Demographic, nutritional, social and environmental predictors of learning skills and depression in 20,000 Indian adolescents: Findings from the UDAYA survey

Samuel Scott,1,2*, Anjali Pant2, Phuong Hong Nguyen1, Sachin Shinde3, Purnima Menon1,2

1 International Food Policy Research Institute, Washington, DC, United States of America, 2 International Food Policy Research Institute, New Delhi, India, 3 Population Council, New Delhi, India

* samuel.scott@cgiar.org

Abstract

Objectives
Adolescent wellbeing is critical to breaking the intergenerational cycle of poverty and one in five of the world’s adolescents live in India. We explored predictors of learning skills and depression in Indian adolescents.

Methods
Data on adolescents aged 10–19y (three groups: 5,840 unmarried males, 8,953 unmarried females, 4,933 married females) were available from the state-representative Understanding the Lives of Adolescents and Young Adults survey in Uttar Pradesh and Bihar. Multivariable logistic regression models adjusted for cluster sampling design and state fixed effects were used to examine factors (demographic, health/nutrition, social, and environmental) associated with three outcomes: reading proficiency, math proficiency, and depressive symptoms.

Findings
Learning skills were poor (28–61% lacked basic reading and math skills depending on adolescent group and outcome) and depression was common (8–26%). Better learning skills were predicted by greater household wealth (AOR 1.72–2.55 depending on group) and household head education (AOR 1.03–1.07 per year), being in school (AOR 4.19–18.65), parental support (AOR 1.11–1.39), having gender equal attitudes (AOR 1.56–2.67), number of food groups consumed at least weekly (unmarried females: AOR 1.11), and having an improved latrine (AOR 1.33–1.51). Poorer learning skills were predicted by family substance use (AOR 0.68–0.74), underweight (males: AOR 0.74), witnessing parental violence (AOR 0.66–0.78). Depressive symptoms were predicted by witnessing parental violence (AOR 1.51–1.92) and experiencing sexual abuse (AOR 2.30–6.16).
Conclusion
Factors across multiple life dimensions are associated with learning skills and depression in Indian adolescents. Adolescent-focused policies and programs should consider health/nutrition, social, and environmental aspects of life in vulnerable individuals.

Introduction
Strategic investments in adolescent capabilities are highly cost effective and are critical for sustainable global development [1, 2]. Adolescents are one sixth of the world’s population—1.3 billion adolescents in 2019—and India is home to one fifth of the world’s adolescents [3].

Indian adolescents face a poor learning environment. While substantial progress has been made in school enrolment in India, the quality of education has worsened [4] and many adolescents do not complete secondary school [5]. The percentage of standard five students, approximately 11-year-olds, who could read a standard two-level text decreased from 53% in 2006 to 48% in 2014 [6]. Similarly, those who could solve division problems decreased from 43% in 2006 to 26% in 2014.

In addition to poor educational quality, adolescents in India face a high burden of common mental disorders including depression. In 2007, a survey found that 25% of adolescents felt sad/hopeless almost every day for two weeks or more in a row [7] and a 2015–2016 adolescent survey found a mental morbidity prevalence of 7% [8]. Though individual surveys recognize adolescent depression as a problem, better tools are needed to estimate the prevalence of adolescent mental health conditions at the population level for comparison to other low and middle income countries; UNICEF is currently leading an effort to develop such a tool [9]. As adolescents in India are soon to enter the workforce and are often parents themselves due to early childbearing, the consequences of poor mental health during adolescence are far-ranging and intergenerational [10, 11].

A two-fold relationship exists between educational and mental health outcomes in adolescents. Healthy young people learn better and have improved life chances [12], and more-educated young people have better mental health [13]. Building effective adolescent learning and health programs requires an evidence base on the determinants in the targeted context. Examining these determinants, however, is inherently difficult because learning and health are shaped by a complex set of factors at individual, family, social, and environmental levels. Surveys rarely collect information on most aspects of adolescents’ lives and often suffer from small sample size, narrow age inclusion, and omission of factors that may contribute to learning ability and mental health. The Understanding the Lives of Adolescents and Young Adults (UDAYA) survey provides a unique opportunity to fill these evidence gaps and inform adolescent-focused programs and policies [14, 15].

The objectives of the current paper were to 1) describe adolescent learning and mental health in northern India in terms of reading proficiency, math proficiency and depressive symptoms and 2) explore which factors—related to demographics, health/nutrition, social and family life, and living environment—predict these outcomes.

Materials and methods
Data source and study population
Data were from the Population Council’s UDAYA study in 2015–2016 [14, 15]. UDAYA collected data for 20,589 adolescents aged 10–19 years in Uttar Pradesh and Bihar states. These
two states are large, highly populated, predominantly rural, high poverty states in northern India and account for 28% of the adolescent population in the country [14, 15]. We examined unmarried males aged 10–19 years, unmarried females aged 10–19 years, and married females aged 15–19 years. Our primary sample for analyses included 19,726 adolescents (after excluding 4.2% with missing data) and our secondary subsample included 7,627 adolescents with data on hemoglobin and body mass index (S1 Table). The primary data collection was approved by the Institutional Review Board of Population Council.

Outcomes

We examined three outcomes: reading proficiency, math proficiency, and depression. Reading and math proficiency were assessed by the Annual Status of Education Report (ASER) tools [5], validated in India [16] and used in the ASER nationwide survey, repeated annually since 2005, to track progress in basic learning. The reading component assessed four levels of proficiency in the Hindi language: ability to recognize letters, read words, read a short paragraph (standard 1 level text; ages 6–7 years), and read a ‘story’ (standard 2 level text; ages 7–8 years). The math component assessed four levels of proficiency: ability to recognize single-digit numbers (1–9), double-digit numbers (11–99), solve two-digit subtraction problems (e.g., 46–29) and three-digit division problems (e.g., 879/7). Depressive symptoms were screened using the 9-item Patient Health Questionnaire (PHQ-9) [17]. The PHQ-9 has been validated in Indian adolescents and was found to be an effective tool to screen for depression in this setting and age group [18]. The PHQ-9 score ranges between 0 and 27, with higher scores indicating more severe symptoms of depression in the past two weeks. The outcomes in our study were dummy variables for ability to read a story, solve at least two subtraction problems, and a PHQ-9 score of 5 or more indicating any depression per the standard cutoff. All variable definitions are provided in S2 Table.

Predictors

We chose predictors for the regression analysis primarily on the basis of the availability of data in the UDAYA surveys and the broader literature on risk factors for adolescent wellbeing [13]. Broadly, we examined risk factors that covered demographic, household, health and nutrition, social and environmental factors.

Demographic factors included age, religion, caste, household wealth, household head education, and state. A household wealth index was constructed using factor analysis of ownership of assets. The first factor derived from the analysis was used to classify adolescents into wealth quartiles.

Health and nutrition factors included anemia, thinness, dietary diversity, currently pregnant, and ever given birth. Hemoglobin (Hb) was measured in the field from a finger-prick blood sample using a portable Hemocue Hb 201+ instrument. Standard age-, sex-, and pregnancy-specific World Health Organization (WHO) cutoffs were applied to define anemia (S2 Table) [19]. Height was measured to the nearest 0.1 cm using a SECA 213 stadiometer and weight was measured to the nearest 100 grams using a SECA 874 electronic scale. Thinness for adolescents 10–18 years old was computed with the ‘zbmicat’ STATA function, which uses age- and gender-adjusted body mass index (BMI) cutoffs from the Childhood Obesity Working Group of the International Obesity Taskforce (IOTF) [20]. As IOTF cut-offs are applicable only to adolescents ≤18 years old, WHO BMI cut-offs were used for the 19-year-old adolescents [21], with thinness defined as having a BMI Z-score <-2 standard deviations from the reference. A food frequency questionnaire was used to capture dietary habits. We used the number of the following eight food groups consumed at least weekly: eggs, chicken/meat, fish,
pulses/beans, dark green vegetables, other vegetables, fruits, and dairy. Pregnancy and birth indicators were only collected in married females.

Social factors included adolescents’ social networks, family relations, household social environment, experience of sexual abuse, and gender attitudes. Social networks were proxied by the number of friends and time spent with friends (often or not often). A parental support score of whether the adolescent discussed friendship, physical changes, leisure and personal matters with their parents ranged from 0–4. Other family/household indicators included whether the adolescent had similarly-aged family members (within three years of the adolescent’s age), substance (drugs, tobacco or alcohol) use by family members, and ever witnessing their father beating their mother. Sexual abuse was measured by whether the adolescent was ever deliberately touched on their private parts when they did not want to be touched. Gender attitudes were assessed by asking if girls should be allowed to decide when they want to marry, and if persons other than the husband/father should be able to decide how household money is to be spent. Our gender attitude indicator was a positive response for either item [22].

Environmental factors included residence (urban/rural), whether the household had an improved sanitation facility, school attendance (out of school, in government school, in private school), and whether the adolescent engaged in paid or unpaid work outside of school in the last year.

Statistical analysis
Analyses were conducted separately for unmarried males, unmarried females, and married females to understand if associations varied between these three groups. Multivariable logistic regression models were used to examine associations between the predictors and each outcome for each group. The regression models included sample weights and were adjusted for clustered standard errors and state fixed effects to account for intra cluster correlation and state-specific unobservable factors. The models were repeated for the subsample with data on anemia and thinness; from these models, we only present results for anemia and thinness (not all predictors) given similar results for other predictors examined in the primary sample. Analyses were conducted in STATA software version 15.

Results
Sample characteristics

Demographic, health, social, and environmental factors. Adolescents were mostly Hindu, from backward castes (i.e. disadvantaged social groups) and poor households (Table 1). Anemia was higher but thinness was lower in females compared to males. Among married females, 22% were currently pregnant and 44% had given birth. Dietary diversity was suboptimal, with 4.4 of 8 food groups consumed at least weekly. Married females were far less likely to meet and spend time with their friends than unmarried adolescents. Adolescents typically discussed 2 of 4 aspects of their lives with their parents and most had a family member who used substances (mainly tobacco and alcohol). Witnessing parental violence and experiencing sexual abuse were reported more by females than males. Most adolescents expressed gender equal attitudes, though the percentage was slightly lower in males than females. Less than half of the adolescents were from households with improved latrine facilities. Compared to males, more females were out of school, fewer were in private schools, and fewer worked outside of school.

Reading proficiency, math proficiency, depressive symptoms. Basic learning outcomes—reading and math proficiency—were poor. Overall, only 71% of unmarried females, 52% of married females and 72% of unmarried males were able to read a story
| Demographic | Male | Female | Married (n = 4,933) |
|-------------|------|--------|------------------|
|             | Unmarried (n = 5,840) | Unmarried (n = 8,953) |                  |
| Age, years  | 15.0 (2.63) | 15.81 (2.22) | 17.96 (1.09)     |
| Aged 15–19 years | 64.35 | 81.63 | 100              |
| Hindu religion | 82.28 | 72.75 | 83.86            |
| Backward caste | 79.93 | 77.17 | 89.88            |
| Wealth index\(^1\) | 0.37 (0.26) | 0.39 (0.26) | 0.28 (0.21)      |
| Household head education, years | 5.78 (5.39) | 5.47 (5.43) | 3.86 (4.56)      |
| Bihar | 47.84 | 44.43 | 65.66            |

| Health and nutrition | Male | Female | Married (n = 4,933) |
|----------------------|------|--------|------------------|
|                      | Unmarried (n = 5,840) | Unmarried (n = 8,953) |                  |
| Anemic\(^2\) | 27.39 | 58.52 | 66.89            |
| Thinness\(^3\) | 45.99 | 38.93 | 30.74            |
| Currently Pregnant | NA | 0 | 21.55            |
| Ever given birth | NA | 0 | 44.37            |
| Dietary diversity\(^4\) | 4.5 (1.54) | 4.38 (1.66) | 4.32 (1.70)      |

| Social | Male | Female | Married (n = 4,933) |
|--------|------|--------|------------------|
|        | Unmarried (n = 5,840) | Unmarried (n = 8,953) |                  |
| Number of friends | 4.48 (3.84) | 3.61 (2.88) | 3.58 (2.78)      |
| Often spends time with friends | 86% | 71% | 9%                  |
| Parental support\(^5\) | 2.05 (1.03) | 2.31 (0.90) | NA                |
| Number similarly aged family\(^6\) | 1.00 (0.90) | 1.15 (0.93) | 0.96 (1.04)       |
| Family substance use | 70.53 | 70.18 | 76.44            |
| Witnessed parental violence | 17.43 | 23.63 | 29.76            |
| Sexual abuse | 1.56 | 8.16 | 9.22             |
| Gender equal attitude\(^7\) | 81.83 | 91.11 | 90.78            |

| Environmental | Male | Female | Married (n = 4,933) |
|---------------|------|--------|------------------|
|                | Unmarried (n = 5,840) | Unmarried (n = 8,953) |                  |
| Lives in urban setting | 47.28 | 47.98 | 37.04            |
| Improved latrine facility at home | 42.72 | 46.02 | 25.93            |
| Out of school | 20.91 | 31.41 | 89.3             |
| In government school | 43.42 | 44.50 | 8.60             |
| In private school | 35.67 | 24.09 | 2.11             |
| Work out of school in last year\(^8\) | 60.99 | 38.49 | 27.16            |

Values are means (SD) or percentages; for each row, groups with different letters are significantly different (p<0.05) using ANOVA test.
\(^1\)Normalized score (0–1) using factor analysis of wealth index (electricity, fan, television, sewing machine, computer, fridge, clock, bicycle, motorbike, car, water pump, tractor, land ownership, cooking fuel type, house material).
\(^2\)Anemia available for subsample (n = 3,140 unmarried males, 2,585 unmarried females, 1,902 married females); defined per WHO age- and sex-specific cutoffs (World Health Organization, 2011).
\(^3\)Thinness available for subsample (n = 3,140 unmarried males, 2,585 unmarried females, 1,902 married females); defined using International Obesity Task Force cutoffs for those aged 10–18 years (Cole et al. 2012) and WHO criteria for those aged 19 years (World Health Organization, 2007).
\(^4\)Number of food groups consumed at least once per week (out of 8 total).
\(^5\)Normalized score (0–1) using factor analysis of multiple topics of discussion with parents (school performance, friendship, physical changes, leisure, personal matters).
\(^6\)Similar aged family members defined as ±3 years.
\(^7\)Dummy variable for ‘yes’ response to either 1) girls should be allowed to decide when they want to marry or 2) persons other than husband/father should be able to make household spending decisions.
\(^8\)Either paid or unpaid work.
NA, not applicable.

https://doi.org/10.1371/journal.pone.0240843.t001
Even by 19 years of age, 15–20% of unmarried adolescents and 44% of married female adolescents could not read a story (Fig 1A and S3 Table). Math proficiency was higher for males than unmarried or married females at all ages from 10 to 19 years (Fig 1B). Depressive symptoms were more common in older compared to younger adolescents and in females compared to males (Fig 1C). One in four married females reported at least mild depressive symptoms. Only 6% of females and 1% of males had moderate to severe depression, thus our outcome predominantly represents mild cases. The mean (SD) PHQ-9 scores were 1.1 (2.2) for unmarried males, 2.0 (3.6) for unmarried females, and 2.9 (4.3) for married females.

Factors associated with learning ability and mental health

Increasing age, being from a relatively wealthy household, and higher education of the household head were associated with higher reading and math proficiency (Figs 2 and 3; adjusted odds ratios and 95% confidence intervals shown in figures). Increasing age was also predictive of depression (Fig 4; S4 Table). In unmarried females, Hindu religion and backward caste predicted poorer reading proficiency.

Thinness was associated with poorer math proficiency among males and consuming more food groups was associated with better math proficiency among unmarried females (Fig 3). In married females, being pregnant was associated with increased odds of depression (S4 Table). Anemia was unrelated to the outcomes after adjustment for other factors.

Friendships—in terms of number of friends or time spent with friends—were generally not associated with the studied outcomes. A higher parental support score and having a gender equal attitude, however, were both strongly predictive of better reading and math proficiency (Figs 2 and 3). In contrast, use of drugs, tobacco, or alcohol by family members and witnessing parental violence were both predictive of poorer reading and math scores. Family substance use, witnessing parental violence, and experiencing sexual abuse were all associated with higher odds of depression (Fig 4).

Living in an urban environment was associated with higher math proficiency among adolescents but showed no association with other outcomes. Having an improved latrine facility at home was associated with higher reading and math in unmarried females but not in males. The strongest predictor of reading and math proficiency among all factors considered was being in school, with those in private school having higher scores than those in government school. Engaging in labor outside of school in the previous year was predictive of poorer
We examined factors across multiple dimensions associated with basic learning outcomes and depressive symptoms among Indian adolescents. We found that better performance on math and reading tests was predicted by being from an advantaged caste, from a relatively wealthy home with a more educated household head and an improved latrine, in school (especially private school), having open communication with parents, and having gender equal attitudes. Depressive symptoms were higher among those who had witnessed parental violence and experienced sexual abuse.

Being from a backward caste predicted lower reading ability in females but not in males. Son preference is a well-described issue in India, especially among socially disadvantaged groups [23]; males in backward castes may be given preference to attend school, and thus the caste-reading association only exists for females. Though demographic factors are non-modifiable and generally treated as confounders, understanding how they relate to outcomes is important for future program targeting. Our findings suggest that low-caste females from poor households with poorly-educated parents should be a target group for programs to improve reading in married females only (S4 Table). Environmental factors were not predictive of depressive symptoms.

**Discussion**

We examined factors across multiple dimensions associated with basic learning outcomes and depressive symptoms among Indian adolescents. We found that better performance on math and reading tests was predicted by being from an advantaged caste, from a relatively wealthy home with a more educated household head and an improved latrine, in school (especially private school), having open communication with parents, and having gender equal attitudes. Depressive symptoms were higher among those who had witnessed parental violence and experienced sexual abuse.

Being from a backward caste predicted lower reading ability in females but not in males. Son preference is a well-described issue in India, especially among socially disadvantaged groups [23]; males in backward castes may be given preference to attend school, and thus the caste-reading association only exists for females. Though demographic factors are non-modifiable and generally treated as confounders, understanding how they relate to outcomes is important for future program targeting. Our findings suggest that low-caste females from poor households with poorly-educated parents should be a target group for programs to improve
reading proficiency. In contrast, demographic factors were largely unrelated to depression, suggesting that mental wellbeing issues cut across the spectrum of social privilege.

The generally weak associations do not imply that health and nutrition is unimportant in terms of academic performance or mental health but rather that, when taking a holistic view of adolescents’ lives in this high poverty context, other factors appear to be more important. A limitation in our case were relatively crude measures of health and nutrition available in the data. Previous work has shown associations between academic or cognitive outcomes and more specific measures such as diet quality measured through a food frequency questionnaire or 24-hour recall [24], biomarkers of micronutrient status or aerobic fitness [25].

We found that an interactive relationship between the adolescent and her/his parents was predictive of reading and math proficiency but not depression. Often spending time with friends was predictive of lower likelihood of depression in males, possibly a coping strategy. Other work has highlighted the importance of social support for adolescent wellbeing. In an analysis of Global School-Based Health Surveys from India, Sri Lanka, Pakistan, and Myanmar, depressive symptoms were less likely in those with close friendships and involved parents [26].

Gender-equal views were positively associated with learning outcomes. In Bihar, learning outcomes were better in adolescents whose teachers had gender equal attitudes [27], thus a learning environment where teachers and students believe in equal treatment of boys and girls...
is related to better learning outcomes. However, we found that gender equal attitudes predicted a two-fold higher risk of depression in married females. After marriage, women in rural India typically move into the home of their spouse’s family where, if they retaliate against traditional gender roles, they could face social challenges. This finding could reflect a frustration with traditional gender roles among young women with more egalitarian views.

Substance abuse by family members, ever witnessing parental violence, and ever experiencing sexual abuse were related to poorer outcomes, especially depression. In Maharashtra, harsh parental behavior, disturbed family relationships, and substance abuse were predictive of poor adolescent mental health [28]. A systematic review and meta-analysis from 21 countries found that girls who experienced sexual violence had a three-fold increased risk of school absenteeism and children who witnessed parental violence scored lower on standardized tests [29]. These findings are also in line with a recent study of adolescents in northern India which found that childhood maltreatment was related to poor mental health in adolescence [30].

The strongest predictor of math and reading ability was attending school, with an added advantage of private over government school. The UDAYA survey is unique among most adolescent surveys in that it sampled households rather than schools, thus capturing out-of-school adolescents. Older adolescents drop out of school in this context for various reasons including early marriage, to help with household chores or to work, inability to pay tuition fees, a lack of secondary schools, or living too far away from the school [31]. Having an improved latrine facility predicted higher reading and math ability in females but not in males. An improved
A latrine could benefit females through greater privacy, lower risk of uro-genital tract infections, and protection from assaults by men [32]. Soil-transmitted helminth infection has been associated with cognitive and educational deficits in school-aged children [33].

As primary school enrolment is now nearly universal in India, improving educational quality, providing adolescents with supportive home and social environments, and promoting secondary school completion are important next steps in achieving better learning outcomes. ASER surveys show declining school performance in India over time [4], which could be for several reasons. As enrolment increases, teacher resources are strained. Additionally, the last to enroll are the most marginalized groups whose performance is likely the worst. Investments into teacher training and school infrastructure have not been adequate to accommodate the increase in enrolment in the last two decades, with most financial resources in the country being used for enhancing higher education (universities) rather than basic K-12 education [34]. The convergence of educational and health policies is critical for achieving adolescent wellbeing [13]. Expansion of secondary education provides a range of indirect health benefits for young people as a social determinant of health and as a platform to deliver health goods and interventions. In many countries, health-education interfaces such as nutrition programs through schools are withdrawn just as children reach puberty, a growth period with increased nutritional needs. Policy interventions that factor in social norms and target multiple drivers of change have been effective in improving educational quality and student performance in developing countries [35]. In India, examples include out-of-school literacy programs [36], teacher feedback [37], teacher pay incentives [38], and remedial and computer-assisted learning [39].

Our study is not without limitations. The multivariable models adjusted for 24 different factors across multiple dimensions of life in a state-representative sample of male and female adolescents of all ages, in and out of school, unmarried and married. Though this approach reduces potential confounding, with cross-sectional data we are not able to identify causal associations or account for previous life experiences that may have affected the studied outcomes. Second, as mentioned, dietary and nutritional data were limited. Third, we were unable to examine predictors of learning outcomes and mental health in married males given that this group was not included in the UDAYA survey.

In conclusion, our findings highlight the importance of addressing the social determinants of mental health in adolescents [40]. While a program designed to keep adolescents in school may benefit academic performance, it may not be sufficient to prevent or address depression. From a curative perspective, a major barrier that needs to be overcome in India is inadequate access to mental health resources. The 2015–16 National Mental Health Survey of India revealed a treatment gap of 85% for common mental disorders among adults [8]. For adolescents, a similar situation of poor access to services is illustrated by a survey of Bangladeshi adolescents; among those with depression, 80% sought no help [41]. India will not be able to meet its development goals without building the education, skills, productivity, and health of its youth population. Our findings imply that building adolescent capabilities and mental health in this context requires a holistic approach targeting health, social, and environmental factors in the most vulnerable individuals.

**Supporting information**

S1 Table. Sample selection steps.

S2 Table. Variable definitions.
S3 Table. Prevalence of reading proficiency, math proficiency, and depressive symptoms by age for unmarried female, married female, and unmarried male Indian adolescents.

(DOCX)

S4 Table. Factors associated with reading proficiency, math proficiency, and depressive symptoms in adolescent Indians—married females 15–19 years.

(DOCX)

S1 Dataset.

(DTA)

S2 Dataset.

(DTA)

Acknowledgments

We thank Harold Alderman for his comments on a draft of the manuscript. We also thank the adolescents who volunteered their time to participate in the survey and answer sensitive questions about their lives as well as the UDAYA field investigators who collected these data.

Author Contributions

Conceptualization: Samuel Scott, Anjali Pant, Phuong Hong Nguyen.

Data curation: Anjali Pant, Phuong Hong Nguyen.

Formal analysis: Anjali Pant, Phuong Hong Nguyen.

Funding acquisition: Purnima Menon.

Investigation: Sachin Shinde.

Methodology: Samuel Scott, Anjali Pant, Phuong Hong Nguyen, Sachin Shinde.

Software: Anjali Pant, Phuong Hong Nguyen.

Supervision: Phuong Hong Nguyen, Purnima Menon.

Visualization: Samuel Scott.

Writing – original draft: Samuel Scott, Phuong Hong Nguyen, Sachin Shinde.

Writing – review & editing: Anjali Pant, Phuong Hong Nguyen, Sachin Shinde, Purnima Menon.

References

1. Dahl RE, Allen NB, Wilbrecht L, Suleiman AB. Importance of investing in adolescence from a developmental science perspective. Nature [Internet]. 2018 Feb 22 [cited 2019 May 28]; 554(7693):441–50. Available from: http://www.nature.com/articles/nature25770 PMID: 29469094

2. Sheehan P, Sweeny K, Rasmussen B, Wils A, Friedman HS, Mahon J, et al. Building the foundations for sustainable development: a case for global investment in the capabilities of adolescents. Lancet. 2017 Apr 19; 390:1792–806. https://doi.org/10.1016/S0140-6736(17)30872-3 PMID: 28433259

3. United Nations. World Population Prospects: The 2017 Revision, DVD Edition. 2017.

4. Chatterjee I, Li I, Robitaille MC. An overview of India’s primary school education policies and outcomes 2005–2011. World Dev [Internet]. 2018; 106:99–110. Available from: https://doi.org/10.1016/j.worlddev.2018.01.016

5. ASER Centre. Annual Status of Education Report (Rural) 2016, Provisional. [Internet]. New Delhi; 2017. http://www.asercentre.org/p/289.html

6. ASER Centre. Trends over Time 2006–2014 (A Supplement to ASER 2014). New Delhi; 2015.
7. WHO. Mental health status of adolescents in South-East Asia: evidence for action [Internet]. 2017. http://www.who.int/iris/handle/10665/254982
8. Gururaj G, Varghese M, Benegal V, Rao G, Pathak K, Singh L, et al. National Mental Health Survey of India, 2015–16: Prevalence, Patterns and Outcomes. Bengaluru; 2016.
9. Carvajal-Aguirre L, Ahs J, Requejo JH. Measurement of mental health among adolescents at the population level mmap [Internet]. 2019. https://www.morressier.com/article/05–road-map-measurement-mental-health-among-adolescents-population-level/5d1a03835755b8317a140c83
10. Nguyen P, Friedman J, Kak M, Menon P, Alderman H. Maternal depressive symptoms are negatively associated with child growth and development: Evidence from rural India. Matern Child Nutr. 2018; 14 (4):1–9.
11. Moustari V, Daly M, Delaney L, Tynellius P, Rasmussen F. Adolescent mental health and unemployment over the lifespan: Population evidence from Sweden. Soc Sci Med [Internet]. 2019 Feb 1 [cited 2019 Aug 7]; 222:305–14. Available from: https://www.sciencedirect.com/science/article/abs/pii/S0277953618307135 PMID: 30677644
12. Hale DR, Viner RM. How adolescent health influences education and employment: investigating longitudinal associations and mechanisms. J Epidemiol Community Health [Internet]. 2018 Jun 1 [cited 2019 Oct 5]; 72(6):465–70. Available from: http://www.ncbi.nlm.nih.gov/pubmed/29615474 https://doi.org/10.1136/jech-2017-209605
13. Patton GC, Sawyer SM, Santelli JS, Ross DA, Affifi R, Allen NB, et al. Our future: a Lancet commission on adolescent health and wellbeing. Vol. 387. Lancet (London, England). 2016. p. 2423–78.
14. Santhya K, Acharya R, Pandey N, Singh S, Rampal S, Zavier A, et al. Understanding the lives of adolescents and young adults (UDAYA) in Bihar, India. New Delhi; 2017.
15. Santhya K, Acharya R, Pandey N, Gupta A, Rampal S, Singh S, et al. Understanding the lives of adolescents and young adults (UDAYA) in Uttar Pradesh, India. New Delhi; 2017.
16. Vagh S. Validating the ASER testing tools. Comparisons with reading fluency measures and the Read India measures. [Internet]. New Delhi; 2010. http://img.asercentre.org/docs/Asersurvey/Toolsvalidating_the ASER_testing_tools__oct_2012__2.pdf
17. Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. J Gen Intern Med [Internet]. 2001 Sep [cited 2019 Apr 29]; 16(9):606–13. Available from: http://www.ncbi.nlm.nih.gov/pubmed/1156941 https://doi.org/10.1046/j.1525-1497.2001.01600960.x
18. Ganguly S, D M, Samanta M, D M, Roy P, D M, et al. Patient Health Questionnaire-9 as an Effective Tool for Screening of Depression Among Indian Adolescents. J Adolesc Heal. 2013; 52(5):546–51.
19. World Health Organization. Haemoglobin concentrations for the diagnosis of anaemia and assessment of severity. 2011.
20. Cole TJ, Lobstein T. Extended international (IOTF) body mass index cut-offs for thinness, overweight and obesity. Pediatr Obes [Internet]. 2012 Aug [cited 2019 Apr 30]; 7(4):284–94. Available from: http://www.ncbi.nlm.nih.gov/pubmed/22715120 https://doi.org/10.1111/j.2047-6310.2012.00064.x
21. World Health Organization. Obesity: preventing and managing the global epidemic. Geneva; 1998.
22. Beatteie TS, Prakash R, Mazzuca A, Kelly L, Javlakar P, Raghavendra T, et al. Prevalence and correlates of psychological distress among 13–14 year old adolescent girls in North Karnataka, South India: a cross-sectional study. BMC Public Health. 2019; 19(1):1–12.
23. Pande RP, Astone NM. Explaining son preference in rural India: the independent role of structural versus individual factors. Popul Res Policy Rev [Internet]. 2007 Apr [cited 2019 Oct 15]; 26(1):1–29. Available from: http://link.springer.com/10.1007/s11113-006-9017-2
24. Correa-Burrows P, Burrows R, Blanco E, Reyes M, Gaahagan S. Nutritional quality of diet and academic performance in Chilean students. Bull World Health Organ [Internet]. 2016 Mar 1 [cited 2019 Oct 3]; 94 (3):185–92. Available from: http://www.ncbi.nlm.nih.gov/pubmed/26966329 https://doi.org/10.2471/BLT.15.161315
25. Scott SP, De Souza MJ, Koehler K, Murray-Kolb LE. Combined iron deficiency and low aerobic fitness doubly burden academic performance among women attending university. J Nutr. 2017 Jan; 147 (1):104–9. https://doi.org/10.3945/jn.116.240192 PMID: 27881596
26. Murshid NS. Parents, friends, and depression: A multi-country study of adolescents in South Asia. Child Youth Serv Rev. 2017; 79(February):166–5.
27. Santhya KG, Zavier AJF, Jejeebhoy SJ. School quality and its association with agency and academic achievements in girls and boys in secondary schools: Evidence from Bihar, India. Int J Educ Dev [Internet]. 2015; 41:35–46. Available from: http://dx.doi.org/10.1016/j.ijedudev.2014.12.002
28. Shalik B, Doke P, Gothankar J. Prevalence of depression among rural adolescents and its correlates in India. Indian J Public Health. 2018; 62:311–4.
29. Fry D, Fang X, Elliott S, Casey T, Zheng X, Li J, et al. The relationships between violence in childhood and educational outcomes: A global systematic review and meta-analysis. Child Abuse Negl [Internet]. 2018 Jan 1 [cited 2019 May 28]; 75:6–28. Available from: https://www.sciencedirect.com/science/article/abs/pii/S0145213417302491 PMID: 28711191

30. Pandey R, Gupta S, Upadhyay A, Gupta RP, Shukla M, Mishra RC, et al. Childhood maltreatment and its mental health consequences among Indian adolescents with a history of child work. Aust N Z J Psychiatry [Internet]. 2020 May 1 [cited 2020 Jul 8]; 54(5):496–508. Available from: http://journals.sagepub.com/doi/10.1177/0004867420909524 PMID: 32156147

31. ASER Centre. Annual Status of Education Report (Rural) 2017. New Delhi; 2018.

32. Sahoo KC, Hulland KRS, Caruso BA, Swain R, Freeman MC, Panigrahi P, et al. Sanitation-related psychosocial stress: A grounded theory study of women across the life-course in Odisha, India. Soc Sci Med [Internet]. 2015 Aug 1 [cited 2019 Apr 28]; 139:80–9. Available from: https://www.sciencedirect.com/science/article/pii/S0277953615300010 PMID: 26164119

33. Pabalan N, Singian E, Tabangay L, Jarjanazi H, Boivin MJ, Ezeamama AE. Soil-transmitted helminth infection, loss of education and cognitive impairment in school-aged children: A systematic review and meta-analysis. Budke CM, editor. PLoS Negl Trop Dis [Internet]. 2018 Jan 12 [cited 2020 Jul 8]; 12(1): e0005523. Available from: https://dx.plos.org/10.1371/journal.pntd.0005523 PMID: 29329288

34. Jha V, Oomen A, Swarup A, Parasnis P, Shah V. India development review: The education edition [Internet]. 2017. https://idronline.org/user-content/uploads/2019/06/IDR-Special-Edition-Education.pdf

35. Masino S, Niño-Zarazúa M. What works to improve the quality of student learning in developing countries? Int J Educ Dev. 2016; 48:53–65.

36. He F, Linden L, McLead M. How to Teach English in India: Testing the Relative Productivity of Instruction Methods within the Pratham English Language Education Program [Internet]. 2008 [cited 2019 May 27]. https://www.povertyactionlab.org/evaluation/how-teach-english-india-testing-relative-productivity-instruction-methods-within-pratham

37. Muralidharan K, Sundararaman V. The Impact of Diagnostic Feedback to Teachers on Student Learning: Experimental Evidence from India. Econ J [Internet]. 2010 Aug 1 [cited 2019 May 27]; 120(546): F187–203. Available from: https://academic.oup.com/ej/article/120/546/F187/5089693

38. Duflo E, Hanna R, Ryan SP. Incentives Work: Getting Teachers to Come to School †. Am Econ Rev [Internet]. 2012 [cited 2019 May 27]; 102(4):1241–78. Available from: http://dx.doi.org/10.1257/aer.102.4.1241

39. Banerjee A V., Cole S, Duflo E, Linden L. Remediing Education: Evidence from Two Randomized Experiments in India. Q J Econ [Internet]. 2007 Aug 1 [cited 2019 May 27]; 122(3):1235–64. Available from: https://academic.oup.com/qje/article-lookup/doi/10.1162/qjec.122.3.1235

40. Roy K, Shinde S, Sarkar B, Malik K, Parikh R, Patel V. Adolescent mental health policy review for India. Soc Psychiatry Psychiatr Epidemiol. 2019.

41. Nasreen HE, Alam MA, Edhborg M. Prevalence and Associated Factors of Depressive Symptoms Among Disadvantaged Adolescents: Results from a Population-Based Study in Bangladesh. J Child Adolesc Psychiatr Nurs. 2016; 29(3):135–44. https://doi.org/10.1111/jcap.12150 PMID: 27553260