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Secular changes in child marriage and secondary school completion among rural adolescent girls in India

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Background Child marriage (<18 years) and school drop-out disproportionately affect girls living in impoverished households in rural areas, with long-term economic and health consequences. Improving retention in education, and delaying age at marriage and first pregnancy have received substantial attention at the national and global level, in line with the Millennium Development Goals and the Sustainable Development Goals (SDGs) (2015-2030).

Methods We examined changes over time in economic, education and child marriage indicators among adolescents from rural households in (i) Northern Karnataka (the most deprived region of Karnataka), (ii) Karnataka state, and (iii) all India, using individualized data from four pre-existing, nationally-representative datasets (District Level Household and Facility Surveys (DLHS 2-4) (2002/4–2012/3) and the National Family Health Survey (NFHS-4) (2015-16)).

Results At the national and state level, we found large improvements in secondary educational attainment among girls and boys living in rural settings (proportion of adolescents completing age-appropriate secondary school education (all India): girls 12.4% 2002/3 vs. 31.6% 2015/6; boys 18.9% 2002/4 vs. 36.8% 2015/6). We also observed large reductions in child marriage and early child-bearing rates (proportion of married women aged 18-24 years married <18 years: 62.4% 2002/4 vs. 23.8% 2015/6; proportion of married girls aged <19 years who are pregnant or have children: 62.4% 2002/4 vs. 21.9% 2015/6). In addition, we found evidence of “clustered deprivations”, whereby girls in rural areas from the poorest families and lowest castes continue to experience multiple forms of disadvantage, with child marriage significantly associated with scheduled caste / scheduled tribe (SC/ST) caste (odds ratio (OR)=1.25, 95% confidence interval (CI)=1.18-1.32), poorest quintile (OR=2.38, 95% CI=2.21-2.55) and illiteracy (OR=2.09, 95% CI=1.95-2.23); and not completing secondary education significantly associated with SC/ST caste (OR=1.52, 95% CI=1.45-1.59), poorest quintile (OR=4.17, 95% CI=3.90-4.46), and child marriage (OR=2.05, 95% CI=1.85-2.26).

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Conclusions The results show substantial improvements in economic, educational and child marriage indicators at the state and national level over the past 14 years. The government has implemented multiple programmes and policies to address child marriage and school drop-out, and these trends suggest such efforts may be having a positive impact. If India is to achieve the SDGs, designing targeted interventions to reach those who continue to be left furthest behind is going to be key.

Child marriage, defined as marriage under the age of 18 years, is associated with a range of adverse economic and health outcomes, including inter-generational poverty, early and inadequately spaced pregnancies, intimate partner violence, poor mental health, poor utilization of maternal health services, maternal and child mortality, and child malnutrition (1-6). The practice disproportionately affects girls from impoverished families in low and middle-income countries (LMIC), particularly those living in rural and slum areas with low access to health care and education (1, 6). Estimates of global trends in child marriage suggest a slow reduction in incidence, with rates usually far higher in rural compared with urban settings (7). In 2010, it was estimated that one-quarter (26%) of women aged 20-24 years were married as children globally, with one-third of all child marriages taking place in India (8). In Asian settings, child marriage is driven by structural and social factors, including poverty and underlying gender norms around sexual purity and family honour, which come to the fore once a girl reaches menarche (9). Young brides often marry men who are much older and move away from their natal home and social support to live with their spouse (3, 6). Married girls assume new roles of wife, mother, and homemaker, with marriage typically marking the end of a girl's education (10, 11).

The past 15 years have seen rapid progress towards universal primary education, with narrowing gender gaps and increased opportunities for disadvantaged groups (12). Globally, the adjusted net enrolment rate in primary education among primary-aged children grew from 83% in 2000 to 90% in 2011 (13). However, 57 million children still need to be reached to achieve universal primary school access (13). Nonetheless, following improvements in primary education access, the policy focus is shifting to improving parity in access and completion of quality secondary school education (12). Access to education is one of the strongest determinants of adolescent health (14). Quality secondary school education is causally associated with a range of positive economic and health outcomes, including improved livelihood and economic options, improved nutrition, improved ability to control fertility, reduced HIV and STI infection, reduced intimate partner violence (IPV), and improved maternal and child survival rates (11, 14-17). Indeed, improvements in education among women of reproductive age was associated with a halving (51.2%) of global child mortality rates between 1970 and 2009 (16).

Drop-out from school is usually the result of a process, rather than a single event, with more than one proximate cause (18). Similar to child marriage, rural location, poverty and gender norms are key determinants globally of school drop-out, with girls disproportionately affected (18, 19). Poverty and the critical need for child labour can lead to frequent absenteeism and subsequent withdrawal from school, especially if children fall behind academically (18, 20). Among families with limited resources, investment in boys' education is often prioritised, fuelled by the belief that investment in girls is lost once they marry and move to their spouse's home. (20, 21). In India, secondary school drop-out is also linked to menarche, with concerns around sexual purity and family honour leading to restriction of girls' mobility and withdrawal from school (9, 20). Girls from scheduled castes and scheduled tribes (SC/ST) – the lowest castes in the Hindu caste system – living in rural areas, can be particularly at risk. These families are usually the most impoverished and marginalised. Dwellings are often located outside main villages, for example in the agricultural fields, presenting additional economic and distance/ time-related barriers to accessing education.

Over the past 15 years, India has experienced substantial improvements in economic growth, with rapid development and expansion of major cities. Internet and mobile phone availability in rural and urban settings has increased exponentially. Additionally, state and national governments have introduced a range of legislative and policy changes, as well as programming designed to address child marriage and improve educational outcomes. This includes the Prohibition of Child Marriage Act (2006) (22), which made marrying a female minor, conducting a marriage that involves a minor and permitting your child to be married as a minor, illegal and punishable by law (jail or fine). In addition, The Right of Children (aged 6 to 14 years) to Free and Compulsory Education Act (2009) (23), effectively removed primary and lower secondary school fees. There have also been national campaigns promoting gender equality and girls' education, the most notable of which are the nationwide "Beto Bachao Beti Padhao (save your daughter, educate your daughter)" programme launched in 2015. Economic schemes designed to support students in government and government-aided schools to remain in school have also been implemented, such as free midday meals, free bicycles, free school uniforms, and scholarships for children from SC/ST families (24).

In 2013–2017, we conducted a cluster-randomized controlled trial (RCT) in two rural districts in north Karnataka, south India, to evaluate *Samata*, a multi-level structural and social norms intervention designed to reduce child marriage and secondary school drop-out among SC/ST adolescent girls (23, 25). At trial end, we found no impact on child marriage or girl retention in secondary school education, and child marriage and school drop-out rates at trial end were far lower than we anticipated (based on district level data available at the start of the trial) in both the intervention and comparison communities (26). We hypothesised that this may have been due to changes in secular trends regarding economic indicators, school retention and child marriage but were not able to find studies which used representative data from after 2005, at the district, state or national level, to support this. We undertook the current analyses to understand the broader context within which this trial took place. Specifically we wanted to examine (i) levels and trends in economic, marriage, sexual and reproductive health and education indicators among rural adolescent girls over the past 15 years; (ii) levels and trends in education indicators among rural adolescent boys; (iii) if trends observed in northern Karnataka were also seen across the state, and India as a whole; and (iv) key social factors associated with education and marriage outcomes among rural adolescent girls.

METHODS

We undertook secondary analysis of pre-existing, nationally-representative datasets from three rounds of India's District Level Household and Facility Surveys (DLHS) conducted from 2002 to 2013 (DLHS-2 in 2002–04, DLHS-3 in 2007–08, DLHS-4 in 2012–13), and the most recent round of the National Family Health Survey (NFHS) conducted in 2015–16 (NFHS-4), to estimate trends in economic, marriage, sexual and reproductive health indicators, as well as education-related indicators among rural adolescents. We chose these surveys for the analysis as they are conducted periodically and provide estimates on reproductive and child health programme indicators at national and sub-national levels across India. Both the DLHS and NFHS-4 surveys employ a similar systematic, multi-stage stratified sampling scheme, whereby villages in rural areas and Census Enumeration Blocks in urban areas were the primary sampling units (PSU) and were selected using a probability proportional to size (PPS) methodology. The required number of households within each PSU were then selected randomly using a systematic random sampling methodology. The use of such a multistage sampling approach helps ensure the representativeness of the sample and avoids selection bias. Survey weights were used to adjust for non-response and the multistage stratified sampling design, in order to make the estimates representative at the state and district levels. The DLHS and NFHS-4 surveys were implemented by the Ministry of Health and Family Welfare (MoHFW) through the International Institute for Population Sciences (IIPS) as a lead agency along with other national and international development partners.

The DLHS (2002 to 2013) provides estimates on household socio-demographic indicators, along with maternal and child health programme indicators, across every district in India. However, the DLHS-IV survey (2012-13) did not collect data from eight of the poorest performing states in India as data from these states were collected using a different survey. The NFHS surveys were meant to provide state and national level estimates only, but, the latest survey round (NFHS-IV, 2015-16), also provided estimates at the district level, and thereby replaced the DLHS and thus were included in the current analysis. Additional detail on the purpose, survey design, methodology, and results are available elsewhere (27).

For both surveys (DLHS and NFHS-IV), interviews were conducted with ever-married women (aged 15-49 years) for the “women’s questionnaire” and with any adult family member (aged 18+ years) for the “household questionnaire”. We used information from the women’s questionnaire to obtain child marriage, co-habitation, child-bearing and mothers’ literacy rates. Data from the household questionnaire contained relevant information on socio-economic characteristics of the household and educational attainment details of household members (including adolescents).

All analyses were carried out using STATA version 14.0 (Stata Corporation, College Station, TX, USA). To examine changes in the levels and trends in economic, marriage, sexual and reproductive health and education indicators among rural adolescents, we used individual and household level data from the 4 surveys and conducted weighted analyses (using the state and district level weights available with the dataset) for nine rural districts in northern Karnataka (as these are the most disadvantaged districts in Karnataka state (28)), all districts in Karnataka, and all districts across India, and stratified analyses based on gender and caste. Results are presented in the form of weighted crude percentages.

To examine current associations between education / marriage outcomes among adolescent rural girls and key social factors (caste, wealth, literacy, marriage) we conducted cross-sectional analyses at the state and national level using data from the most recent survey round (NFHS-4) using logistic regression. Results are presented in the form of crude odds-ratio (OR) and 95% confidence intervals. We did not adjust these analyses for confounding factors as the purpose of this analysis was to understand which social factors were associated with school drop-out and child marriage.

RESULTS

Secular changes in economic indicators

We examined 6 economic indicators among SC/ST and non-SC/ST rural households over a 14-year period (2002-2016). In northern Karnataka, we found a dramatic step-wise increase in the proportion of rural households with electricity (79.8% vs. 97.0%), phone access (landline or mobile) (6.4% vs. 86.9%), and any of 3 assets (TV, fan, refrigerator) (33.2% vs. 81.5%); this was true both for non-SC/ST and for SC/ST households. These trends were also seen across Karnataka state and India (Table 1). Likewise, although not always directly linear, there was a dramatic increase between 2002/3 and 2015/6 in the proportion of rural households in northern Karnataka who use clean fuel for cooking (8.9% vs. 17.6%), who have use of a toilet facility (8.6% vs. 21.6%), and who live in a house fully or partially constructed with solid building materials (pucca or semi-pucca) (76.6% vs. 94.0%), with these increases seen for both non-SC/ST and SC/ST households. However, a higher proportion of non-SC/ST households compared with SC/ST households reported attaining these 6 different economic indicators, reflecting caste disparities in economic attainment. Similar increases and caste disparities were also seen among rural households across Karnataka state and India (Table 2 and Table 3).

Table 1. Profile of all rural girls

INDICATORS	NORTHERN KARNATAKA DISTRICTS (9 DISTRICTS)*				KARNATAKA				INDIA			
	DLHS II	DLHS III	DLHS IV†	NFHS IV	DLHS II	DLHS III	DLHS IV†	NFHS IV	DLHS II	DLHS III	DLHS IV†	NFHS IV
	2002/3 % (N)	2007/8 % (N)	2012/3 % (N)	2015/6 % (N)	2002/3 % (N)	2007/8 % (N)	2012/3 % (N)	2015/6 % (N)	2002/3 % (N)	2007/8 % (N)	2012/3 % (N)	2015/6 % (N)
Economic:												
N	5747	6469	8939	4419	18733	20904	26540	14490	415135	548694	217904	408296
Proportion of HH with electricity	79.8 (4601)	87.2 (5617)	93.6 (8353)	97.0 (4292)	83.1 (15466)	86.2 (18022)	94.7 (25118)	96.9 (14012)	63.5 (233098)	60.1 (323517)	93.7 (203725)	83.0 (342631)
Proportion of HH having any phone	6.4 (392)	27.9 (1795)	80.5 (7197)	86.9 (3801)	10.0 (2090)	34.2 (7128)	83.3 (22125)	88.5 (12762)	7.6 (36821)	29.0 (157838)	82.1 (179043)	87.4 (354978)
Proportion of HH with any of 3 assets (TV, Fan, Refrigerator)	33.2 (1978)	43.5 (2728)	56.4 (5061)	81.5 (3582)	39.0 (7421)	48.3 (10085)	68.3 (18135)	83.3 (12012)	48.3 (177761)	43.8 (237650)	73.1 (159436)	72.9 (286027)
Proportion of HH using clean fuel for cooking	8.9 (539)	3.5 (204)	7.6 (683)	17.6 (711)	12.3 (2510)	7.9 (1634)	19.6 (5210)	32.0 (4394)	13.8 (56483)	8.8 (47258)	28.4 (61886)	24.1 (86873)
Proportion of HH uses a toilet facility	8.6 (524)	6.0 (342)	9.0 (810)	21.6 (962)	19.2 (4087)	23.0 (4771)	35.2 (9391)	47.1 (6973)	19.2 (126244)	33.3 (178274)	64.0 (140973)	44.8 (201030)
Proportion of HH has Pakka/Semi Pakka house	76.6 (4454)	63.7 (4066)	81.6 (7300)	94.0 (4117)	84.1 (16036)	72.2 (15080)	84.1 (22371)	95.6 (13725)	60.1 (227606)	54.0 (294471)	74.4 (161210)	91.5 (354719)
Marriage:												
N	1641	1865	2283	1298	4388	4521	4839	3596	92517	111239	29931	118688
Proportion of women aged 18-24 who were married below 18 years	77.4 (1264)	74.9 (1401)	52.0 (1192)	26.7 (345)	64.0 (2810)	58.5 (2650)	42.2 (2043)	21.8 (758)	62.4 (53729)	51.7 (58114)	34.0 (10100)	23.8 (25415)
SRH:												
N	1641	1865	2283	1298	4388	4521	4839	3596	92517	111239	29931	118688
Proportion of women aged 18-24 who were married <18 years and co-habiting <18 years	77.4 (1264)	72.9 (1366)	48.3 (1109)	25.6 (329)	64.0 (2810)	57.5 (2605)	39.2 (1903)	20.8 (724)	62.4 (53729)	46.5 (52169)	32.2 (9562)	21.9 (23256)
N	705	632	489	659	1295	1050	762	1894	22026	22818	3346	72534
Proportion of married girls aged <19 years pregnant or have children	59.9 (419)	56.0 (360)	53.8 (265)	5.0 (34)	56.5 (763)	53.9 (566)	52.6 (404)	5.8 (96)	52.8 (11471)	47.6 (10905)	49.6 (1680)	5.3 (3404)
N	4321	5943	8165	3606	13510	18264	22650	11285	305792	443664	162793	328344
Proportion of Mothers who are literate	25.0 (1125)	33.3 (1938)	38.2 (3137)	44.0 (1576)	40.4 (5683)	49.4 (9003)	54.9 (12468)	60.4 (6763)	39.3 (127072)	46.3 (202869)	63.2 (103528)	56.6 (187688)
Education:												
N	1279	1377	1573	676	3408	3552	3755	1799	80595	106097	26858	62928
Proportion of girls aged 12-14 entered into secondary school	12.8 (162)	18.9 (256)	22.6 (360)	26.9 (175)	23.9 (798)	26.0 (922)	36.0 (1361)	33.5 (606)	24.9 (13569)	19.3 (20250)	39.3 (10476)	28.1 (16903)
N	1269	1311	1449	477	3441	3371	3512	1462	73205	85319	25834	57075
Proportion of girls aged 15-17 completed secondary education	15.3 (209)	23.8 (300)	33.0 (483)	41.5 (197)	23.4 (848)	34.4 (1159)	49.2 (1729)	55.8 (815)	21.9 (11974)	21.6 (18249)	49.6 (12781)	36.5 (19331)
N	1461	1604	2040	627	4524	4354	4496	1740	87567	101247	29786	59931
Proportion of girls aged 18-20 completed higher-secondary education	7.6 (116)	9.8 (150)	17.6 (365)	26.6 (168)	10.8 (538)	17.2 (749)	29.7 (1353)	38.4 (673)	12.4 (8993)	14.0 (14149)	37.5 (11213)	31.6 (17822)

DLHS – District Level Household and Facility Surveys, NFHS – National Family Health Survey, HH – Household, SRH – Sexual and Reproductive Health

*9 districts include – Bidar, Gulbarga, Bijapur, Yadgir, Bagalkot, Raichur, Gadag, Koppal and Bellary.

†Data not collected from 8 poorly performing States in India (as data from these States were collected in a different survey).

Secular changes in child marriage, cohabitation and child-bearing

There has been a substantial step-wise reduction in the proportion of women aged 18–24 years who were married by 18 years (77.4% vs. 26.7%), and who were married *and* cohabiting by 18 years (77.4% vs. 25.6%), as well as substantial reductions in the proportion of married adolescent girls (<19 years) who were pregnant or had children (59.9% vs. 5.0%) in rural northern Karnataka between 2002/3 and 2015/6 (Table 1). Literacy rates among mothers (15–49 years) significantly improved during this 14-year period (25.0% vs. 44.0%). These improvements were also seen among non-SC/ST and SC/ST females across Karnataka state and India (Tables 2 and 3). Although the gap is diminishing, caste disparities remain, with rural SC/ST girls having higher rates of child marriage, cohabitation and childbearing, and lower literacy rates, compared with rural non-SC/ST girls. At each of the four-time points, child marriage rates child marriage rates were far higher and maternal literacy rates were far lower in northern Karnataka, compared with Karnataka state and all India (Table 1).

Table 2. Profile of rural non-Scheduled Caste/Scheduled Tribe girls

INDICATORS	NORTHERN KARNATAKA DISTRICTS (9 DISTRICTS)*				KARNATAKA				INDIA			
	DLHS II	DLHS III	DLHS IV†	NFHS IV	DLHS II	DLHS III	DLHS IV†	NFHS IV	DLHS II	DLHS III	DLHS IV†	NFHS IV
	2002/3 % (N)	2007/8 % (N)	2012/3 % (N)	2015/6 % (N)	2002/3 % (N)	2007/8 % (N)	2012/3 % (N)	2015/6 % (N)	2002/3 % (N)	2007/8 % (N)	2012/3 % (N)	2015/6 % (N)
Economic:												
N	3956	4198	5464	2497	13364	14678	17212	9108	255655	321487	110035	233383
Proportion of HH with electricity	82.0 (3259)	88.0 (3677)	94.0 (5131)	97.2 (2429)	86.1 (11431)	88.1 (12936)	95.4 (16419)	97.6 (8880)	67.0 (151746)	62.8 (198366)	96.3 (106033)	84.5 (198400)
Proportion of HH having any phone	8.1 (338)	32.1 (1332)	82.8 (4524)	89.3 (2209)	12.5 (1872)	39.2 (5736)	85.7 (14759)	91.0 (8251)	9.8 (28359)	36.0 (114482)	86.1 (94697)	90.5 (211802)
Proportion of HH with any of 3 assets (TV, Fan, Refrigerator)	39.1 (1593)	48.7 (1973)	59.8 (3281)	84.5 (2098)	45.1 (6125)	53.7 (7864)	71.7 (12346)	86.6 (7862)	55.3 (129424)	50.7 (160300)	80.2 (88773)	77.1 (177479)
Proportion of HH using clean fuel for cooking	11.1 (459)	4.9 (184)	10.1 (557)	22.4 (523)	15.0 (2180)	10.2 (1483)	23.9 (4119)	38.1 (3290)	17.3 (39867)	11.0 (34399)	36.4 (40440)	29.1 (61097)
Proportion of HH uses a toilet facility	8.3 (351)	7.7 (289)	11.9 (651)	24.0 (603)	22.5 (3435)	28.3 (4113)	42.5 (7349)	53.5 (4976)	23.1 (80258)	33.9 (108067)	65.4 (71926)	51.0 (121902)
Proportion of HH has Pakka/Semi Pakka house	79.4 (3187)	68.1 (2835)	84.7 (4630)	95.6 (2370)	87.0 (11826)	76.0 (11148)	87.1 (15030)	96.8 (8744)	66.1 (161597)	63.4 (202848)	84.2 (92653)	92.9 (208486)
Marriage:												
N	1108	1191	1340	698	2958	2996	2906	2100	58537	67238	15145	69318
Proportion of women aged 18-24 who were married below 18 years	74.4 (819)	70.7 (846)	49.5 (667)	25.3 (171)	59.8 (1759)	53.5 (1607)	39.5 (1148)	19.8 (394)	59.6 (32801)	50.7 (34416)	32.9 (4924)	22.7 (14474)
SRH:												
N	1108	1191	1340	698	2958	2996	2906	2100	58537	67238	15145	69318
Proportion of women aged 18-24 who were married <18 years and co-habiting <18 years	74.4 (819)	68.0 (817)	45.4 (613)	23.9 (161)	59.8 (1759)	52.2 (1569)	36.7 (1067)	18.6 (371)	59.6 (32801)	44.8 (30345)	31.2 (4670)	20.6 (13000)
N	430	361	280	396	783	609	445	1160	13533	14023	1698	42565
Proportion of married girls aged <19 years pregnant or have children	59.4 (252)	52.9 (197)	50.4 (143)	4.1 (16)	53.5 (443)	51.4 (313)	51.1 (230)	5.0 (49)	50.8 (6760)	48.0 (6761)	48.5 (826)	4.9 (1823)
N	2962	3830	4948	2032	9601	12748	14482	6938	192477	271004	83787	193625
Proportion of Mothers who are literate	30.4 (946)	40.1 (1503)	45.9 (2273)	49.3 (1001)	46.7 (4706)	56.8 (7228)	62.5 (9055)	66.2 (4574)	45.4 (88892)	50.7 (136045)	69.5 (58359)	60.9 (118019)
Education:												
N	849	809	908	372	2322	2328	2254	1079	49854	62188	12381	35341
Proportion of girls aged 12-14 entered into secondary school	16.6 (135)	21.6 (172)	26.1 (238)	31.2 (113)	26.3 (596)	28.1 (654)	39.1 (886)	36.1 (397)	26.7 (9641)	22.1 (13509)	45.6 (5653)	29.5 (10386)
N	861	828	860	272	2410	2302	2193	911	45469	51413	12193	33076
Proportion of girls aged 15-17 completed secondary education	18.8 (175)	27.0 (213)	38.4 (331)	45.1 (120)	27.7 (693)	38.7 (889)	54.6 (1196)	60.8 (552)	25.2 (8816)	25.5 (12935)	59.5 (7304)	40.0 (12812)
N	1030	1030	1188	346	3196	2928	2733	1043	54444	59795	14405	34811
Proportion of girls aged 18-20 completed higher-secondary education	9.3 (100)	12.0 (117)	20.9 (252)	33.8 (119)	12.7 (457)	20.8 (606)	34.9 (964)	44.5 (469)	14.7 (6671)	17.4 (10288)	46.7 (6804)	36.0 (12378)

DLHS – District Level Household and Facility Surveys, NFHS – National Family Health Survey, HH – Household, SRH – Sexual and Reproductive Health

*9 districts include – Bidar, Gulbarga, Bijapur, Yadgir, Bagalkot, Raichur, Gadag, Koppal and Bellary.

†Data not collected from 8 poorly performing States in India (as data from these States were collected in a different survey).

Secular changes in educational attainment

There have been dramatic step-wise improvements in educational attainment among boys and girls living in rural areas in northern Karnataka, Karnataka state and India. Educational outcomes have improved substantially among girls, with more than double the proportion of girls living in rural northern Karnataka starting secondary school (12.8% vs. 26.9%), completing secondary school (15.3% vs. 41.5%), and completing higher secondary education (7.6% vs. 26.6%) in 2015/6 compared with 2002/3 (Table 1). However, in 2015/6, rural girls from SC/ST households were still less likely to start secondary school (21.4% vs. 31.2%), or complete secondary (36.7% vs. 45.1%) or higher-secondary education (17.9% vs. 33.8%), compared with rural girls from non-SC/ST households (Tables 2 and 3). These overall improvements in educational attainment, and disparities based on caste, were also seen across Karnataka state and India.

Table 3. Profile of rural Scheduled Caste/Scheduled Tribe girls

INDICATORS	NORTHERN KARNATAKA DISTRICTS (9 DISTRICTS)*				KARNATAKA				INDIA			
	DLHS II	DLHS III	DLHS IV†	NFHS IV	DLHS II	DLHS III	DLHS IV†	NFHS IV	DLHS II	DLHS III	DLHS IV†	NFHS IV
	2002/3 % (N)	2007/8 % (N)	2012/3 % (N)	2015/6 % (N)	2002/3 % (N)	2007/8 % (N)	2012/3 % (N)	2015/6 % (N)	2002/3 % (N)	2007/8 % (N)	2012/3 % (N)	2015/6 % (N)
Economic:												
N	1791	2271	3475	1922	5369	6226	9328	5382	159480	227207	107869	174913
Proportion of HH with electricity	74.9 (1342)	85.8 (1940)	92.9 (3222)	96.7 (1863)	76.0 (4035)	81.7 (5086)	93.3 (8699)	95.7 (5132)	56.5 (81352)	56.4 (125151)	90.8 (97692)	80.4 (144231)
Proportion of HH having any phone	2.8 (54) (463)	20.0 (463)	76.9 (2673)	83.7 (1592)	3.8 (218) (1392)	22.4 (7366)	78.9 (4511)	84.1 (8462)	3.2 (43356)	19.3 (84346)	78.0 (84346)	81.8 (143176)
Proportion of HH with any of 3 assets (TV, Fan, Refrigerator)	20.6 (385)	33.6 (755)	51.2 (1780)	77.6 (1484)	24.4 (1296)	35.7 (2221)	62.2 (5789)	77.7 (4150)	34.2 (48337)	34.4 (77350)	65.5 (70663)	65.4 (108548)
Proportion of HH using clean fuel for cooking	4.3 (80)	0.8 (20)	3.7 (126)	11.1 (188)	5.8 (330)	2.5 (151)	11.8 (1091)	21.7 (1104)	6.7 (16616)	5.9 (12859)	19.8 (21446)	15.0 (25776)
Proportion of HH uses a toilet facility	9.2 (173)	2.6 (53)	4.6 (159)	18.3 (359)	11.3 (652)	10.7 (658)	21.9 (2042)	35.9 (1997)	11.3 (45986)	32.4 (70207)	62.6 (69047)	33.7 (79128)
Proportion of HH has Pakka/Semi Pakka house	70.6 (1267)	55.2 (1231)	76.7 (2670)	91.8 (1747)	77.4 (4210)	63.2 (3932)	78.6 (7341)	93.4 (4981)	47.9 (66009)	41.0 (91623)	64.1 (68557)	88.9 (146233)
Marriage:												
N	533	674	943	600	1430	1525	1933	1496	33980	44001	14786	49370
Proportion of women aged 18-24 who were married below 18 years	83.6 (445)	82.4 (555)	55.6 (525)	28.3 (174)	72.8 (1051)	68.4 (1043)	46.1 (895)	24.7 (364)	67.9 (20928)	53.3 (23698)	35.3 (5176)	25.7 (10941)
SRH:												
N	533	674	943	600	1430	1525	1933	1496	33980	44001	14786	49370
Proportion of women aged 18-24 who were married <18 years and co-habiting <18 years	83.6 (445)	81.5 (549)	52.4 (496)	27.6 (168)	72.8 (1051)	67.9 (1036)	43.0 (836)	24.1 (353)	67.9 (20928)	49.2 (21824)	33.3 (4892)	24.1 (10256)
N	275	271	209	263	512	441	317	734	8493	8795	1648	29969
Proportion of married girls aged <19 years pregnant or have children	60.8 (167)	60.2 (163)	58.5 (122)	6.4 (18)	61.3 (320)	57.3 (253)	54.8 (174)	7.0 (47)	56.3 (4711)	46.9 (4144)	50.8 (854)	6.1 (1581)
N	1359	2113	3217	1574	3909	5516	8168	4347	113315	172660	79006	134719
Proportion of Mothers who are literate	13.5 (179)	20.9 (435)	26.5 (864)	37.1 (575)	25.4 (977)	32.2 (1775)	41.7 (3413)	50.8 (2189)	26.1 (38180)	39.4 (66824)	56.3 (45169)	48.6 (69669)
Education:												
N	430	568	665	304	1086	1224	1501	720	30741	43909	14477	27587
Proportion of girls aged 12-14 entered into secondary school	5.6 (27)	14.9 (84)	17.9 (122)	21.4 (62)	19.1 (202)	21.9 (268)	31.4 (475)	29.7 (209)	21.5 (3928)	15.5 (6741)	33.6 (4823)	25.6 (6517)
N	408	483	589	205	1031	1069	1319	551	27736	33906	13641	23999
Proportion of girls aged 15-17 completed secondary education	7.9 (34)	18.2 (87)	25.1 (152)	36.7 (77)	13.9 (155)	25.2 (270)	40.2 (533)	47.9 (263)	15.4 (3158)	15.8 (5314)	40.4 (5477)	30.5 (6519)
N	431	574	852	281	1328	1426	1763	697	33123	41452	15381	25120
Proportion of girls aged 18-20 completed higher-secondary education	3.6 (16)	6.0 (33)	12.9 (113)	17.9 (49)	6.2 (81)	10.0 (143)	21.6 (389)	29.1 (204)	7.8 (2322)	9.3 (3861)	28.6 (4409)	23.7 (5444)

DLHS – District Level Household and Facility Surveys, NFHS – National Family Health Survey, HH – Household, SRH – Sexual and Reproductive Health

*9 districts include – Bidar, Gulbarga, Bijapur, Yadgir, Bagalkot, Raichur, Gadag, Koppal and Bellary.

†Data not collected from 8 poorly performing States in India (as data from these States were collected in a different survey).

Similarly, between 2002/3 and 2015/6, there was a dramatic increase in the proportion of boys living in rural areas in northern Karnataka who (i) entered into secondary school (16.7% vs. 25.5%), (ii) completed secondary school (23.0% vs. 41.0%), and (iii) completed higher-secondary education (15.0% vs. 38.4%) (Table 4). Boys from non-SC/ST families had better secondary and higher-secondary completion rates than boys from SC/ST backgrounds (Table 5 and Table 6). These improvements and patterns were also seen among boys living in rural areas across Karnataka state and all India.

Of note, by 2015/6 there was parity in secondary school entry (24.5% vs. 26.9%) and completion (41.0% vs. 41.5%) between rural boys and girls in northern Karnataka, but boys were still more likely to complete higher secondary school education compared with girls (38.4% vs. 26.6%). Similar gender parity in secondary school educational attainment was also seen in the 2015/16 data from all of Karnataka and across India. However, for both girls and boys,

Table 4. Profile of all rural boys

INDICATORS	NORTHERN KARNATAKA DISTRICTS (9 DISTRICTS)*				KARNATAKA				INDIA			
	DLHS II	DLHS III	DLHS IV†	NFHS IV	DLHS II	DLHS III	DLHS IV†	NFHS IV	DLHS II	DLHS III	DLHS IV†	NFHS IV
	2002/3 % (N)	2007/8 % (N)	2012/3 % (N)	2015/6 % (N)	2002/3 % (N)	2007/8 % (N)	2012/3 % (N)	2015/6 % (N)	2002/3 % (N)	2007/8 % (N)	2012/3 % (N)	2015/6 % (N)
Education:												
N	1320	1405	1591	653	3607	3615	3696	1751	86247	107262	28750	65380
Proportion of boys aged 12-14 entered into secondary school	16.7 (225)	21.8 (299)	23.9 (379)	24.5 (155)	23.2 (841)	25.5 (922)	32.5 (1202)	33.2 (581)	24.8 (16111)	19.8 (21092)	36.2 (10327)	26.6 (16728)
N	1088	1267	1511	639	3166	3358	3625	1710	74257	95705	28116	60272
Proportion of boys aged 15-17 completed secondary education	23.3 (256)	30.1 (395)	34.0 (513)	41.0 (247)	27.3 (861)	37.2 (1250)	45.0 (1639)	48.4 (813)	25.3 (14589)	23.6 (22520)	48.0 (13440)	35.6 (20089)
N	1324	1405	1764	710	3867	3804	4163	1858	81261	103323	29753	57503
Proportion of boys aged 18-20 completed higher-secondary education	15.0 (196)	22.8 (309)	31.3 (551)	38.4 (259)	17.4 (670)	25.7 (976)	36.9 (1542)	39.8 (737)	18.9 (12915)	19.9 (20568)	41.5 (12298)	36.8 (19457)

DLHS – District Level Household and Facility Surveys, NFHS – National Family Health Survey
 *9 districts include – Bidar, Gulbarga, Bijapur, Yadgir, Bagalkot, Raichur, Gadag, Koppal and Bellary.
 †Data not collected from 8 poorly performing States in India (as data from these States were collected in a different survey).

Table 5. Profile of rural non- Scheduled Caste /Scheduled Tribe boys

INDICATORS	NORTHERN KARNATAKA DISTRICTS (9 DISTRICTS)*				KARNATAKA				INDIA			
	DLHS II	DLHS III	DLHS IV†	NFHS IV	DLHS II	DLHS III	DLHS IV†	NFHS IV	DLHS II	DLHS III	DLHS IV†	NFHS IV
	2002/3 % (N)	2007/8 % (N)	2012/3 % (N)	2015/6 % (N)	2002/3 % (N)	2007/8 % (N)	2012/3 % (N)	2015/6 % (N)	2002/3 % (N)	2007/8 % (N)	2012/3 % (N)	2015/6 % (N)
Education:												
N	881	851	895	324	2507	2441	2235	1003	53546	63613	13621	37517
Proportion of boys aged 12-14 entered into secondary school	18.0 (165)	21.6 (180)	26.9 (238)	23.8 (76)	24.3 (619)	26.7 (651)	35.4 (790)	33.9 (344)	26.5 (11287)	22.1 (13874)	42.2 (5768)	27.7 (10410)
N	729	791	888	364	2248	2278	2243	1044	46086	56663	13423	34778
Proportion of boys aged 15-17 completed secondary education	26.6 (198)	33.1 (273)	37.1 (331)	43.7 (153)	30.7 (686)	39.7 (905)	49.4 (1113)	50.9 (522)	29.0 (10557)	28.2 (15802)	57.2 (7734)	39.5 (13413)
N	903	879	1008	408	2689	2534	2511	1142	50604	60007	14343	33018
Proportion of boys aged 18-20 completed higher-secondary education	18.0 (157)	25.7 (217)	36.4 (367)	41.0 (161)	20.1 (540)	28.1 (710)	42.9 (1083)	42.9 (496)	21.2 (9291)	24.2 (14404)	51.5 (7411)	41.6 (13321)

DLHS – District Level Household and Facility Surveys, NFHS – National Family Health Survey.
 *9 districts include – Bidar, Gulbarga, Bijapur, Yadgir, Bagalkot, Raichur, Gadag, Koppal and Bellary.
 †Data not collected from 8 poorly performing States in India (as data from these States were collected in a different survey).

Table 6. Profile of rural Scheduled Caste /Scheduled Tribe boys

INDICATORS	NORTHERN KARNATAKA DISTRICTS (9 DISTRICTS)*				KARNATAKA				INDIA			
	DLHS II	DLHS III	DLHS IV†	NFHS IV	DLHS II	DLHS III	DLHS IV†	NFHS IV	DLHS II	DLHS III	DLHS IV†	NFHS IV
	2002/3 % (N)	2007/8 % (N)	2012/3 % (N)	2015/6 % (N)	2002/3 % (N)	2007/8 % (N)	2012/3 % (N)	2015/6 % (N)	2002/3 % (N)	2007/8 % (N)	2012/3 % (N)	2015/6 % (N)
Education:												
N	439	554	696	329	1100	1174	1461	748	32701	43649	15129	27863
Proportion of boys aged 12-14 entered into secondary school	14.3 (60)	22.1 (119)	20.0 (141)	25.2 (79)	20.9 (222)	23.0 (271)	28.2 (412)	32.3 (237)	21.6 (4824)	16.6 (7218)	30.6 (4559)	24.7 (6318)
N	359	476	623	275	918	1080	1382	666	28171	39042	14693	25494
Proportion of boys aged 15-17 completed secondary education	16.6 (58)	25.2 (122)	29.6 (182)	37.2 (94)	19.3 (175)	31.9 (345)	37.9 (526)	44.4 (291)	17.8 (4032)	17.2 (6718)	39.2 (5706)	28.7 (6676)
N	421	526	756	302	1178	1270	1652	716	30657	43316	15410	24485
Proportion of boys aged 18-20 completed higher-secondary education	8.8 (39)	17.8 (92)	24.5 (184)	34.6 (98)	11.5 (130)	20.9 (266)	27.7 (459)	34.6 (241)	14.4 (3624)	14.1 (6164)	31.9 (4887)	28.6 (6136)

DLHS – District Level Household and Facility Surveys, NFHS – National Family Health Survey.
 *9 districts include – Bidar, Gulbarga, Bijapur, Yadgir, Bagalkot, Raichur, Gadag, Koppal and Bellary.
 †Data not collected from 8 poorly performing States in India (as data from these States were collected in a different survey).

rates of secondary school entry and completion remained far lower in northern Karnataka compared with Karnataka state, but rates in northern Karnataka are comparable to all-India estimates (Table 1 and Table 4).

Associations between social factors, marriage and education among rural adolescent girls

To identify which girls remain most at risk of child marriage, we conducted univariate regression analyses using NFHS-4 data (2015/6) from rural Karnataka state (Table 7). Compared with girls who were married aged 20–24 years, girls who were married <18 years were significantly more likely to be from the poorest wealth quintile and to be illiterate, with the odds increasing with decreasing age at marriage (Table 7). In addition, there was evidence that marriage aged 16–17 years was more likely among girls from SC/ST castes, but there was no evidence of caste differences in marriage rates for girls married <16 years old. When we repeated these analyses using data from all rural India, we found significant associations between child marriage and SC/ST caste, poverty and illiteracy (Table 7).

Table 7. Age at marriage and its associations with sociodemographic vulnerabilities among ever married 20–24-year-old women (Rural): data from National Family Health Survey-4

	KARNATAKA						INDIA					
	Scheduled caste/ scheduled tribe (N=2078)		Poorest quintile (N=2260)		Illiterate (N=2260)		Scheduled caste/ scheduled tribe (N=69454)		Poorest quintile (N=72135)		Illiterate (N=72135)	
	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value
Age at marriage:												
20-24	Ref		Ref		Ref		Ref		Ref		Ref	
18-19	1.01 (0.77-1.31)	0.969	1.37 (0.98-1.91)	0.063	1.44 (0.98-2.11)	0.061	1.14 (1.09-1.20)	0.000	1.77 (1.65-1.89)	0.000	1.46 (1.37-1.56)	0.000
16-17	1.36 (1.02-1.82)	0.037	1.60 (1.13-2.27)	0.009	2.26 (1.52-3.36)	0.000	1.25 (1.18-1.32)	0.000	2.38 (2.21-2.55)	0.000	2.09 (1.95-2.23)	0.000
<16	1.12 (0.79-1.60)	0.517	2.49 (1.69-3.68)	0.000	3.81 (2.50-5.82)	0.000	1.23 (1.15-1.31)	0.000	2.93 (2.71-3.16)	0.000	3.39 (3.16-3.64)	0.000

CI – confidence interval, OR – odds ratio

To identify which girls remain most at risk of not completing secondary school education, we again conducted regression analyses using NFHS-4 data. Across rural Karnataka state, among girls aged 12–14 years, SC/ST caste and being from the poorest quintile were significantly associated with not starting secondary school. Among girls aged 15–17 years and 18–20 years, SC/ST caste, poverty and marriage were significantly associated with not completing secondary school or higher-secondary school, respectively (Table 8). These patterns were also found when we repeated these analyses using data from all rural India (Table 8).

Table 8. School attainment and its associations with sociodemographic vulnerabilities among girls (Rural): data from National Family Health Survey-4

	KARNATAKA						INDIA					
	Scheduled caste/ scheduled tribe		Poorest quintile		Married/Married but gauna not performed		Scheduled caste/ scheduled tribe		Poorest quintile		Married/Married but gauna not performed	
	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value	OR (95% CI)	P-value
Girls aged 12-14 entered into secondary school (Class 8):												
N	1799		1956		1297		62928		65691		42132	
Yes	Ref		Ref		Ref		Ref		Ref		Ref	
No	1.34 (1.06-1.68)	0.013	1.81 (1.40-2.33)	0.000	0.47 (0.20-1.08)	0.074	1.22 (1.16-1.28)	0.000	2.53 (2.39-2.68)	0.000	0.94 (0.79-1.12)	0.479
Girls aged 15-17 completed secondary education (Class 10):												
N	1462		1601		1601		57075		59398		59398	
Yes	Ref		Ref		Ref		Ref		Ref		Ref	
No	1.69 (1.33-2.14)	0.000	2.48 (1.88-3.29)	0.000	1.86 (1.16-2.99)	0.010	1.52 (1.45-1.59)	0.000	4.17 (3.90-4.46)	0.000	2.05 (1.85-2.26)	0.000
Girls aged 18-20 completed higher-secondary education (Class 12):												
N	1740		1887		1887		59931		62560		62560	
Yes	Ref		Ref		Ref		Ref		Ref		Ref	
No	1.96 (1.54-2.48)	0.000	3.65 (2.61-5.12)	0.000	5.56 (4.29-7.22)	0.000	1.81 (1.72-1.90)	0.000	4.91 (4.53-5.33)	0.000	4.37 (4.16-4.60)	0.000

CI – confidence interval, OR – odds ratio

DISCUSSION

In this study, we conducted an ecological analysis of pre-existing, nationally representative datasets and found large improvements in household economic indicators and secondary educational attainment, and large reductions in child marriage and early child-bearing rates over the past 15 years, at the district, state and national levels. Not only that, we also found evidence of clustered deprivations, whereby adolescent girls living in rural areas from the lowest castes (SC/ST) and the poorest families, continue to be the most at risk of secondary school non-completion and early marriage. This study adds to the evidence base by using nationally representative data, including those from the most recent survey (2015/6), to document these trends, and to examine intersecting vulnerabilities of the most marginalised girls. These trends in child marriage and secondary school retention have also been noted in other LMICs globally (7, 16, 29). The findings will be useful for education and health policy makers and implementers seeking to identify those individuals and families who continue to be most at risk, so as to inform new policies and programming to achieve the SDG targets of leaving no one behind.

The improvements in educational attainment over the past 14 years, and the reductions in child marriage and early child-bearing rates, were seen among rural households in northern Karnataka as well as across Karnataka state and India and help explain the low rates of child marriage and secondary school drop-out seen at trial end in the Samata trial (26). Nonetheless, secondary school non-entry and child marriage rates remain highest among SC/ST girls living in rural northern Karnataka, compared with all of Karnataka and India, suggesting northern Karnataka remains disadvantaged. There have also been substantial economic improvements for rural households across India, with more households living in semi-permanent or permanent dwellings, and increased access to electricity, clean fuel, toilet facilities, and phones. Caste disparities persist with regard to economic indicators, education and marriage rates, and higher secondary school (16–18 years) completion, but gender parity in lower secondary school enrolment and completion has been achieved. This evidence suggests that sustained political will, coupled with legislative and policy changes, appears to have benefited rural young people, within relatively short time-frames.

Despite these successes, there remains a sizeable population still at risk of poor educational outcomes, child marriage and early child-bearing. The current analysis suggests that it is young people (aged 12–20 years) from the poorest households and the lowest castes (SC/ST) that are most at risk of not starting or completing secondary school, marrying early and bearing children during adolescence. Identifying and supporting these girls—those who experience multiple forms of clustered disadvantage—will be key to India achieving its Sustainable Development Goal (SDG) aspirations, including: 4.1 (ensuring all girls and boys complete free, equitable and quality primary and secondary education), 4.5 (eliminating gender disparities in education), 5.3 (eliminating child marriage), 3.1 (reducing global maternal mortality) and 3.2 (ending preventable deaths of newborns and children under 5 years) (30).

Key strengths of these data include the representativeness of the sample, the robustness of the data and the measures, and the ability to get a range of information from a single survey. However, by analysing the data by caste and by gender, some cells become small, meaning there is a larger amount of uncertainty around the percentages. In addition, the DLHS-IV survey excluded data from eight of the poorest performing States in India (as data from these states was collected using a different survey); exclusion of these states would have resulted in improved levels for some indicators at this time point. As the questionnaires were administered face-to-face, the variables included in our analysis may have been subject to reporting bias, resulting in, for example, under-reporting of child marriage in the household questionnaire, and over-reporting of school retention. Reporting biases may have increased after the introduction of legislation and awareness-raising campaigns regarding these issues among the general population in 2006 and 2009, respectively (22, 23). The interviewing of ever-married girls and women for the women's questionnaire nec-

essarily skews our comparison group, meaning we could only compare pregnancy and literacy outcomes among married women aged 19-24 years and not among all women aged 19-24 years. This may have led to underestimates of the impact of child marriage on these outcomes. Ecological analysis of cross-sectional data precludes the ability to make causal inferences.

CONCLUSIONS

Taken together, our analyses suggest that the lack of impact seen in the Samata trial may have been a result of the large secular changes occurring in India during this period. Future trials should assess background trends before investing in a community randomized assessment of project impacts. Unlike the earlier Millennium Development Goals (MDGs), the SDGs include a commitment to “Leave No one Behind,” even those who by virtue of intersecting inequalities and stigma are hardest to reach (31). We recommend that to benefit this group, future efforts should focus explicitly on the most disadvantaged families and start 1-2 years before young girls reach menarche (32-35). More broadly to achieve the SDGs, India must shift its focus now from enrolment, to improving the quality of education (12).

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Ethics approval: As this analysis used data from pre-existing nationally-representative datasets from India, no additional ethical approval was sought for the analyses presented in this manuscript.

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Authors contributions: TB, SM and RP conceptualised the study and the analyses. PJ and RP conducted the data analysis. TB wrote the first draft of the manuscript. All authors interpreted the data and reviewed and revised the manuscript.

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