poverty in 2017 (World Bank, 2022). Another study reports that 89% of children lacked basic skills in India (Gust et al., 2024). The 2023 Annual Status of Education Report survey among 14-18-year-olds notes that 26% could not read a grade 2 level text fluently in their local language and 57% could not solve a division problem (3-digit by 1-digit), a skill that is usually expected in grades 3-4 (ASER Centre, 2024). The survey notes further that foundational skills were far from universal even among those who were enrolled in grades 11-12 – only 88% were able to read a grade 2 level text fluently and 52% could solve a simple division problem. Furthermore, learning levels have shown little to no improvement in recent years, and, in some assessments, have even deteriorated. For example, data from the National Achievement Surveys show that average scores obtained by grade 10 students declined for science (253 to 206 out of 500), social science (254 to 231) and mathematics (254 to 220) between 2018 and 2021 (National Council of Educational Research and Training, 2021; Ministry of Education, 2022).

Gender gaps are negligible in most education participation indicators, including dropout rates. For example, dropout rates were 12% and 13%, respectively, among girls and boys in secondary school in 2021-22 (Department of School Education and Literacy, 2022). However, gender gaps are notable in school performance indicators. The National Achievement Survey reports that girls enrolled in grade

10 scored higher than boys in modern Indian language and English, while boys scored better than girls in Mathematics (Ministry of Education, 2022).

Several studies have examined factors associated with school discontinuation in India, using both cross-sectional data (Gouda and Sekher, 2014; Prakash et al., 2017; Goel and Husain, 2018; Garg et al., 2023) and longitudinal data (Siddhu, 2011; Singh and Mukherjee, 2017; Nakajima et al., 2018; Marphatia et al., 2019; Cueto and León, 2020; Paul et al., 2021; Kumar et al., 2023). While some of these studies focused on the correlates of discontinuation among girls or conducted sex-disaggregated analyses, others did not differentiate between girls and boys. Overall, these studies have identified a variety of factors underlying school discontinuation. However, only a few of these studies examined the relationship between educational performance and school discontinuation (Siddhu, 2011; Singh and Mukherjee, 2017; Nakajima et al., 2018; Marphatia et al., 2019; Cueto and León, 2020; Paul et al., 2021). Although measured differently (e.g., grade repetition, perceptions about performance, receptive vocabulary ability test, Raven's test, reading skill, test in mathematics and Hindi), these studies confirm a direct relationship between learning deficits and school discontinuation. Even so, findings are not consistent across studies. While Paul and co-authors' (2021) analysis of data from two rounds of the India Human Development Survey found that grade repetition increased the risk of the school discontinuation during the inter-survey period, no such relationship was observed in Cueto and León's (2020) analysis of data from five rounds of the Young Lives study in Andhra Pradesh and Telangana. Similarly, while various analyses using Young Lives data showed that reading/writing skills at age 8/12 were associated with the reduced chances of discontinuation (Singh and Mukherjee, 2017; Nakajima et al., 2018; Cueto and León, 2020), Siddhu (2011) observed no such association in a study in Uttar Pradesh. Findings from sex-disaggregated analysis of the association between performance and school discontinuation are also inconsistent. For example, Siddhu (2011) found that cognitive ability as assessed by the Raven's test affected girls' transition to secondary school but not boys' transition. On the other hand, Nakajima and co-authors (2018) found that reading and writing skills at age 12 positively predicted upper primary school completion by age 15 and upper secondary entry by age 19 among boys but not among girls. Marphatia and colleagues (2019) reported that grade repetition increased the risk of discontinuation among boys but not among girls.

2   Materials and Methods

2.1   Study setting

The study (Understanding the lives of adolescent and young adults, hereafter referred to as UDAYA study) was conducted in the states of Bihar and Uttar Pradesh in India. Uttar Pradesh, with a projected population of 238.1 million in 2024, has the largest population of any state in the country, accounting for 17% of India's population (National Commission on Population, 2019). Bihar, with a projected population of 128.6 million, is the second largest state in terms of population, accounting for 9% of India's population. Bihar and Uttar Pradesh, with a projected combined adolescent population of 72.9 million in 2021, are home to every third adolescent aged 10-19 in India. Both states are predominantly rural; population projection data show that 88% of the population in Bihar and 76% in Uttar Pradesh resided in rural areas in 2024. Economically, Bihar and Uttar Pradesh are the poorest among all the states and union territories in India with per capita income well below the national average and the lowest among the states - INR 54,111 in Bihar and INR 83,636 in Uttar Pradesh as against INR 169,496 nationally at current prices in 2022-23 (Department of Economic Affairs, 2024).

Indicators of education participation and performance of children and adolescents highlight poor performance of both states, particularly, Bihar. While net enrolment rate was at par with the national rate at the primary school level (90% in Bihar, 87% in Uttar Pradesh and 91% nationally), rates at the lower secondary and upper secondary levels were well below the national average (35%, 34% and 48%, respectively in Bihar, Uttar Pradesh and nationally, at the lower secondary level and 18%, 25% and 34%, respectively, at the upper secondary level in 2021-22; Department of School Education and Literacy, 2022). While the dropout rate at primary school level was low in both states (<5%), dropout rate for lower secondary school was 21% in Bihar and 10% in Uttar Pradesh in 2021-22. The Annual Status of Education Report surveys show that the proportion of children who could read grade 2 level text fluently among those who were enrolled in grade 8 declined from 81% in 2012 to 71% in 2022 in rural Bihar and stagnated at 70-71% in rural Uttar Pradesh (ASER Centre, 2023). While those who could solve a division problem declined from 67% to 60% in rural Bihar, the proportion increased from 37% to 49% in rural Uttar Pradesh during this period (ASER Centre, 2023).

As at the national level, education system data from both states indicate that gender gaps are negligible in most indicators related to school participation. However, significant gender gaps in learning levels are noticeable in both states, mostly favouring boys. For example, average score of grade 10 male students was higher than that of female students in modern Indian language (257 vs. 245 out of 500 in Bihar and 255 vs. 249 in Uttar Pradesh), mathematics (237 vs. 222 in Bihar and 216 vs. 207 in Uttar Pradesh), science (210 vs. 195 in Bihar and 194 vs. 188 in Uttar Pradesh), social science (229 vs. 216 in Bihar and 217 vs. 211 in Uttar Pradesh) and English (265 vs. 253 in Bihar and 256 vs. 250 in Uttar Pradesh) in 2021 (Ministry of Education, 2022).

2.2 Study design

The UDAYA study from which data presented in this paper were drawn is the first-ever longitudinal study of a state-representative sample of adolescents aged 10-19 in Bihar and Uttar Pradesh (UDAYA data and tools are available at Harvard Dataverse, V2; Population Council, 2017; Santhya, 2020). The first wave of the survey was conducted in 2015–2016 and the second wave was conducted in 2018–2019. The goal of the study was to establish the levels, patterns and trends in the situation of younger (10–14) and older (15–19) adolescents and to assess factors that influence the quality of transitions they make. The study was designed to provide state-level estimates for five categories of adolescents, namely, unmarried boys aged 10–14, unmarried boys aged 15–19, unmarried girls aged 10–14, unmarried girls aged 15–19 and married girls aged 15–19. The study adopted a systematic, multi-stage stratified sampling design to draw primary sampling units (PSUs) independently for rural (75 villages) and urban (75 wards) areas. In each primary sampling unit, households to be interviewed were selected by systematic sampling (for more details about the study design, see Santhya et al., 2017). We interviewed a total of 20,594 adolescents in the first wave, with a response rate of 92% and just 1% of selected respondents refused to participate. The main reason for non-response was that the respondent was not at home (5%). Of the 20,594 respondents who were eligible for re-interview, we reinterviewed 16,818 adolescents. We excluded 3% of respondents who gave inconsistent response to questions related to age and education at the follow-up survey; therefore, the final follow-up sample comprised 16,292 respondents, thus resulting in an effective follow-up rate of 79%. The main reasons for loss-to-follow-up were that the participant had migrated and the participant or his/her parent or guardian refused (for more details about the follow-up survey, see Patel et al., 2021). The questionnaire and the tools used in wave 2 replicated those used in wave 1 in most respects to ensure comparability across waves.

Our descriptive analysis of early school leaving and learning deficits drew on data from adolescents who were ever enrolled in school and interviewed at both waves (N=11,476, comprising 7,159 girls and 4,317 boys). Enrolment in school was nearly universal in the study sample (just 4% were never enrolled in school) and as such, the background characteristics of the sample of ever-enrolled adolescents did not differ with those of the overall UDAYA sample at wave 1 (see S.1). Multivariate analysis of the relationship between learning deficits and early school leaving drew on data from adolescents who were enrolled in school, including distance education courses, at wave 1 and interviewed at both waves (N=9,169, comprising 5,493 girls and 3,676 boys). Thus, we were able to ensure that first round of learning assessment which took place along with the first wave of interview preceded the outcome variable of early school leaving. The background characteristics of the sample of currently enrolled adolescents differed with those of the overall UDAYA sample at wave 1 (See S.1). The currently enrolled adolescents were younger, better educated and wealthier than the overall UDAYA sample. Additionally, a larger proportion of the currently enrolled adolescents belonged to Hindu religion and socially privileged castes and resided in Bihar.

We note that 21% of the ever-enrolled adolescents and 19% of the currently enrolled adolescents were lost to follow up in the second wave of the UDAYA study (See S.2). We fitted probit regression model to examine the extent to which the socio-demographic characteristics of ever/currently enrolled adolescents who were re-interviewed at wave 2 and those who were not differed. We found that the characteristics of those who were re-interviewed and those who were not differed significantly in terms of years of schooling completed, religion, caste, household wealth, place of residence and state of residence (See S.3). Those who belonged to socially disadvantaged castes and tribes (i.e., scheduled castes and tribes and other backward castes), those from economically better-off households and those from Bihar were more likely than others to be re-interviewed. On the other hand, those who were better educated, Muslim and resident of urban areas were less likely than others to be re-interviewed. We controlled for these variables in the discrete-time hazard model and the fixed-effects model, as appropriately (see S.4).

We excluded girls who were married at wave 1 from the analysis because only 11% of married girls were enrolled in school at wave 1. Moreover, married boys were not included in the UDAYA study because early marriage is not so among boys, and thus, the exclusion of married girls' sample made gender comparisons neater.

The Population Council's Institutional Review Board approved the study protocol.

2.3   Variables

Early school leaving: We defined early school leaving, the outcome variable, in terms of discontinuing schooling before completing secondary education, that is, grade 12. We measured it in two ways: (1) cumulative probability of leaving school before completing grade 12 among ever enrolled adolescents aged 13-22 at wave 2; and (2) the proportion of ever enrolled young people aged 18-22 at wave 2 who discontinued schooling before completing grade 12. We note that the official entrance age to primary education is 6 years and theoretical duration for completing secondary education is 12 years in these states. Therefore, young people aged 18 and above are theoretically expected to have completed secondary education.

Learning deficits: Our key explanatory variable is learning deficits. We defined learning deficits in terms of foundational skills. The UDAYA study used the Annual Status of Education Report survey tools to

assess literacy and numeracy levels among all survey participants who were ever enrolled in school. The literacy assessment tool assessed ability to read in the native language, Hindi and consisted of four levels: recognition of letters, ability to read words, ability to read a short paragraph (Grade 1 level text), and ability to read a longer 'story' (Grade 2 level text) (ASER Centre, 2017). Respondents were marked at the highest level which they can read comfortably, that is, with no more than three mistakes. The numeracy assessment tool consisted of four levels: recognition of single-digit numbers (1–9), recognition of double-digit numbers (11–99), two-digit subtraction sum with carry-over (Grade 2 level) and a three-digit division sum (Grades 3-4 level). Respondents were marked at the highest level which they can do correctly. We created a four-category variable of learning deficits, based on these assessments: (1) no learning deficit, that is, can read grade 2 text fluently and solve a division problem, (2) can read grade 2 text fluently, but cannot solve a division problem, (3) cannot read grade 2 text fluently, but can solve a division problem and (4) severe learning deficit, that is, cannot read grade 2 text or solve a division problem.

Other covariates: Our multivariate analyses controlled for several individual, household/family and school related variables that are found to be associated with school discontinuation in earlier studies. These variables included age, sex, engagement in paid work, marital status, decision-making say in personal matters, freedom of movement, gender role attitudes and age at first-time enrolment in school (see Table A.4 for a brief description of these variables). At the household/family level, variables controlled for included household wealth, religion, caste, mother's education, parent-child communication on personal matters and gender discriminatory practices by parents. School-related variables that were controlled for included type of school attended, private coaching and enrolment in schools with basic amenities (such as drinking water, functional toilet, playground and library). We also controlled for place of residence and the state of residence. While discrete-time hazard models controlled for both time-varying and time-invariant covariates, fixed-effects models controlled for time-varying covariates.

Table 1 shows the summary statistics at wave 1 and wave 2 for covariates other than learning deficits. Ever-enrolled study participants were aged on average 17 years at wave 2 and substantial proportions had engaged in paid work in the year preceding the interview (22-38% at wave 2). Some 11% of girls and 4% of boys got married during the inter-survey period. Having a say in personal matters increased over time and 62% of girls and 78% of boys reported some say at wave 2. Likewise, freedom of movement improved over time and 52% of girls and 93% of boys reported freedom to visit selected locations unescorted at wave 2. Most study participants expressed gender egalitarian attitudes and adherence to egalitarian attitudes increased over time. Most study participants were from rural areas (65-77%) and belonged to Hindu religion (77-86%). More than half of the respondents belonged to other backward castes (54-55%) and a quarter belonged to scheduled castes or tribes (23-27%). The mean household wealth index score was 25/26 out of 57 at wave 2. Mothers of the majority of study participants had no formal education. Communication with parents was far from universal. Small proportions of study participants had acknowledged gender discriminatory practices at home, where parents favoured sons over daughters (8-13% at wave 1). The majority of study participants were enrolled in a government educational institution and availability of basic amenities—drinking water, a playground, toilets, and libraries—was limited in the schools in which they were enrolled. A notable proportion of study participants had had private tutoring in the month prior to the interview.

2.4   Analysis

We used a life table analysis to examine the cumulative probability of early school leaving among those who were ever enrolled in school disaggregated by background characteristics. We used life table analysis because those who have not experienced school leaving by wave 2 or earlier but who are still at risk of the event can be included in the life table analysis. Dropout was the failure event and those who had continued schooling by wave 2 were censored. We applied the log rank test to test the null hypothesis of no difference in early school leaving between different sub-groups. We calculated the proportion of young people who discontinued schooling before completing grade 12 among those who were ever enrolled and were aged 18 and above at wave 2 to complement the findings of the life table analysis.

We fitted discrete-time hazard models using logistic regression to examine the relationship between learning deficits and early school leaving. The advantage of the discrete-time model over various continuous models is that it makes no assumption about the shape of the hazard-rate function (Lloyd et al., 2000). The period of observation started at the grade that respondents attended at the time of their wave 1 interview to ensure that the wave 1 assessment of learning deficits preceded the occurrence of early school leaving. We used information reported in two survey waves, with information that changed over time being considered as time-varying covariates. Unfortunately, we did not have information on the exact timing of a change in several time-varying covariates (e.g., respondents' learning deficits, decision-making say, freedom of movement, gender role attitudes, household wealth, parent-child communication, gender discriminatory experiences at home, type of school attended, private coaching and enrolment in schools with basic amenities). We used data from wave 1 for the first half of person-years of exposure and data from wave 2 for the second half of person-years of exposure for such variables.

Examining the association between learning deficits and early school leaving is complicated by the issue of endogeneity arising from simultaneity, omitted variables and measurement errors. Therefore, we also used fixed-effects regression models to examine the relationship between learning deficits and early school leaving. We opted for fixed-effects regression because it leverages the longitudinal structure of the data and estimates within-subject differences in the outcome variable over time as a function of within-subject differences in explanatory variables. It also addresses endogeneity by controlling for time-invariant characteristics of the respondents or their environments and eliminates omitted variable bias (Bell and Jones, 2015). The Hausman test results confirmed that fixed-effects model was more appropriate than the random-effects model for our analysis. The fixed-effects regression analysis drew on the subsample of adolescents who were enrolled in grades below 12 at wave 1 and were aged 18 and above at wave 2.

We fitted separate models for all adolescents and for girls and boys separately to capture differences in effects of learning deficits on early school leaving between girls and boys. We applied Z test to examine whether the regression coefficients from the girls' and boys' models differed significantly. All analyses were conducted using STATA software (version 16.1). ASER Centre. 2017. *Annual Status of Education Report (Rural) 2016, Provisional*. New Delhi: ASER Centre.

3   Results

3.1   Early school leaving

Findings presented in Figure 1 indicate that early school leaving was substantial among adolescents in Bihar and Uttar Pradesh and that the probability of early school leaving differed significantly by

adolescents' background characteristics. Although discontinuation was minimal before completing grades 1-5 (1-4%), dropouts rose steadily thereafter, reaching 8-13% before completing grades 6-8, 22-30% before completing grades 9-10 and 39% before completing grade 12. While gender gaps in school discontinuation were negligible or at best modest before completing grade 8, the gap widened thereafter, with a higher dropout rate among girls than boys, for example, 42% versus 38% dropout before completing grade 12. Rural-urban gap in school discontinuation was, likewise, at best modest before completing grade 8, while the gap widened thereafter, with a higher dropout rate before completing grade 12 among rural than urban adolescents (42% vs. 29%). Adolescents belonging to Muslim religion had a higher probability of early school leaving than those belonging to Hindu religion; substantial dropout was evident even before completing grade 4 among the former, with dropouts rising steadily thereafter to reach 53% before completing grade 12 compared to 37% among the latter. Caste-wise differences were also substantial, with the highest rate of early school leaving found among adolescents belonging to scheduled castes and tribes (50%), followed by those belonging to other backward castes (40%) and general castes (24%). The probability of early school leaving steadily declined with household wealth, from 68% among adolescents belonging to the poorest households to 19% among those belonging to the richest households. While the rate of school leaving was similar in Bihar and Uttar Pradesh until before completing grade 9, the rate diverged thereafter, with Bihar reporting a higher rate of school leaving before completing grade 12 than Uttar Pradesh (45% vs 36%).

Estimates of early school leaving obtained using data from those who would have theoretically transitioned out of school, that is, those who were ever enrolled and were aged 18 and above at wave 2, were similar to those obtained by the life table analysis (Figure 2). Early school leaving rose steadily from 12% before completing grade 8 to 29% before completing grade 10 and 38% before completing grade 12. Moreover, a larger proportion of girls than boys left school before completing each of these milestones.

3.2   Learning deficits

Most adolescents experienced learning deficits of varying intensity. Only 41% of adolescents aged 10-19 were able to read a grade 2 text fluently in Hindi and solve a simple division problem at wave 1, with boys scoring better than girls (46% vs. 29%; Table 2). At the other extreme, 25% of adolescents displayed severe learning deficit, that is, they could not read grade 2 text or solve a simple division problem, with a slightly more girls than boys falling into this group than boys (29% vs. 23%). Population-based analysis shows that learning levels improved over time – the percentage of adolescents who could read a grade 2 text fluently and solve a division problem increased to 47% at wave 2; this improvement was observed among both girls (35%) and boys (53%). Cohort-wise analysis shows that improvement in learning levels was not linear (Figure 3). While level learning levels improved for 18% of adolescents, levels declined for 10% and remained unchanged for 73% between the two waves of data collection. Similar levels of changes were observed for girls and boys.

3.3   Relationship between learning deficits and early school leaving

Findings from discrete-time hazard models presented in Table 3 show that learning deficits influenced the probability of early school leaving and that there was a dose effect, with the effects size three times as large for those who could not read grade 2 text fluently and solve a division problem (β =1.959, p<0.001) than those who could read grade 2 text fluently but could not solve a division problem (β =0.568, p<0.001). Learning deficits affected the probability of early school leaving among girls and boys (β =0.372, p<0.05 and β =0.705, p<0.001, respectively, for those with moderate learning deficits; β

=1.822 and 2.057, p<0.001, respectively, for those with severe learning deficits). A comparison of regression coefficients, using Z test, shows that coefficients for girls and boys did not differ significantly (z=1.3592, p=0.174 for moderate learning deficits and z=0.77388, p=0.439 for severe learning deficits).

Although not exactly comparable, results of the fixed-effects regression reiterate the relationship between learning deficits and early school leaving (Table 4). Findings show that severe learning deficits influenced early school leaving (β =0.195, p<0.05). However, no such relationship was observed for moderate learning deficits. Findings from the gender disaggregated fixed-effects analysis were consistent with those of the discrete-time hazard analysis. Severe learning deficits were associated with early school discontinuation for girls and boys (β =0.155, p<0.001 and β =0.213, p<0.05, respectively). Here again, a comparison of regression coefficients shows that coefficients for girls and boys did not differ significantly (z=-0.5065, p=0.613).

3.4   Factors other than learning deficits affecting early school leaving

Findings from the discrete-time hazard model presented in Table 5 show that the probability of early school leaving increased with age (β =0.423, p<0.001). Compared to girls, the probability of early school leaving was lower for boys (β = -0.398, p<0.01). The probability of early school leaving was higher among adolescents who were engaged in paid work (β =1.281, p<0.001) and who got married during the inter-survey period (β =1.180, p<0.001). Adolescents who held gender egalitarian attitudes had lower probability of early school leaving than others (β = -0.502, p<0.001). Indicators related to adolescents' agency such as decision-making say and freedom of movement were found to be not related to the probability of early school leaving in the discrete-time hazard models. The probability of early school leaving declined with age at first-time enrolment in school which was counter-intuitive (β =-0.181, p<0.001). Adolescents who were Muslim had higher probability of early school leaving than Hindus (β =0.813, p<0.001). On the other hand, adolescents who belonged to wealthier households had lower probability of early school leaving (β =-0.054, p<0.01). So did adolescents whose mother was literate (β =-0.428, p<0.001) and whose parents discussed personal matters with them (β =-0.218, p<0.001). The probability of early school leaving was lower for adolescents who attended schools with basic amenities (β =-0.591, p<0.001) and who were enrolled in private schools (β =-0.323, p<0.001) than others. Finally, adolescents who resided in Bihar had higher probability of early school leaving than those from Uttar Pradesh (β =0.434, p<0.001).

While some factors affected the probability of early school leaving equally among girls and boys (for example, age, gender role attitudes, household wealth, religion, parent-child communication and enrolment in schools with basic amenities), other factors had gender differentiated effects. For example, engagement in paid work had greater effect on the probability of early school leaving for boys than girls (β =1.601, p<0.001 vs. β =1.000, p<0.001). Several others – marriage during the inter-survey period, mother's education, private coaching – predicted the probability for girls but not for boys. And age at first-time enrolment in school, decision-making say and residence in Bihar predicted the probability for boys but not for girls.

Findings from the fixed-effects models reiterate that age, engagement in paid work, marriage during the inter-survey period, parent-child communication, enrolment in private school and enrolment in schools with basic amenities affected the chances of early school leaving (Table 6). Fixed-effects regression models additionally show that adolescents who exercised some say in personal matters and who received private coaching had higher chances of early school leaving. However, factors such as adherence to gender egalitarian attitudes and household wealth that were found to influence early

school leaving in the discrete-time hazard models were not found to be associated with it in the fixed-effects models. While most of these factors equally affected the probability of early school discontinuation among girls and boys, some factors predicted the probability of early school leaving only for girls (marriage during the inter-survey period increased and freedom of movement decreased the probability), while others predicted the probability of early school leaving only for boys (engagement in paid work increased and enrolment in private school decreased the probability).

4 Discussion

The economic, social and health costs of not completing a full cycle of basic education and not acquiring basic skills are steep. Although the body of evidence on the relationship between foundational skills deficits and early school leaving has expanded, there is a need for additional rigorous research to shed light on the causal relationship between the two, particularly in settings in which girls and boys are at high risk of learning poverty and discontinuation. Our study responds to this need and provides rigorous evidence on the relationship between learning deficits and early school leaving among a longitudinal cohort of adolescents in India's two most populous states. Our study also provides robust evidence on factors other than learning deficits that affected early school leaving.

Although education system data have shown modest levels of school discontinuation at secondary level (13% nationally and 14% in Bihar and Uttar Pradesh; Department of School Education and Literacy, 2022), our study indicates that early school leaving was substantially higher among adolescents in Bihar and Uttar Pradesh. Moreover, early school leaving was higher for adolescents belonging to socio-economically disadvantaged groups than others. Our findings mirror those from community-based sample surveys in India (National Statistical Office, 2020; Garg et al., 2023; ASER Centre, 2024). Similarly, contrary to education system data that have shown no gender difference in discontinuation rates, our study shows that a larger proportion of girls than boys left school before completing educational milestones such as completing grades 8, 10 and 12. This concurs with a secondary analysis of data from the 2017-18 nation-wide survey on education by the National Statistical Office which found that early school leaving was somewhat higher among females (76%) than males (72%) (Garg et al., 2023).

Learning deficits of varying intensity affected most adolescents in Bihar and Uttar Pradesh and girls performed worse than boys, particularly in numeracy. These findings concur with observations from other surveys of learning levels in these states (ASER Centre, 2023; Ministry of Education, 2022). Our study also indicates that notable proportions of girls and boys did not retain their foundational skills over time, as observed in other longitudinal studies (Soler-Hampejsek et al., 2018).

A functional level of literacy and numeracy is indispensable for children to learn other subjects, develop other higher-order cognitive skills such as problem solving, logical reasoning and critical thinking and achieve their full potential (World Bank, 2019; UNICEF and Hempel Foundation, 2023). Several previous studies from India and elsewhere have acknowledged the role of basic foundational skills in school completion (Rumberger and Lim, 2008; Singh and Mukherjee, 2017; Nakajima et al., 2018; Cueto and León, 2020; De Witte et al., 2023). Our study reiterates this view; learning deficits affected early school leaving even after controlling for a range of individual, household and school level variables. Moreover, effect was larger for those with severe than moderate learning deficits. To the extent that success begets success, it may be that better learning outcomes improve goals and attitudes about continuing in school and increase the self-confidence to do what is in their control and

needed to stay in school. It is also possible that better performing students elicit positive reinforcement and support from family, school and community to realise their educational aspirations.

Although both early school leaving and learning deficits were gendered among adolescents in the study – girls were more likely to leave school and girls had greater learning deficits than boys – there was no gender dimension to the effects of learning deficits on early school leaving, highlighting that acquiring foundational skills are critical for educational progress of both girls and boys. Our findings, which show that learning deficits increased school leaving for both girls and boys, contrast with findings from an earlier study from India that reported that reading and writing skills at age 12 positively predicted upper primary school completion by age 15 and upper secondary entry by age 19 among boys but not among girls (Nakajima et al., 2018).

Several findings from our study showcase that gendered beliefs and practices influenced adolescents', particularly girls', chances of early school leaving. First, the discrete-time hazard model (but not the fixed-effects model) shows that the probability of early school leaving was lower for girls and boys who held gender egalitarian attitudes than others. Second, gender-disaggregated fixed-effects analysis shows that girls with freedom of movement were less likely to have discontinued schooling before completing grade 12 than girls who were not allowed to move freely. Third, findings from both discrete-time hazard model and the fixed-effects model highlight the detrimental effect of marriage in adolescence on school completion for girls. Girls who got married during the inter-survey period had higher probability of leaving school early than those who remained unmarried. No such relationship was observed for boys among whom marriage is not as common. We note that 11% of girls and 1% of boys reported that they had discontinued their schooling during the inter-survey period because they had gotten engaged or married. The association between these gendered practices and school participation is documented in several studies from South Asia and sub-Saharan Africa (Field and Ambrus, 2008; Lloyd and Mensch, 2008; Asadullah and Wahhaj, 2012; Callum et al., 2012; Nguyen and Wodon, 2014; Delprato et al., 2015; Wodon et al., 2015; Sekine and Hodgkin. 2017; Prakash et al., 2017; Kumar et al., 2023). There are several pathways through which these gendered beliefs and practices may constrain adolescents', particularly girls', school completion. For example, adherence to egalitarian gender role attitudes can promote school participation and a sense of school belonging (Vella, 1994; Huyge et al., 2015). Moreover, some have found that adolescents with egalitarian attitudes are more likely to hold higher educational aspirations than others (Davis and Greenstein, 2009). Likewise, mobility can reduce distance cost of attending school, give girls a public identity, increase their exposure to information and help them develop interpersonal skills and self-confidence. Early marriage can constrain girls' school continuation because of new responsibilities that require girls to care for a new household, childbirth and childcare and limited capability of girls who marry young to assert themselves (Lloyd and Mensch, 2008; Jenson and Thornton, 2009).

Findings show that not all dimensions of adolescents' agency affected early school leaving in the same direction. As described above, adherence to egalitarian gender role attitudes reduced early school leaving among girls and boys. However, the fixed-effects analysis (not in the discrete-time hazard model) shows that girls and boys with some say in decisions on personal matters had higher probability of early school leaving than others.

Transitioning into adult roles interfered with the chances of early school leaving. As with early marriage for girls, engagement in paid work increased the risk of early school leaving among adolescents, more so among boys than girls. The association between adolescents' employment and school participation concurs with several other studies (Rumberger and Lim, 2008; Sabates et al., 2010; Singh and

Mukherjee, 2017; González-Rodríguez et al., 2019; De Witte et al., 2023; Kumar et al., 2023). A mixed-method study in India found that combining schooling and work affects school participation and performance because of irregular attendance in school, inability to handle the pressures of both studying and working at a young age, not having time for school assignments at home and work-related distractions and physical exhaustion, and that those children who combined schooling and work gradually drop out of school (Santhya et al., 2024).

The role of family/parental factors in adolescents' school participation is widely acknowledged in the extant literature (Rumberger and Lim, 2008; Sabates et al., 2010; Lyche, 2010; Singh and Mukherjee, 2017; González-Rodríguez et al., 2019; Paul et al., 2021; De Witte et al., 2023; Kumar et al., 2023). Parents can provide a richer home environment, access to better schools and supplemental learning opportunities, improve the cognitive development of children and influence children's motivation and educational aspirations and achievement (Rumberger and Lim, 2008). Our findings also highlight that several dimensions of parental/family resources influenced adolescents' probability of early school leaving. The discrete-time hazard model shows that the probability of early school leaving declined with household wealth for girls and boys. It also shows that the probability of early school leaving was lower for girls whose mother was literate than girls whose mother was illiterate, although no such relationship was observed for boys. Finally, the discrete-time hazard model and the fixed-effect model show that adolescents who reported that they discussed personal matters with their parent/s had lower chances of early school leaving than others.

Findings also show that adolescents who attended schools with basic amenities had lower likelihood of early school leaving than others. A review of literature on how school infrastructure affects children's learning outcomes notes that there is strong evidence that the provision of and access to basic services increase the chances of pupils and teachers attending school, remaining healthy at school, and, in the case of teachers, staying in their profession (Barret et al., 2019). Moreover, adolescents who attended a private school had lower chances of early school leaving than those who attended a government school; this finding corroborates the findings of an earlier study in India (Paul et al., 2021).

Findings from our analysis should be interpreted with some limitations in mind. First, although the UDAYA overall sample at wave 1 was representative of adolescents aged 10-19 in Bihar and Uttar Pradesh, our analysis focused on adolescents ever/currently enrolled in school at wave 1 and there was some attrition bias between survey rounds. Therefore, these findings may not be generalizable to adolescents across India. Second, the ASER tools that we used to measure learning levels, although reliable and valid (Johnson and Parrado, 2021), measured only whether adolescents had attained basic foundational literacy and numeracy. Third, the measures of learning deficits and other time-varying covariates came from 2015-16 and 2018-19 survey waves, and therefore, captured change in these variables over the three-year inter-survey period. However, these changes are not as precise as yearly assessments. Finally, our multi-variate analyses controlled for several individual, family and school-related co-variates; however, we acknowledge that there may be unmeasured co-variates that may have influenced outcomes.

Despite these limitations, our study makes major contributions to the literature on learning deficits and early school leaving. Our study highlights the need for concerted efforts to improve learning outcomes. Indeed, the pursuit of universal foundational literacy and numeracy in primary schools is a priority goal of India's National Education Policy 2020 (Ministry of Human Resource Development, 2020). The Government of India has launched the National Initiative for Proficiency in Reading with

Understanding and Numeracy (NIPUN Bharat) to achieve this goal (Press Information Bureau, Government of India, 2021). Several measures have been proposed – child centred pedagogy, specific teacher training modules focusing on foundational literacy and numeracy designed through the National Initiative for School Heads' and Teachers' Holistic Advancement (NISHTHA, a teacher capacity building programme) and use of Digital Infrastructure for Knowledge Sharing (DIKSHA, a national digital platform for school education) for foundational literacy and numeracy, for example. A strong commitment is needed to ensure that these measures are effectively implemented and that they reach the most disadvantaged groups.

A review of studies that used experimental or quasi-experimental designs to evaluate the impact of educational and related interventions on schooling outcomes in India shows that strategies such as awareness-building programmes for parents, increasing numbers of teachers, making improvements to pedagogy and instruction, remedial education, incentives to teachers and community- or school-based monitoring hold promises for improving learning outcomes (Santhya, 2024). For example, cluster randomized trials have shown positive effect of parental engagement activities along with remedial education by community volunteers and awareness-building programmes to inform parents on the social and economic gains of girls' secondary education on learning outcomes (Lakshminarayana et al., 2013; Santhya et al., 2016; IDinsight, 2018). Likewise, several trials have showcased the effectiveness of remedial education and improvements in pedagogy and lessons delivery (e.g., teaching students according to their ability level, delivery of a child-centric curriculum, structured pedagogy) on improving learning outcomes (Banerjee et al., 2007; Dixon et al., 2011; Lakshminarayana et al., 2013; Duflo et al., 2015; Wennersten et al., 2015; Banerjee et al., 2016; Joddar and Cooper, 2017; IDinsight, 2018). Strategies focused on teachers, including performance-based payments and incentives to teachers and hiring additional teachers as well as engaging community members and school management committees and school-based monitoring were also found to be promising (Muralidharan and Sundararaman, 2011; Duflo et al., 2012; Muralidharan and Sundararaman, 2013; Santhya et al., 2016; IDinsight, 2018). Investments are required to adapt, re-evaluate, and upscale these promising models.

While investment in improving foundational skills is paramount for preventing early school leaving, they are not the only drivers of truncated education. Accompanying measures which address gendered beliefs and practices and premature transition to adult roles, enhance parental engagement and improve education systems, including education infrastructure, are also needed.

Acknowledgements

Table 1: Summary statistics for explanatory variables other than learning deficits used in the multivariate analyses at wave 1 and wave 2

Variables	Ever enrolled				Currently enrolled at wave 1			
	Girls		Boys		Girls		Boys	
	Wave 1	Wave 2	Wave 1	Wave 2	Wave 1	Wave 2	Wave 1	Wave 2
Age (Mean)	13.7 (2.6)	16.6 (2.6)	14.0 (2.7)	17.0 (2.8)	13.3 (2.4)	16.2 (2.5)	13.6 (2.6)	16.6 (2.7)
Engagement in paid work (%)	11.4	22.2	19.6	38.0	8.0	20.3	13.1	31.2
Got married during the inter-survey period (%)	0.0	10.6	0.0	4.4	0.0	7.3	0.0	2.5
Decision-making say (%)	42.6	61.8	56.2	78.3	45.3	62.0	56.1	76.7
Freedom of movement (%)	40.7	52.2	82.2	93.4	42.6	56.3	80.4	92.9
Gender role attitudes (%)	51.0	69.3	40.5	52.8	52.8	71.9	40.7	54.2
Age at first-time enrolment (Mean)	5.6 (1.4)	--	5.7 (1.3)	--				
Household wealth (Mean)	22.2 (9.2)	25.5 (8.4)	20.8 (8.8)	25.2 (7.9)	22.7 (9.4)	25.9 (8.5)	21.2 (8.9)	25.5 (7.9)
Religion (%)								
Hindu	77.1	--	85.5	--	80.3	--	86.4	--
Muslim and others	22.9	--	14.6	--	19.7	--	13.6	--
Caste (%)								
Scheduled caste/tribe	23.3	--	27.0	--	22.5	--	26.0	--
Other backward caste	54.2	--	55.3	--	54.0	--	55.4	--
General caste	22.5	--	17.7	--	23.5	--	18.6	--
Mother's education – literate (%)	35.0	--	30.2	--	38.6	--	31.4	--
Place of residence – Rural (%)	67.6	65.4	83.5	77.3	67.3	64.6	83.7	77.5
Parent-child communication (Mean)	1.8 (1.0)	1.7 (1.1)	1.2 (0.8)	1.1 (0.9)	2.0 (0.9)	1.9 (1.1)	1.4 (0.8)	1.2 (0.9)
Gender discriminatory practices at home (%)	12.5	9.1	7.6	11.0	12.0	9.0	7.7	11.6
Attended private school (%)	38.5	37.2	44.0	43.8	40.8	39.2	45.7	45.3
Received private coaching (%)	28.4	27.2	38.0	36.9	33.7	32.1	43.5	42.1

Attended schools with basic amenities (%)	36.9	49.4	26.6	39.5	38.0	52.5	28.2	42.9
State of residence – Bihar (%)	27.3	--	33.0	--	29.2	--	34.4	--
Number of respondents	7,159	7,159	4,317	4,317	5,493	5,493	3,676	3,676

Values in the parentheses show standard deviation.

Table 2: Percentage distribution of young people who were ever enrolled in school by learning levels, 2015-16 and 2018-19

Learning levels	2015-16			2018-19		
	Girls (10-19 years)	Boys (10-19 years)	Total (10-19 years)	Girls (13-22 years)	Boys (13-22 years)	Total (13-22 years)
Can read grade 2 text and solve a division problem	29.4	45.6	41.0	35.3	53.2	47.3
Can read grade 2 text, but cannot solve a division problem	41.1	30.2	32.5	45.8	28.3	33.1
Cannot read grade 2 text, but can solve a division problem	0.7	1.6	1.4	0.4	1.8	1.4
Cannot read grade 2 text or solve a division problem	28.9	22.6	25.1	18.6	16.8	18.2
Number of respondents ever enrolled and took learning assessment	8,796	5,766	14,562	6,743	4,181	10,924

Table 3: Effect of learning deficits on early school leaving, according to discrete-time hazard models

Learning deficits indicators	Girls	Boys	Total
Moderate learning deficit			
β coeff. [95 % CI]	0.372	0.705	0.568
	[0.014 – 0.729]	[0.384 – 1.027]	[0.316 – 0.821]
p value (robust standard error)	0.042 (0.182)	0.000 (0.164)	0.000 (0.129)
Severe learning deficit			
β coeff. [95 % CI]	1.822	2.057	1.959
	[1.359 – 2.285]	[1.683 – 2.432]	[1.669 – 2.249]
p value (robust standard error)	0.000 (0.236)	0.000 (0.191)	0.000 (0.148)
Number of person-years	14,352	10,775	25,127
Wald chi2(17)	563.29	552.62	921.07
Prob>chi2	0.000	0.000	0.000
Pseudo R2	0.2841	0.2954	0.2855
Log pseudolikelihood	-3699.0481	-1618.1391	-4756.1021
Number of respondents[@]	5,304	3,580	8,884

@ We excluded 285 respondents who did not attempt the learning assessment at wave 2.

Table 4: Effect of learning deficits on early school leaving, according to fixed-effects models

Learning deficits indicators	Girls	Boys	Total
Moderate learning deficit			
β coeff. [95 % CI]	-0.004	0.033	0.024
	[-0.040 – 0.031]	[-0.025–0.090]	[-0.020–0.069]
p value (robust standard error)	0.805 (0.018)	0.270 (0.029)	0.286 (0.023)
Severe learning deficit			
β coeff. [95 % CI]	0.155	0.213	0. 195
	[0.063–0.247]	[0.008–0.417]	[0.028–0.362]
p value (robust standard error)	0.001 (0.047)	0.042 (0.104)	0.022 (0.085)
F-stat	34.20***	14.57***	31.34***
F-test for individual effects	0.97	0.85	0.95
Rho	0.367	0.317	0.343
Hausman test: Chi-square	378.7	109.4	510.8
Number of respondents	3,044	1,579	4,623

Table 5: Estimated effects of explanatory variables other than learning deficits on early school leaving from discrete-time hazard models

Variables	Girls	Boys	Total
Age	0.395***	0.406***	0.423***
	(0.328 – 0.462)	(0.335 – 0.478)	(0.374 – 0.472)
Boys (Ref. Girls)			-0.398**
			(-0.655 – -0.141)
Engagement in paid work (Ref. No)	1.000***	1.601***	1.281***
	(0.603 – 1.398)	(1.316 – 1.886)	(1.066 – 1.497)
Got married during the inter-survey period (Ref. No)	1.518***	0.261	1.180***
	(1.084 – 1.953)	(-0.373 – 0.896)	(0.821 – 1.538)
Age at first-time enrolment	-0.081	-0.208***	-0.181***
	(-0.201 – 0.038)	(-0.324 – -0.092)	(-0.264 – -0.099)
Decision-making say	0.169	-0.356*	-0.148
	(-0.127 – 0.465)	(-0.641 – -0.071)	(-0.359 – 0.063)
Freedom of movement (Ref. No)	-0.093	-0.157	-0.027
	(-0.393 – 0.207)	(-0.596 – 0.281)	(-0.278 – 0.225)
Gender role attitudes	-0.407*	-0.607***	-0.502***
	(-0.728 – -0.086)	(-0.934 – -0.280)	(-0.728 – -0.275)
Household wealth	-0.069***	-0.036***	-0.054***
	(-0.095 – -0.009)	(-0.058 – -0.015)	(-0.070 – -0.037)
Muslim and others (Ref. Hindu)	0.798***	0.780***	0.813***
	(0.394 – 1.203)	(0.332 – 1.227)	(0.498 – 1.128)
Other backward caste (Ref. Scheduled caste/tribe)	-0.299	-0.183	-0.179
	(-0.662 – 0.063)	(-0.519 – 0.153)	(-0.420 – 0.063)
General caste	-0.106	0.001	-0.021
	(-0.595 – 0.384)	(-0.497 – 0.498)	(-0.388 – 0.347)
Literate mothers (Ref. illiterate)	-0.547**	-0.317	-0.428***
	(-0.938 – -0.156)	(-0.643 – 0.008)	(-0.678 – -0.179)
Urban residence (Ref. Rural)	-0.072	0.143	0.040
	(-0.427 – 0.282)	(-0.197 – 0.483)	(-0.211 – 0.292)
Parent-child communication (Ref. No)	-0.172**	-0.298***	-0.218***
	(-0.302 – -0.041)	(-0.477 – -0.118)	(-0.326 – -0.109)
Gender discriminatory practices at home (Ref. No)	0.169	0.298	0. 227
	(-0.239 – 0.578)	(-0.087 – 0.683)	(-0.056 –0.510)
Enrolment in private school (Ref. Government school)	-0.272	-0.225	-0.323**
	(-0.641 – 0.097)	(-0.529 – 0.079)	(-0.564 – -0.081)
Private coaching (Ref. No)	-0.474***	-0.099	-0.206
	(-0.759 – -0.188)	(-0.405– 0.207)	(-0.435 – 0.022)
Enrolment in schools with basic amenities (Ref. No)	-0.424*	-0.640***	-0.591***
	(-0.756 – -0.092)	(-0.948 – -0.332)	(-0.818 – -0.365)
Bihar (Ref. Uttar Pradesh)	0.203	0.465*	0.434***
	(-0.099 – 0.506)	(0.312 – 0.945)	(0.200 – 0.668)
Number of person-years	14,352	10,775	25,127
Wald chi2(17)	563.29	552.62	921.07
Prob>chi2	0.000	0.000	0.000

Pseudo R2	0.2841	0.2954	0.2855
Log pseudolikelihood	-3699.0481	-1618.1391	-4756.1021

Table 6: Estimated effects of explanatory variables other than learning deficits on early school leaving from fixed-effects models

Variables	Girls	Boys	Total
Age	0.050***	0.054***	0.057***
	(0.042 – 0.059)	(0.042 – 0.067)	(0.047 – 0.066)
Engagement in paid work (Ref. No)	-0.005	0.120***	0.083***
	(-0.039 – 0.029)	(0.068 – 0.173)	(0.040 – 0.126)
Got married during the inter-survey period (Ref. No)	0.161***	0.028	0.123**
	(0.076 – 0.245)	(-0.109 – 0.165)	(0.041 – 0.204)
Decision-making say	0.046***	0.053*	0.053***
	(0.021 – 0.071)	(0.011 – 0.094)	(0.022 – 0.084)
Freedom of movement (Ref. No)	-0.032*	-0.052	-0.042
	(-0.059 – -0.004)	(-0.203 – 0.099)	(-0.097 – 0.014)
Gender role attitudes	-0.012	0.006	0.002
	(-0.047 – 0.024)	(-0.043 – 0.056)	(-0.036 – 0.040)
Household wealth	-0.001	-0.001	-0.001
	(-0.004 – 0.002)	(-0.004 – 0.003)	(-0.003 – 0.002)
Urban residence (Ref. Rural)	-0.029	0.013	0.007
	(-0.099 – 0.041)	(-0.087 – 0.112)	(-0.075 – 0.089)
Parent-child communication (Ref. No)	-0.072***	-0.057***	-0.068***
	(-0.090 – -0.054)	(-0.082 – -0.031)	(-0.087 – -0.049)
Gender discriminatory practices at home (Ref. No)	0.023	-0.010	0.004
	(-0.006 – 0.052)	(-0.056 – 0.037)	(-0.029 – 0.036)
Enrolment in private school (Ref. Government school)	0.006	-0.050***	-0.050***
	(0.091 – 0.134)	(-0.080 – -0.020)	(-0.077 – -0.024)
Private coaching (Ref. No)	0.113***	0.079***	0.092***
	(-0.006 – 0.052)	(0.046 – 0.112)	(0.064 – 0.119)
Enrolment in schools with basic amenities (Ref. No)	-0.080***	-0.099***	-0.098***
	(-0.106 – -0.054)	(-0.137 – -0.061)	(-0.128 – -0.068)
F-stat	34.20***	14.57***	31.34***
F-test for individual effects	0.97	0.85	0.95
Rho	0.367	0.317	0.343
Hausman test: Chi-square	378.7	109.4	510.8
Number of respondents	3,044	1,579	4,623

Figure 1: Cumulative probability of young people aged 13-22 years leaving school before completing specified grade by selected chacteristics, Bihar and Uttar Pradesh, 2018-19
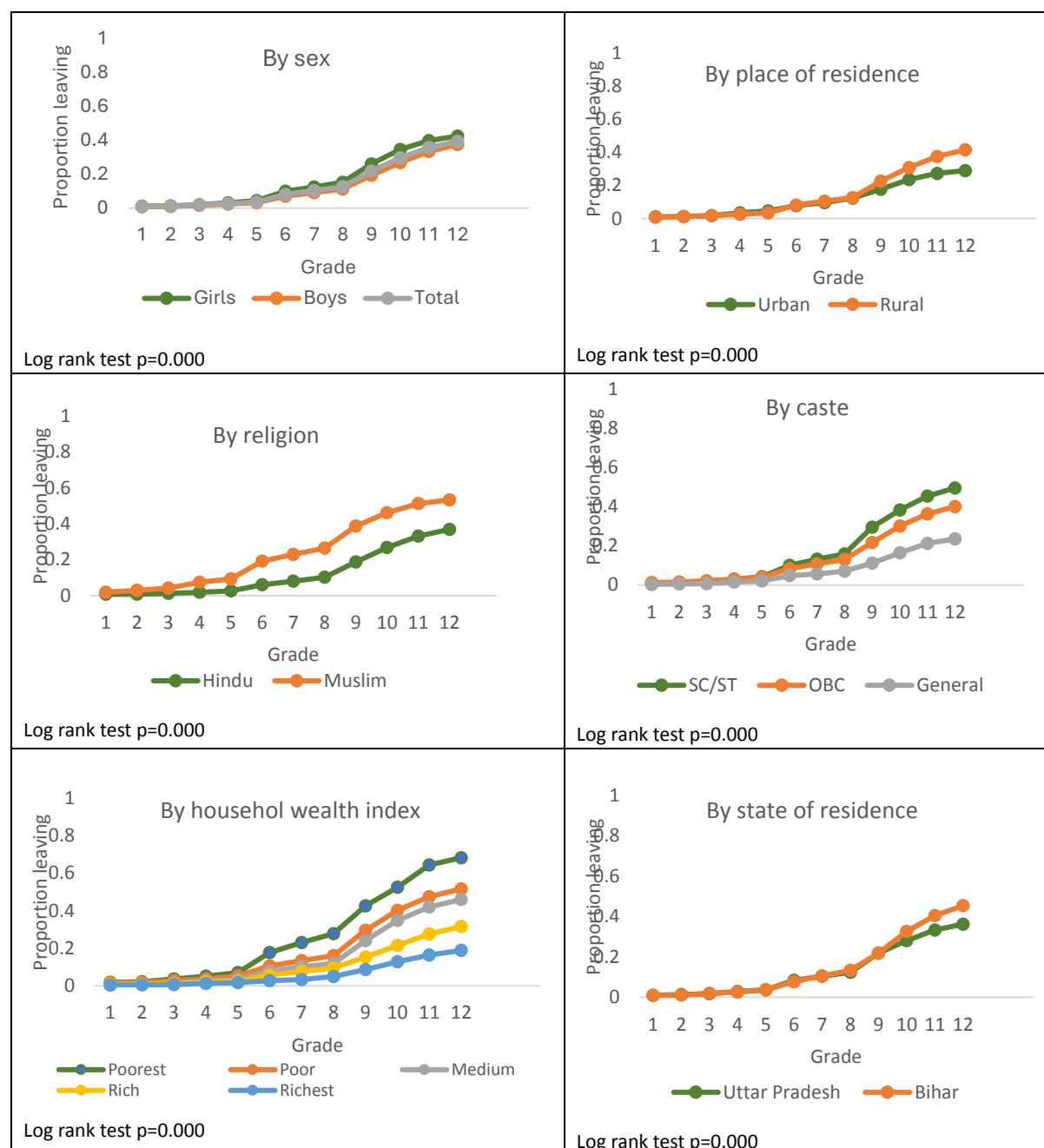
Figure 2: Proportion of young people aged 18-22 years who dropped out before completing selected grades by sex, Bihar and Uttar Pradesh, 2018-19
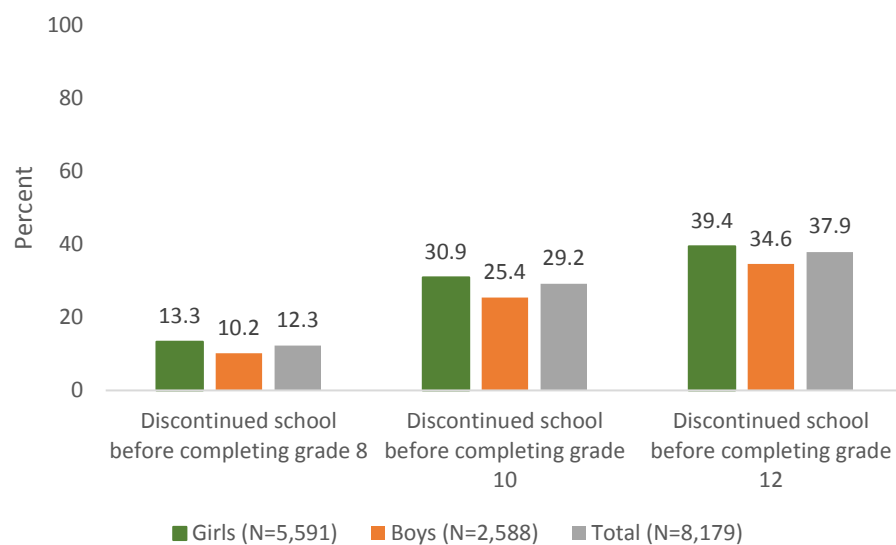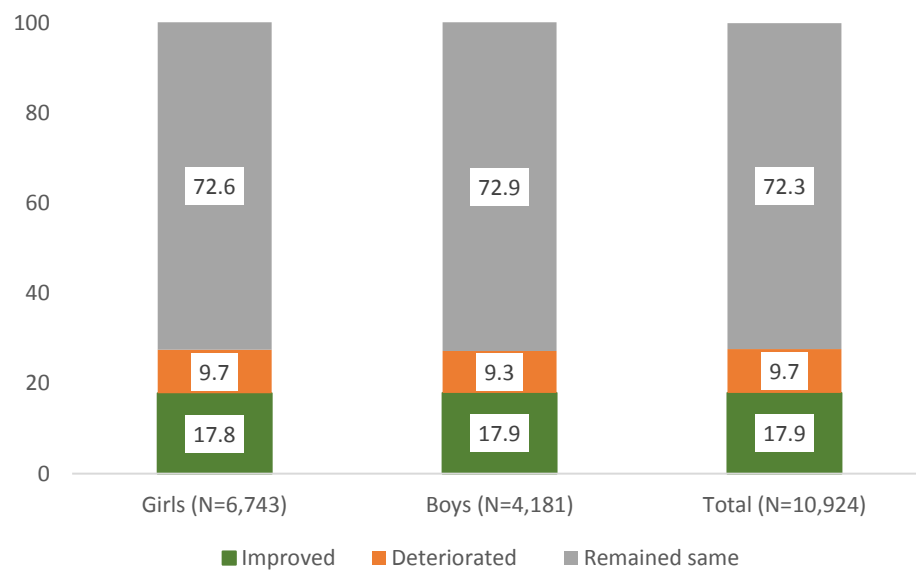
Figure 3: Individual level changes in learning levels between survey rounds, Bihar and Uttar Pradesh, 2015-16 and 2018-19

S.1: Percentage distribution of overall UDAYA sample and the analytical samples, according to selected background characteristics, Bihar and Uttar Pradesh, 2015-16

Selected characteristics (%)	All respondents aged 10-19 at wave 1			Respondents ever enrolled in school at wave 1			Respondents currently enrolled in school at wave 1		
	Girls	Boys	Total	Girls	Boys	Total	Girls	Boys	Total
Age							***	***	***
10-14	17.6	34.9	24.3	18.0	35.4	24.9	23.3	41.0	30.9
15-19	82.5	65.1	75.7	82.0	64.6	75.1	76.7	59.0	69.1
Place of residence									
Urban	20.8	15.1	17.3	20.8	14.8	17.0	20.8	14.7	16.9
Rural	79.2	84.9	82.7	79.2	85.2	83.0	79.2	85.3	83.1
Religion							***	***	***
Hindu	77.9	84.1	81.7	79.4	85.0	82.9	82.1	86.0	84.6
Muslim/Others	22.1	16.0	18.3	20.6	15.0	17.1	17.9	14.0	15.4
Caste							**	**	***
Scheduled castes/tribes	22.9	26.6	25.2	22.6	26.5	25.1	21.6	25.4	24.0
Other backward castes	58.3	55.7	56.6	57.9	55.7	56.5	58.2	55.8	56.7
General castes	18.9	17.7	18.2	19.5	17.8	18.4	20.2	18.8	19.3
Years of schooling completed							***	***	***
None	5.6	2.7	3.8	---	---	---	---	---	---
1-4 years	20.4	20.8	20.8	21.6	21.4	21.5	22.1	21.6	21.7
5-9 years	58.0	59.3	59.3	61.5	61.0	61.2	60.8	60.0	60.3
10+ years	16.0	17.1	17.1	16.9	17.6	17.4	17.1	18.4	18.0
Household wealth quintile							***	***	***
First	15.5	13.8	14.5	14.2	13.5	13.8	12.9	12.2	12.4
Second	18.4	21.1	20.1	18.3	21.0	20.0	17.7	20.5	19.5
Third	21.3	22.9	22.3	21.6	23.1	22.5	21.4	23.0	22.4
Fourth	24.0	21.9	22.7	24.2	21.9	22.8	24.9	22.1	23.1
Fifth	20.8	20.2	20.4	21.7	20.5	20.9	23.1	22.3	22.6
State of residence							***	***	***
Bihar	47.9	36.9	41.0	47.6	37.1	41.0	50.8	39.0	43.3
Uttar Pradesh	52.1	63.1	59.0	52.4	62.9	59.0	49.2	61.0	56.7
Number of respondents@	9,419	5,969	15,388	8,796	5,766	14,562	6,591	4,746	11,337

@ excludes the sample of girls who were married at wave 1; ** indicates that the distribution of the sample of currently enrolled adolescents differed with that of the overall sample at p<=0.01; *** indicates that the distribution of the sample of currently enrolled adolescents differed with that of the overall sample at p<=0.001

S.2: Number of respondents who were interviewed and who took learning assessments at wave 1 and wave 2, Bihar and Uttar Pradesh, 2015-16 and 2018-19

	Interviewed in 2015-16			Re-interviewed in 2018-19		
	Girls	Boys	Total	Girls	Boys	Total
Number of respondents@	9419	5969	15388	7607 (80.8%)	4428 (74.1%)	12035 (78.2%)
Number of respondents ever enrolled in school	8796	5766	14562	7159 (81.4%)	4317 (74.9%)	11476 (78.8%)
Number of respondents who were currently enrolled in school, including distance learning at wave 1	6591	4746	11337	5493 (83.3%)	3676 (77.5%)	9169 (80.9%)
Took learning assessment	8796	5766	14562	6826 (77.6%)	4173 (72.4%)	10999 (75.5%)

@ excludes the sample of girls who were married at wave 1; values in the parentheses indicate follow-up rates

S.3: Results from the probit regression analysis of attrition bias

Background characteristics	Ever enrolled at wave 1			Currently enrolled at wave 1		
	Girls Coeff. [95%CI]	Boys Coeff. [95%CI]	Total Coeff. [95%CI]	Girls Coeff. [95%CI]	Boys Coeff. [95%CI]	Total Coeff. [95%CI]
Currently studying (No=Ref)	0.312*** [0.20, 0.42]	0.553*** [0.47, 0.63]	0.451*** [0.39, 0.51]	---	---	---
Years of schooling completed	-0.004 [-0.02, 0.01]	-0.050*** [-0.06, -0.04]	-0.036*** [-0.04, -0.03]	-0.008 [-0.02, 0.01]	-0.067*** [-0.08, -0.06]	-0.051*** [-0.06, -0.04]
Muslim: Religion (Hindu = Ref)	-0.164*** [-0.27, -0.06]	-0.187*** [-0.27, -0.10]	-0.156*** [-0.22, -0.09]	-0.212*** [-0.33, -0.09]	-0.212*** [-0.31, -0.12]	-0.210*** [-0.28, -0.14]
Caste (General castes=ref)						
Scheduled castes/tribes	0.201** [0.06, 0.34]	0.135** [0.04, 0.23]	0.138*** [0.06, 0.22]	0.239*** [0.08, 0.40]	0.135** [0.03, 0.24]	0.149*** [0.06, 0.24]
Other backward castes	0.152** [0.04, 0.26]	0.150*** [0.07, 0.23]	0.142*** [0.08, 0.21]	0.159*** [0.04, 0.28]	0.163*** [0.08, 0.25]	0.157*** [0.09, 0.23]
Wealth quintiles	0.002 [-0.00, 0.01]	0.01*** [0.00, 0.01]	0.006*** [0.00, 0.01]	0.001 [-0.01, 0.01]	0.007** [0.00, 0.01]	0.005** [0.00, 0.01]
Urban: Place of residence (rural=ref)	-0.318*** [-0.43, -0.21]	-0.250*** [-0.34, -0.16]	-0.248*** [-0.31, -0.18]	-0.326*** [-0.45, -0.21]	-0.281*** [-0.38, -0,19]	-0.269*** [-0.34, -0.20]
Bihar: State (Uttar Pradesh=ref)	0.199*** [0.10, 0.29]	0.044 [-0.02, 0.11]	0.123*** [0.07, 0.17]	0.196*** [0.09, 0.30]	0.031 [-0.04, 0.10]	0.110*** [0.05, 0.17]
Constant	0.711*** [0.50, 0.92]	0.507*** [0.36, 0.65]	0.587*** [0.47, 0.71]	1.097*** [0.87, 1.32]	1.203*** [1.05, 1.36]	1.165*** [1.04, 1.29]
Number of respondents	8,796	5,766	14,562	6,591	4,746	11,337

Note: ***p<=0.001; **p<=0.01; *p<=0.05

S.4: Description for explanatory variables used in the multivariate analyses

Variables	Definition and response categories	Discrete-time hazard model	Fixed-effects model
Age	In completed years	√	√
Sex	Female/male	√	
Engagement in paid work	Engaged in paid work in the year preceding the interview (Yes/No)	√	√
Marital status	Got married during the inter-survey period (Yes/No)	√	√
Decision-making say	Had some say in all decisions; items for those who were aged 10-14 years at wave 1 were years of schooling they should have and their choice of friends and items for those who were aged 15-19 years were years of schooling they should have, major household purchases, and whether to work or stay at home	√	√
Freedom of movement	Allowed to visit unescorted two out of three locations - a shop/market or a friend/relative within their village/ ward, a shop/ market or a friend/relative outside their village/ward, and a programme (mela, sports event, adolescent group meetings) within their village/ward	√	√
Gender-role attitudes	Scored 4 or 5 on the index of gender role attitudes; the statements referred to: the relative importance of educating boys versus girls and boys' sharing household chores with their sisters (for those aged 10-14 years at wave 1); fathers and mothers sharing chores related to childcare and a girl having a male friend (for those aged 15-19 years); and girls' interest in being teased by boys, girls' right to be involved in decisions related to timing of their marriage, and fathers'/husbands' perceived right to decide about spending household money (for both groups).	√	√
Age at first-time enrolment	Age when enrolled in school for the first time in completed years	√	
Household wealth	Household wealth index based on ownership of selected durable goods and amenities with possible scores ranging from 0 to 57	√	√
Religion	Hindu/ Muslim and others[1]	√	
Caste	Scheduled caste or tribe, other backward caste and general caste	√	
Mother's education	Mothers who were literate (Yes/No)	√	

Parent-child communication	An additive index that captured the number of topics that adolescents discussed with their parent/s in the year preceding the interview - school performance, friendship and physical changes during adolescence or how pregnancy occurs)	√	√
Gender discriminatory experiences at home	Experienced gender discriminatory practices at home where parents favoured sons over daughters in any of the following (the quantity or quality of food items given, the amount of pocket money given and the type of school in which they were enrolled)[2] (Yes/No)	√	√
Type of school attended	Government/ private school	√	√
Private coaching	Received private coaching in the month preceding the interview (Yes/No)	√	√
Enrolled in schools with basic amenities	Attended school with basic amenities such as drinking water, functional toilet, playground and library (Yes/No)	√	√
Place of residence	Rural/ urban	√	√
State	Bihar/ Uttar Pradesh	√	

[1] 0.6% girls and 0.3% boys belonged to other religions. [2] Questions on gender discriminatory practices at home, i.e., whether their parents favoured them (among boys) or discriminated against them (among girls) vis-à-vis their opposite-sex siblings, were posed to those who reported co-residing with opposite-sex siblings who were up to three years younger or older than the respondent; those respondents who were not eligible for these questions were considered not to have experienced gender discriminatory practices.

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