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The Impact of Cleft Lip and Palate Repair Surgery on Cognitive and Academic Outcomes for Teens in India

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Abstract: India has a backlog of nearly one million patients in need of cleft lip and palate repair. Unrepaired cleft results in social stigma and diminished health, psychological wellbeing, and academic functioning. Cleft repair surgery has the potential to restore functioning in these domains. However, the magnitude of the social, educational, and economic impact of cleft repair surgery has not been evaluated using statistically rigorous methods. An estimation of the academic and educational impact of cleft repair has implications for the appropriate allocation of public health resources. We analyze original data gathered from teenagers in West Bengal, India using the difference-in-differences estimation method. We compare the life outcomes of teens who had cleft repair surgery to their nearest age (non-cleft) siblings and in turn compare this difference to the difference between teens who did not have access to the surgery at a young age and the life outcomes of their own siblings. Contrary to the outcome predicted by the cleft literature, our study's main finding is that cleft teens in our sample do not perform significantly worse than their (non-cleft) siblings on cognitive, math, and reading ability measures. However, the poor quality of public education in rural India makes it difficult to distinguish the treatment effect on academic ability. Furthermore, this study is underpowered. A larger sample size and additional studies across regions throughout India would be needed to yield more definitive and meaningful results.

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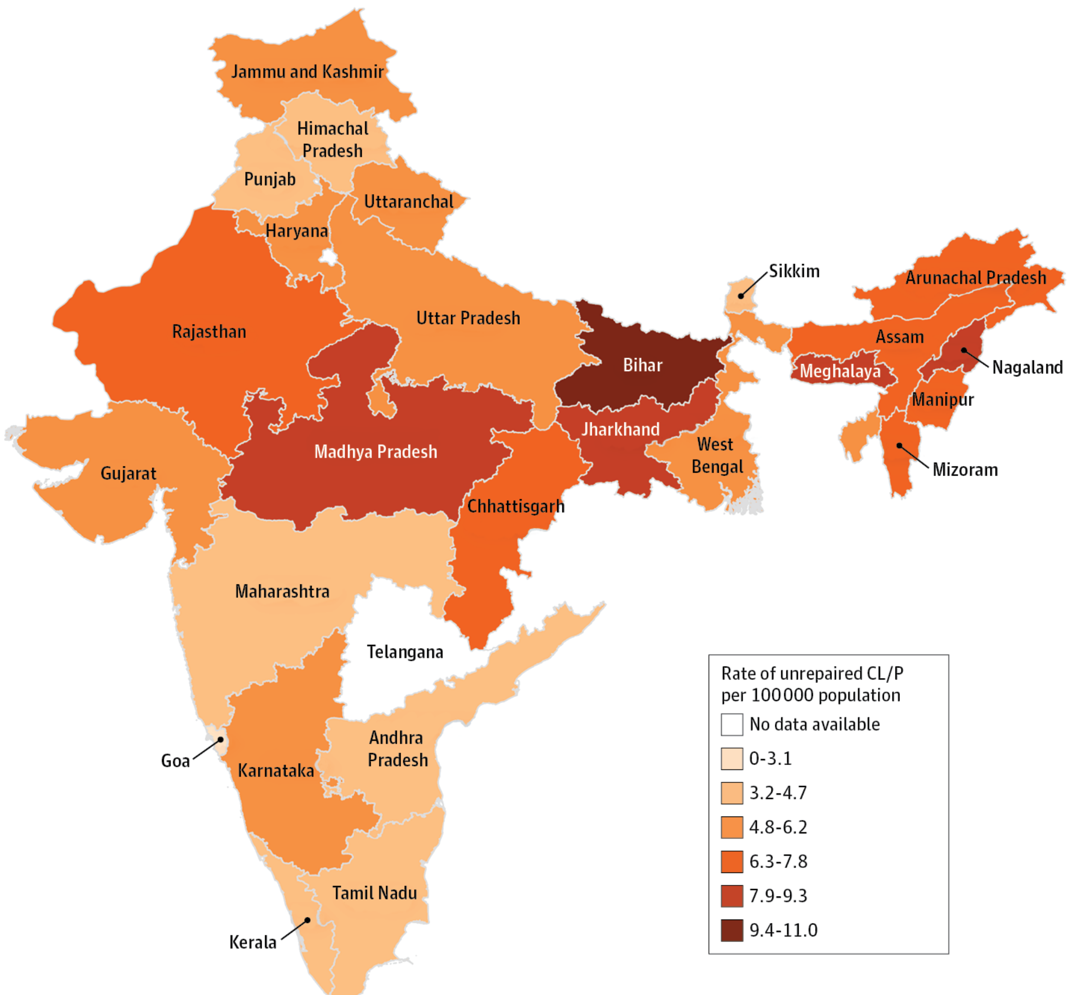
1. Introduction

Understanding and measuring the effects of health interventions on key economic outcomes and quality of life indicators has been the subject of a broad literature. The economics literature recognizes that both attractiveness and a wide range of physical health problems impact human capital accumulation (Grossman and Kaestner, 1997; Gordon et al., 2013). Although cleft lip or palate is a physical condition, it impacts functioning across many domains including social, economic, and psychological. Amartya Sen's capability approach focuses on measuring well-being in terms of a person's capability to achieve, accomplish, be, or do. In his capability approach, Sen expanded the theoretical framework of economic outcomes beyond a narrow focus on wealth and income to include capability and functioning across any number of domains, including health, education, psychology, and social engagement (Sen, 1990). Thus, a diverse set of outcomes must be considered to measure the full impact of a disability such as cleft, which differentially impacts each person's quality of life and ability to realize their full potential.

Following Amartya Sen's theory as applied to disability by Mitra (2006), we hypothesize that cleft repair resolves the stigmatizing impact of social and cultural environmental barriers to regularly attend school and maintain social relationships outside of the home. A household survey in India found that about one in five children reported being "beaten or pinched" in school--just in the previous month (Desai et al. 2009). We hypothesize that as a result of decreased discrimination, bullying, ridicule, and differential treatment, treated cleft children experience fewer feelings of shame and social isolation and improved psychological well-being. Parental attachment, family interactions, and community acceptance may improve (Mednick et al., 2013). School attendance, concentration span, and learning capacity may increase. Following the logic of Sen's capability approach, the cumulative long-term impact of these changes is hypothesized to drive improvements in academic functioning and a wide range of psychosocial outcomes as well as increased employment, lifetime earnings, and an increased capability set allowing the child the freedom to choose from and pursue a wider range of potential achievements (See Figure 1).

Being born with a cleft lip and/or palate (CLP) often results in abnormal facial appearance, difficulty feeding, dental complications, speech disorders, and ear and respiratory tract infections. Clefts have also been associated with social stigma, diminished psychological well-being, and reduced cognitive and academic functioning (Bordoloi, Kumar, Saikia 2016, Nopoulos et al., 2002). Estimates of the backlog of patients in India with unrepaired cleft lip or palate vary. It was estimated to be as high as one million by Singh (2009) and as low as 72,000 by Stewart et al. (2016). Of an estimated 24.5 million births per year in India, the incidence of cleft lip and palate is between 27,000 and 33,000 clefts per year (Singh, 2009; Mossey, 2009). Globally, 2.1-4.7 million Disability Adjusted Life Years (DALYs) were averted through cleft repair operations at a total estimated cost of US$196 M. However, many cases of orofacial cleft in rural areas of India go unrepaired (Khajanchi, 2015; Sumeet, 2012). The estimated rate of unrepaired cleft in West Bengal is 4.8-6.2 per 100,000 people in the population (Stewart et al., 2016).



Stewart et al. (2016) Journal of the American Medical Association

To date, much of the literature on the impacts of cleft surgery has focused on medical outcomes (Dorf and Curtin, 1982; Sharma et al., 2012). However, cleft repair surgery also has the potential to restore psychological wellbeing, academic ability, educational attainment, and socioeconomic outcomes.

This study undertakes the question: What is the impact of cleft lip and palate surgery on cognitive and academic outcomes of teenagers born with orofacial clefts in India?

The impact of cleft repair surgery within the medical model is clear. It restores the normal appearance of facial features, and decreases challenges associated with speech development, poor nutrition, ear disease, and dental problems (Mednick et al., 2013). However, the impact of cleft and cleft repair in the context of social, psychological, academic and cognitive functioning has not been thoroughly researched. Although some studies, cited below, have explored the correlation between cleft and a range of outcomes, none have credibly isolated and estimated the causal impact of reparative surgery on outcomes owing to an abundance of selection bias issues making it challenging to construct a valid counterfactual for individual cleft patients. This study makes a unique contribution by estimating a counterfactual using quasi-experimental methods, described in more detail in the Empirical Strategy section.

2. Literature Review

The Correlation Between Cleft Incidence and Cognitive and Academic Outcomes

A large and growing body of empirical research, detailed below, finds a negative correlation between cleft, intellectual ability, and academic outcomes. Studies also find attractiveness has a significant impact on academic outcomes in youth. However, little or no research has attempted to measure the restorative impact of cleft repair on academic and cognitive functioning.

The research literature emphasizes that cleft negatively impacts language development and early intervention is critical to maximizing the restorative potential of cleft repair. Researchers are working to identify the developmental stages most impacted by cleft. Neiman et al. find that 5-month-old infants with cleft exhibit ‘at-risk/delayed’ development in the motor, self-help, and cognitive domains. And toddlers with cleft palate show ‘at-risk/delayed’ development in the expressive language domain (Neiman et al., 1997). Another study of infants age 3, 12, and 24 months finds infants with cleft show deficits in the cognitive and verbal domain (Speltz et al., 2000). Hentges et al. (2011) found children who underwent surgical repair at three months had significantly poorer cognitive development than children who underwent neonatal repair. Another study found little or no difference in language ability between cleft and control children at age 5 and 7 years (Brent et al., 2010). However, questions remain about the research methods and sample selection process employed by that study.

Multiple studies find a negative correlation between cleft and IQ scores. A Norwegian study used national administrative data, linking birth registry records with records of intelligence scores at the time of military inscription, which is compulsory. They found that intellectual performance was lower in those with cleft palate (Eide et al., 2006). A study in the United States found adults with oral clefts have significantly lower full-scale Intelligence Quotient (IQ) scores than controls. After controlling for IQ, cleft adults showed specific deficits in verbal fluency. Nopoulos et al. found, "adult males with oral clefts manifest a specific pattern of cognitive deficits. As the development of the face is highly interdependent with the development of the brain, it is theorized that the etiology of these cognitive deficits is a primary problem with abnormal brain development." They further found adults with repaired cleft have mean IQ 96.96 (S.D. = 13.2) and adults in the control group sample have mean IQ 109.5 (S.D. = 9.27, N = 40) (Nopoulos et al., 2002). Thus, the effect of having cleft on IQ scores is -1.35 standard deviations in magnitude in comparison to the scores of controls.

Recent research identifying pathways that mediate cleft and cognitive development shows that more responsive early mother-infant interactions with infants who have already had cleft repair are associated with better child cognitive functioning (Hentges et al., 2011; Murray et al., 2008). Earlier research had hypothesized a link between hearing problems and cognitive development but failed to reach a consensus (Richmen & Millard 1997; Jocelyn et al., 1996).

Some estimated 30-40% of children with cleft have reading disabilities compared to 10-15% in the non-cleft population. due to short-term verbal memory deficits in children with cleft. Reading disabilities in children with cleft have been related to verbal expressive problems, lower verbal intelligence, and language disorders (Richman, 1980; Richman and Eliason, 1984; Richman et. al, 1988; ibid 2005; Broder et al., 1998; Kapp-Simon, 1986). Strong agreement exists among researchers that reading ability is particularly affected by cleft. However, the relationship between cleft and math ability has been less well studied and less of a consensus has emerged (Hentges et al., 2011).

Swedish studies found children with cleft lip and or palate had a greater likelihood of not graduating from the compulsory education system at age 16, reduced odds of receiving high grades, and lower GPA compared to a control group (Persson et al., 2008; ibid 2012).

The relationship between attractiveness and facial symmetry is mediated by a link between judgements of apparent health and facial symmetry (Jones, 2001). Causal attributions of cleft lip and palate vary across cultures (Mednick et al., 2013). For example, some individuals in India who practice Hinduism believe that a cleft lip or palate is the result of sins from a past life (Weatherly-White et al., 2005). Thus, the social and cultural environment of children with cleft determines whether disability and deformity are culturally tolerated, whether they experience discrimination or differential treatment, whether they are allowed to attend school, and whether they experience a safe and supportive environment in the classroom.

Research suggests confidence and perceived competence are the primary channels through which physical attractiveness impacts academic and labor market outcomes. Jackson, Hunter and Hodge (1995) find that attractiveness is related to perceived competence and actual competence in children but but only related to perceived competence in adults. Mobius and Rosenblat (2006) find a significant attractiveness premium in the labor market and identify three primary transmission channels: *"(a) physically attractive workers are more confident and higher confidence increases wages; (b) for a given level of confidence, physically attractive workers are (wrongly) considered more able by employers; (c) controlling for worker confidence, physically attractive workers have oral skills (such as communication and social skills) that raise their wages when they interact with employers."*

Hernandez-Julian and Peters (2017) find discrimination is responsible for returns to appearance in academic outcomes in the United States. They find no evidence that appearance is correlated with otherwise unobserved productivity. Attractive students earn lower grades in online courses, where appearance has no impact on grading, than those in traditional courses, where professors may discriminate based on appearance.

Bauldry et al. (2016) find that attractiveness is a more important psychosocial resource for educational attainment for children from poor families than for children from affluent families (resource substitution). They further find that in general, children from disadvantaged backgrounds are less likely to be perceived as attractive than children from advantaged backgrounds (amplification).

It should be noted that all of the studies, cited above, present correlational evidence suggesting a link between attractiveness or cleft, and cognitive or academic outcomes. However, none of those studies credibly estimate the isolated, causal impact of cleft or cleft repair on outcomes.

A capability-approach-based view of cleft disability points to the importance of considering a wide range of outcomes when undertaking a thorough impact evaluation of surgical cleft repair. The evidence presented here of the impact of cleft, disability, and attractiveness on cognitive and academic outcomes drove development and selection of the assessments used to measure academic and cognitive functioning in this impact evaluation study.

3. Empirical Strategy

A difference-in-differences estimation method is used to identify the causal impact of the surgical cleft repair intervention by comparing the life outcomes of teens that received the treatment to their nearest age (non-cleft) siblings. And in turn comparing this difference to the difference between teens with cleft who did not have access to the surgery at a young age and their own (non-cleft) siblings. The difference-in-differences method compares changes or differences in an untreated comparison group to changes or differences in a treatment group to construct a counterfactual estimate of how outcomes would have evolved in the absence of treatment. Thus, our identifying assumption is that in the absence of cleft surgery for treated cleft teens, the difference in outcomes between treated cleft teens and their siblings would be the same as the difference between untreated cleft teens and their sibs. Thus, we assume the differences between cleft patients and siblings in the control group provide a good counterfactual for differences between cleft patients and siblings that would have been observed for the treated group in the absence of treatment. With difference-in-differences it is permissible if other (observed or unobserved) factors lead to changes in outcomes, so long as they similarly affect both the treated and the untreated groups.

The use of fixed effects eliminates unobservable family characteristics (socioeconomic status, parental education, income, etc.), and geographically determined economic, institutional, and social characteristics; such as the quality of local schools, local economic variables, the efficacy of local social support networks, and the local level of social stigmatization of cleft. All of these family and geographically determined effects could be correlated with academic outcomes.

In which case, OLS analysis that pools across families would yield biased estimators of the impact of treatment. Fixed effect estimation (differencing across sibling pairs before applying OLS regression) is the preferred solution (Wooldridge, 2016). As shown by Stock and Watson (2008) cluster correlation is generally unimportant with large cluster sizes, but with small cluster sizes the use of cluster-robust standard errors is advised. Thus, we cluster standard errors at the family level.

Estimates of impact are derived from regression models rather than the differencing of simple group means of outcomes. Using OLS regression modeling allows the estimates to be adjusted for other factors (e.g. birth order, gender, age) that may differ between the treatment and control groups. Regression models also offer a way to estimate the statistical significance of the association between each additional cleft surgery and outcomes, by including a variable that indicates the number of surgeries required and the number of surgeries received for each cleft patient in the sample (Dimick & Ryan, 2014).

We exploit plausibly exogenous variation in the timing and location of outreach campaigns conducted by Operation Smile promoting free cleft repair surgery. We suggest individuals in our treatment group, teenage patients who received cleft surgery in West Bengal from 2004-2015, may be similar to those who never received surgery due to the timing and location of screening camps, the primary recruitment tool used by Operation Smile to identify patients in need of cleft repair.

Still, households whose children received the surgery at a younger age during earlier waves of Operation Smile outreach, might differ systematically from those who did not. This would raise concerns about endogeneity in any simple comparison of treated and untreated patient groups. To address this concern, we employ family level fixed effects to control for unobserved factors at the household level that impact the treatment of cleft including socioeconomic status, social capital, income, parental education, literacy, health knowledge, etc. However, it is possible these unobserved factors are correlated with treatment. For example, if parents with more social connections are more likely to learn about and then pursue free cleft surgery from Operation Smile, they might select into the treatment group in greater numbers. However, with difference-in-differences it is permissible if there are (observed or unobserved) differences between treatment and control groups related to outcomes, so long as they affect outcomes similarly for both cleft patients and their siblings. For example, if parents of untreated cleft patients tended to have lower levels of education and that negatively impacted academic outcomes for their children, that would be permissible as long as it had similar effects on the cleft child and sibling.

Spillovers present a potential threat to our identifying assumption. If untreated cleft "drags down" outcomes for all siblings because parents are devoting disproportionately large time and financial resources to caring for the child with untreated cleft at the expense of the other siblings it would result in positive bias or inflated estimates of impact. However, it is, also probable that because cleft conditions are strongly stigmatized in India, parents may neglect cleft children relative to their siblings. In that case downward bias would increase the gap between untreated cleft patient and sibling relative to the gap between treated cleft patient and sibling, resulting in underestimation of the impact of surgery.

Our main specification is:

$$y_{ij}=\alpha+ \beta C_i+\tau S_i+\omega OS_i+\boldsymbol{X_{ij}}'\boldsymbol{\theta}+\mu_j+\varepsilon_{ij} \quad (1)$$

where y_{ij} is outcome index y for person i in household j, C_i is a variable representing the severity of a cleft lip in terms of number of surgeries required for repair to "near normalcy," S_i are the number of reparative cleft surgeries performed on the child, OS_i is a dummy variable representing whether Operation Smile performed at least one of the surgeries, $\boldsymbol{X_i}'\boldsymbol{\theta}$ are a vector of control variables including gender, age, and birth order that will be used to distinguish a child within the household, μ_j is a household level fixed effect, and ε_{ij} is the error term. Our ability to include the OS_i dummy variable will depend on whether project resources allow us to obtain a large enough sample of patients who were previously treated by Operation Smile.

Using this specification, we will estimate the impact of being born with increasing cleft severity, β, the impact of surgeries, τ, and the added impact of Operation Smile surgery, ω.
It may be that both the degree of cleft severity as well as surgeries have diminishing returns—that increasing levels of severity matter less than simply having cleft at all, or that the first surgery has the biggest effects on life outcomes and subsequent surgeries have lesser effects. Therefore, a second estimation is carried out:

$$y_{ij}=\alpha+ \boldsymbol{C_i}'\boldsymbol{\beta}+\boldsymbol{S_i}'\boldsymbol{\tau}+\omega OS_i+\boldsymbol{X_{ij}}'\boldsymbol{\theta}+\mu_j+\varepsilon_{ij} \quad (2)$$

Where $\boldsymbol{C_i}$ in (2) represents a vector of dummy variables for cleft severity that range from requiring at least 2 surgeries to 7 or more surgeries, $\boldsymbol{S_i}$ represents a vector of dummy variables indicating whether a child has had 1 cleft surgery, 2 cleft surgeries, 3 cleft surgeries or 4 or more cleft surgeries.

Where Y_{ij} is outcome index y for person i in household j, C_i is a variable representing the severity of cleft, S_i are the number of reparative cleft surgeries performed on the child, $X_i'0$ is a vector of control variables including gender, age, and birth order that will be used to distinguish a child within the household, μ_j is a household level fixed effect, and ε_{ij} is the error term.

By comparing the difference-in-differences in life outcomes, we construct a counterfactual estimate of the level of life outcomes that would have been achievable in the absence of cleft, based on the outcomes realized by their siblings. We also estimate in standard deviations how much each additional cleft surgery restores.

Standardized medical procedures, such as cleft surgery, could be expected to have relatively homogeneous effects across regions. Given the relatively universal effect of cleft surgery these findings likely have external validity and apply to regions outside of India and West Bengal. However, the efficacy and efficiency of the implementing organization (Operation Smile) could vary regionally as factors including localized networks and social capital, language barriers, and the availability of suitable surgical facilities could impact the success and scale of the intervention.

4. Data

Survey modules administered to teenagers with cleft and their non-cleft siblings measure cognitive functioning, educational completion, and academic outcomes. using a digit span memory test, Annual Status of Education Report (ASER) math test, ASER reading test, and original questionnaire. The ASER exercise is large and repeated annually drawing a sample of more than 600,000 children from almost every district in rural India. The ASER reading test is one page, with different competency benchmarks: letters, simple words, simple sentences, and a reading passage expected to be understood by grade two students. The ASER math test asks children whether they can recognize two-digit numbers, and can progress to the highest level tested, three digits divided by a single digit (e.g., 759 divided by 6). This study used math and reading portions of an actual ASER exam to measure math and reading ability in teens with cleft and their nearest age siblings.

A parental survey was also administered to measure key outcomes and parental perceptions across teenagers with cleft and their non-cleft siblings. The parental survey was designed to ask each question sequentially across all siblings to avoid focusing on the cleft patient sibling. Additional data was gathered to construct a matrix of control variables including demographics, family information, gender, birth order, and whether cleft operations were performed by Operation Smile or other medical service providers.

Table 1 shows evidence of statistically significant differences in resources, education, and religion between households that received Operation Smile (OS) surgeries compared to those who received surgeries from other providers or those who have not yet received any surgery. Cleft patients from families with greater levels of education and resources are more likely to have already received surgery independent of OS. Likewise, those who already received OS surgeries are more educated and affluent than those who have not yet received surgery. The level of parental education and the rate of having electricity in the home is statistically significantly lower among the families of patients who received OS surgeries compared to families of patients who received surgeries from other health care providers. This suggests that OS is engaging with poorer families with lower levels of parental education. We also see evidence that families of patients who received OS surgeries are more likely to have a toilet than families of patients who have not yet received any surgery. This is suggestive of selection into treatment (cleft surgery) by families that have greater resources and assets (families more likely to have toilets). This could be due to more educated parents having greater social capital, connections, and resources, and thus having both the awareness and resources to obtain cleft surgery. We also see evidence of statistically more Hindu (as opposed to Muslim) families with patients that received OS surgery (compared to no surgery) and more Hindu families that received any surgery (compared to no surgery).

Table 2B shows greater variation in academic and cognitive outcomes between treatment and control families than between patients and siblings within each family. Table 2B shows significantly greater levels of cognitive and academic ability among children from treatment families (families whose cleft patients already received surgery) compared to control families (whose cleft patients have not yet received surgery). However, we see no statistically significant differences between patients and siblings within treatment families or within control families.

However, tables 2A and 2B report simple group means without controlling for age, gender, or birth order. It should be noted that "treatment" and "control" groups have been defined in grossly simplified terms to create these tables. "Treatment" refers to a family with a cleft patient that has received one or more surgeries. "Control" refers to a family with a cleft patient that has not yet received any surgery.

The mean age for patients who have not had surgery (14.6) is lower than the mean age for patients who have had surgery (15.4) (p-value = 0.125). Age is controlled for in subsequent regression analysis.

Using historical and diagnostic information a variable was constructed to tally the number of surgeries required by each cleft patient in the study. Each cleft condition or combination of conditions requires a series of a different number of reparative surgeries, sometimes performed over several years.

Average surgery scenarios:

1. Incomplete unilateral or bilateral cleft lip, but no cleft palate: 2 surgeries
3. Incomplete unilateral or bilateral cleft palate, but no cleft lip: 3 surgeries
5. Complete unilateral or bilateral cleft lip: 4 surgeries
7. Incomplete cleft lip (bilateral or unilateral) and incomplete cleft palate (bilateral or unilateral): 5 surgeries
8. Complete unilateral cleft lip and palate: 6 surgeries
9. Complete bilateral cleft lip and palate: 7 surgeries
10. Complete bilateral cleft lip and palate with deviated premaxilla: 8 surgeries

5. Empirical Results

This section presents estimates of the impact of cleft severity and cleft repair surgery on cognitive and academic ability, educational completion, and parental perceptions of academic ability. Coefficients on the number of surgeries performed measure the restorative impact of each additional cleft repair surgery. Coefficients on cleft severity measure the marginal impact of having a more severe cleft condition that requires one more surgical procedure to correct. This section also summarizes estimates of the relationship between age and academic and cognitive ability and presents robustness checks.

5.1 Estimates of Impact on Academic and Cognitive Ability

Table 3 provides estimates of impact from Specification (1) based on OLS difference-in-differences regressions with family level fixed effects and standard errors clustered at the family level. Table 3 shows estimates of impact for individual outcomes measuring cognitive ability (forward and backward digit span memory test), academic ability (math and reading ability measured by the ASER test). No statistically significant correlation is seen between cleft severity or cleft repair and any cognitive or academic ability outcomes. Among the estimates presented, the impact of cleft severity on reading ability -.079 (S.E. = .0572) is most nearly statistically significant at $p<.10$ (See Figure 2).

5.2 Estimates of Impact on Educational Completion, Current Enrollment, and Number of Days of School Missed

As shown in Table 5, OLS difference-in-differences estimation of the impact of cleft severity and cleft repair on current enrollment, number of days of school missed in the last month, and educational completion demonstrate no statistically significant correlation between cleft severity or repair and completion, enrollment, highest grade completed, or days missed.

However, our logit estimation shows that cleft severity does have a significant negative impact on the probability a child under the age of 14 can successfully count from one to twenty. Note that this logit estimation does not include fixed effects so it does not provide a clean counterfactual estimate of impact. Because the logit estimation does not absorb the family level fixed effects, standard errors may be biased and our OLS difference-in-differences estimates likely provide a more reliable counterfactual estimate of impact.

5.3 Estimates of Impact on Parental Perception of Academic Ability

As shown in Table 7, data from the parental questionnaire demonstrate that cleft severity and the number of cleft repair surgeries performed have no statistically significant impact on parental perceptions of children's math, reading, academic success, and intelligence.

5.4 Estimates of Relationship Between Age and Academic and Cognitive Ability

Thus far, we have failed to find that any one of the estimates of impact of cleft severity (number of surgeries required) or cleft repair (number of surgeries performed) has a significant impact on any of our cognitive or academic outcomes of interest. We ask the question then, does attending public schools in rural West Bengal have any impact on academic ability for any population?

To probe this question, we intentionally carried out some of our estimations on a restricted sample of (non-cleft) siblings only. We sought evidence of any significant relationship between age and academic ability. OLS regressions in Tables 9A & 9B were estimated using a restricted sample of only those 83 out of 112 (non-cleft) siblings currently attending school. Age is highly correlated with highest grade completed, as predicted by the literature on education in India. This is due to the universal practice of social promotion (automatic advancement from grade to grade regardless of academic ability) from age 6 to 14. Age has no statistically significant impact on math ability. However, it has a weakly significant impact on reading ability showing the null rejected at the 10% level ($p = 0.084$). Surprisingly, our data shows no statistically significant correlation between age and math ability. Math ability should increase as age increases and children learn math in school. No significant correlation between math ability and age means. The lack of a correlation between age and math ability for (non-cleft) siblings enrolled in school suggests students are not gaining math and reading ability as they advance in age and grade level. Our data is consistent with the literature, which shows a massive failure of the public education system in India (Pritchett 2013). Thus, one might reasonably conclude that the inefficacy of the public education system in West Bengal makes it difficult to distinguish any treatment impact on academic ability because academic ability is so exceptionally low even among (non-cleft) siblings in our sample.

5.5 Anderson Indices of Cognitive and Academic Outcomes

We also present measures of impact using Anderson indexes within each family of variables. An Anderson index is constructed to measure parental perception of academic ability, observed academic ability, cognitive ability, and overall (cognitive and academic) ability as stipulated in our pre-analysis plan. The Anderson Index is created by de-meaning and normalizing each of the dependent variables in the respective family. The Anderson Index assigns weights such that individual variables within the family that exhibit lower covariance with the other variables are weighted proportionally higher in the index because they contain more independent information. This allows us to reach more general conclusions about the impact of cleft severity and cleft surgery on families of outcomes such as cognitive or academic ability, and helps address the issue of the potential spurious rejection of null hypotheses due to over-testing. None of the Anderson indexes measuring general cognitive and academic ability show a statistically significant correlation between cleft severity or cleft repair and ability.

5.6 Alternate Specifications

Our pre-analysis plan calls for estimating of impacts using Specification (2) as a means of investigating whether additional cleft surgeries offer increasing or decreasing returns. Dummy variables were constructed indicating whether each cleft child has had 1 cleft surgery, 2 cleft surgeries, 3 cleft surgeries or 4 or more cleft surgeries. Table 12 shows the impact of each level of cleft severity and the impact of receiving each number of surgeries (1st, 2nd, 3rd, etc.) on cognitive and academic outcomes. Requiring three or six surgeries has a statistically significant negative impact on math ability. However, there is no clear pattern or trend suggesting this may be an artifact of the data owing to the small sample size. Tables 4, 6, 8, and 11 present estimations from difference-in-differences regressions that assume an over-simplified grouping of all teens born with any cleft (of varying severity, repaired or unrepaired) into a single category and all teens who have received any surgery into another category. Even estimations of impact for these over-simplified groupings of cleft patients and treatment vs. control show no signs of statistically significant correlation between having any cleft, receiving any cleft repair surgery, and any of our outcomes of interest.

6. Summary and Conclusion

Do cleft severity and cleft repair surgery impact cognitive and academic outcomes?
Contrary to the outcome predicted by the cleft literature, our study finds that cleft children in our sample do not perform significantly worse than their (non-cleft) nearest age siblings on cognitive, math, and reading ability measures. We also find that academic ability is very low

among all of the largely rural Indian teenagers in our study. This is true regardless of cleft status and regardless of treatment status.

As detailed in the literature review section, correlations have been found between being born with cleft and lower cognitive and academic outcomes. There does not appear to be any previously existing literature exploring the restorative impact of cleft surgery. Logically, it might be expected that cleft repair surgery has a positive impact on academic outcomes as children with repaired cleft might attend school more regularly because they are no longer being teased, speak with more clarity, engage in more social behavior, including conversation, and thus develop superior language, reading, and math skills. However, the data gathered for this study, in West Bengal, India, does not support that finding. None of the coefficients on the number of surgeries performed nor cleft severity are significant at $\alpha = .10$.

However, several aspects of the literature are confirmed by our data. Consistent with studies by Davie et. al (1972) and Breland (1972), a significant positive correlation is noted between birth order and reading ability in our study (see Tables 9A & 9B). Earlier-born siblings in our sample score higher on the ASER reading exam than later-born siblings.

A growing body of research shows that although primary and secondary school enrollment rates in India have increased in recent years, rates of learning and education remain low compared to developed countries. One year of schooling in the United States is equal to three to four years in many developing countries (Kaarsen 2014). The problem of low levels of learning per year of instruction is particularly acute in rural India (Pritchett 2015). Pritchett finds that in India there is just a 3-10 percentage point increase in student mastery of basic mathematics per year and learning measured as the net addition in the percent of a cohort correctly answering a standardized set of basic math questions, is 9-13% per year, meaning "seven out of eight children made no progress on a typical item after an entire year of schooling." Pritchett writes: "These poor results appear driven by teacher absenteeism and a large gap between actual learning and curricular pace. Students are passed from grade to grade, despite not learning, receive little remediation to catch up, and thus the proportion of students who lag behind grows as grades progress."

Our results are consistent with Pritchett's research finding that remarkably little learning is happening each year for each individual student in the public-school system in India. Despite large increases in public spending on education in recent decades, Indian schools remain under-resourced and rates of teacher absenteeism remain high. In India, less than half of government primary school teachers were found to be both present and engaged in teaching on any given school day (Chaudhury et al. 2006). Although the Right to Education (RTE) initiative passed into law as a constitutional amendment in 2009 made primary school attendance free and compulsory for all Indian children age 6 to 14, the quality of public education in much of India is abysmal and the annual gains in academic ability realized by each student remain exceptionally low (Pritchett, 2013). RTE enshrined in law the longstanding and common practice of social promotion in India. All students in grades one through eight are automatically passed to the next grade regardless of academic ability. Special education learning needs go largely unmet (Karande & Gogtay, 2010).

Data from assessments conducted by ASER in In West Bengal, India in 2016 show that of twelve children who enter fourth grade not knowing how to do a simple division problem, *only one* will learn in the fourth grade, which means that eleven of twelve children will not. The same data show that 39.5% of eighth graders can recognize numbers up to 99 but cannot do subtraction and only 51.8% of children in fifth grade are able to read a simple second grade story (ASER, 2016). West Bengal ranks among the three worst performing states in India in reading and math outcomes (ASER, 2008). Given that very little learning is happening anyway in public schools, having cleft and not attending school may not put teens at much of a disadvantage in comparison to their non-cleft siblings who are also not learning much.

Given the estimated coefficients and standard errors from Table 11, with 99 percent confidence, we can rule out effects of having any cleft on cognitive ability greater than -.85 standard deviations in magnitude. This finding is inconsistent with the finding by Nopoulos et al. (2002) that the effect of having cleft on IQ scores is -1.35 standard deviations in magnitude in comparison to the scores of controls.[1] Given the estimated coefficients and standard errors from Table 3, with 99 per cent confidence, we can rule out effects of cleft severity on reading ability greater than -.214 standard deviations in magnitude.

It is plausible that cleft severity and cleft repair surgery have no significant impact on cognitive and academic outcomes for teenagers in India. However, the poor quality of public education in rural India makes it difficult to distinguish the treatment effect on academic ability. Additionally, this study is underpowered and a larger sample size and additional studies across regions throughout India would be needed to yield more definitive and meaningful

[1] Nopoulos et al. (2002) find adults with repaired cleft have mean IQ 96.96 (S.D. = 13.2) and adults in the control group sample have mean IQ 109.5 (S.D. = 9.27). N = 40

results. Only additional data collection is likely to lead to better estimates of the impact of cleft surgery on cognitive and academic outcomes.

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Figure 1 – Causal Chain & Implicit Assumptions

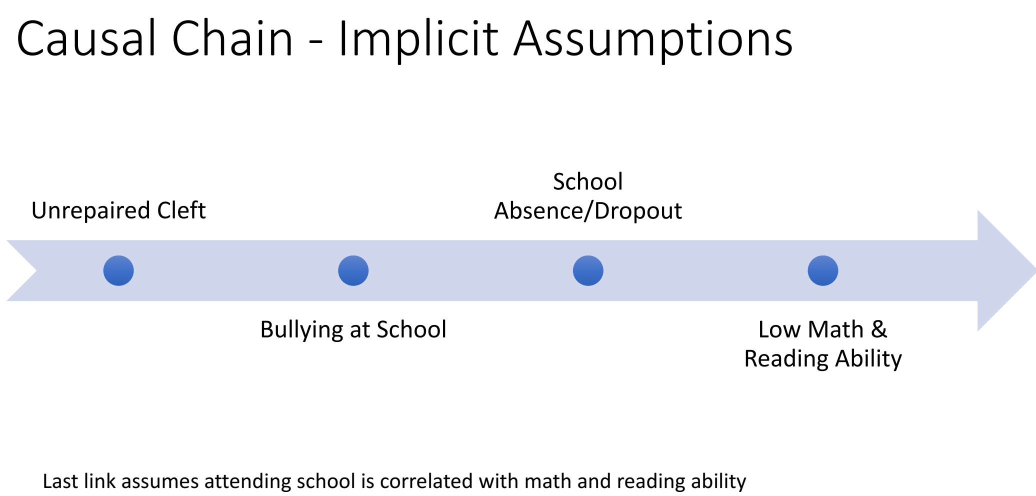

Figure 2 – Magnitude and Significance of Estimates

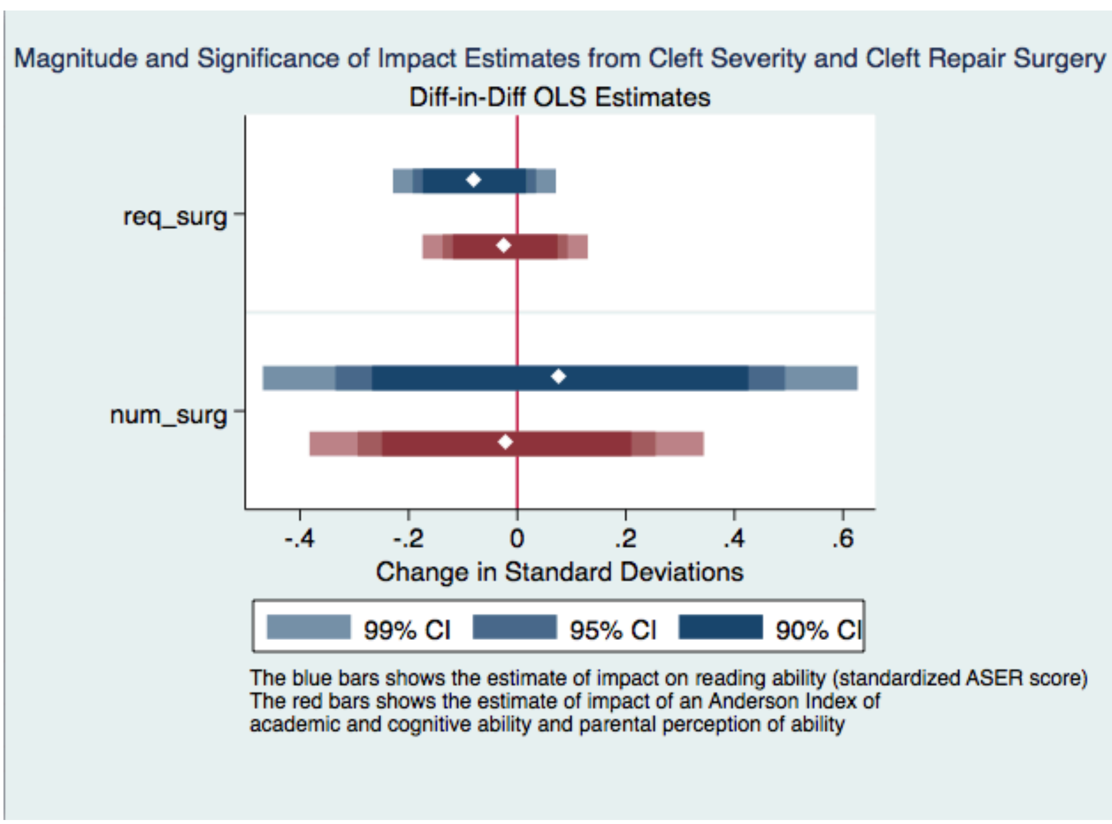

Table 1 - Descriptive Statistics: Across Households

	1 or More OS Surgeries	1 or More Surgeries	No Surgery	OS vs. Other Surgery	OS vs. No Surgery	Any Surgery vs. No Surgery
Housing Quality Index	0.011	0.057	-0.188	-0.110	0.198	0.244
	(0.088)	(0.077)	(0.130)	(0.157)	(0.154)	(0.158)
Parent Education (standardized)	-0.100	0.057	-0.189	-0.377**	0.089	0.247
	(0.104)	(0.079)	(0.117)	(0.158)	(0.168)	(0.158)
Electricity dummy: yes = 1, no = 0	0.840	0.884	0.902	-0.104**	-0.062	-0.018
	(0.037)	(0.025)	(0.042)	(0.049)	(0.060)	(0.051)
Toilet dummy: yes = 1, no = 0	0.720	0.663	0.538	0.137*	0.182**	0.124
	(0.045)	(0.036)	(0.070)	(0.073)	(0.080)	(0.076)
Religion: Hindu=0, Muslim=1, Christian=2, Buddhist=3	0.300	0.314	0.500	-0.033	-0.200**	-0.186**
	(0.046)	(0.035)	(0.070)	(0.072)	(0.081)	(0.075)
N	100	72	52	172	152	124

Notes: Unweighted sample averages reported with standard errors in parentheses. Housing Quality Index is a standardized Anderson Index of wall, roof, and floor materials. Parent education is the average of a categorical variable for all parents in the household: None=0, Primary=1, Secondary=2, University=3. It is standardized so that it can be interpreted as standard deviations in this table. Electricity Dummy is a dummy variable for having electricity in the house. Toilet is a dummy for having a toilet or latrine at the house. Religion is a categorical variable where 0=Hindu and 1=Muslim. *=p<.10 **=p<.05 ***p<.01

Table 2.1 - Descriptive Statistics for Individual Outcomes Within Households

	No Surgery		One or More Surgeries	
	Patient	Sibling	Patient	Sibling
Forward Digit Span	6.115	7.192	6.826	7.068
(cognitive ability)	(0.434)	(0.526)	(0.324)	(0.258)
Backward Digit Span	2.846	2.231	3.081	3.116
(cognitive ability)	(0.543)	(0.491)	(0.273)	(0.233)
ASER Math Score	2.000	2.154	2.360	2.384
(math ability)	(0.166)	(0.213)	(0.128)	(0.128)
ASER Reading Score	1.731	2.231	2.872	2.849
(reading ability)	(0.312)	(0.285)	(0.159)	(0.161)
Highest Number Counted (1-20)	15.577	14.885	16.977	17.174
	(1.047)	(1.197)	(0.586)	(0.447)
Able to Count 1-20 (yes = 1, no = 0)	0.462	0.538	0.558	0.512
	(0.100)	(0.100)	(0.054)	(0.054)
N	26	26	86	86

Notes: Unweighted sample averages reported with standard errors in parentheses. Male is a dummy variable for gender with male=1 and female=0. Means of raw scores are reported. Outcomes have not been standardized.

Table 2.2 - Testing Differences Between Group Means from Table 2.1

	CP vs. CS	CP vs. TP	CP vs. TS	CS vs. TP	CS vs. TS	TP vs. TS
Forward Digit Span	-1.077	-0.710	-0.953*	0.367	0.124	-0.243
(cognitive ability)	(0.682)	(0.636)	(0.526)	(0.656)	(0.551)	(0.414)
Backward Digit Span	0.615	-0.235	-0.269	-0.851	-0.885*	-0.034
(cognitive ability)	(0.732)	(0.580)	(0.518)	(0.566)	(0.502)	(0.359)
ASER Math Score	-0.154	-0.360	-0.384	-0.207	-0.230	-0.023
(math ability)	(0.270)	(0.251)	(0.251)	(0.261)	(0.261)	(0.181)
ASER Reading Score	-0.500	-1.141***	-1.118***	-0.641*	-0.618*	0.023
(reading ability)	(0.422)	(0.337)	(0.339)	(0.329)	(0.332)	(0.226)
Highest Number Counted (1-20)	0.692	-1.400	-1.597	-2.092*	-2.290**	-0.198
	(1.590)	(1.212)	(0.995)	(1.252)	(1.044)	(0.737)
Able to Count 1-20 (1=yes, 0=no)	-0.077	-0.097	-0.050	-0.020	0.027	0.047
	(0.141)	(0.112)	(0.113)	(0.112)	(0.113)	(0.076)
N	52	112	112	112	112	172

Notes: CP = Cleft Patient, CS = Cleft Sibling, TP = Treatment Patient, TS = Treatment Sibling
The differences of means of raw scores from Table 2.1 (above) are reported and tested for statistical significance. *=p<.10 **=p<.05 ***p<.01

Table 3: Academic and Cognitive Estimates of Impact for Cleft Severity and Cleft Surgery Repair

---OLS With Household Fixed Effects, Clustered Standard Errors at Household Level---

Variable	(1) Digit Span	(2) Backward Digit Span	(3) Reading	(4) Math
# of Surgeries Required	-0.0478	-0.00347	-0.0790	0.0126
	(0.0539)	(0.0606)	(0.0572)	(0.0508)
# of Surgeries Received	0.0183	-0.0820	0.0791	-0.0598
	(0.129)	(0.149)	(0.209)	(0.141)
OS Dummy	0.0874	0.0816	0.200	0.00630
	(0.304)	(0.305)	(0.299)	(0.290)
Birth Order	-0.0645	-0.167	-0.287*	-0.146
	(0.167)	(0.173)	(0.146)	(0.170)
Observations	224	224	224	224
R-squared	0.033	0.074	0.118	0.040
Households	112	112	112	112

Notes: Each column reports the results of a separate regression. All models include household fixed effects as well as linear controls for age, gender, birth order of child, and a dummy variable for whether the surgery was performed by Operation Smile or another health care provider. Operation Smile dummy: 1=Received at least one OS surgery, 0=Has not received any OS surgeries. Male dummy: 1 = Male, 0 = Female. Robust standard errors clustered at the household level.

*** p<0.01, ** p<0.05, * p<0.1

Table 4: Academic and Cognitive Estimates of Impact for Being Born with Any Cleft and Receiving One or More Cleft Surgeries

---OLS With Household Fixed Effects, Clustered Standard Errors at Household Level---

VARIABLES	(1) Digit Span	(2) Backward Digit Span	(3) Reading	(4) Math
Cleft Patient Dummy	-0.385	0.269	-0.322	-0.161
	(0.269)	(0.352)	(0.325)	(0.270)
Any Surgery Dummy	0.186	-0.453	0.0687	0.149
	(0.412)	(0.406)	(0.393)	(0.369)
OS Dummy	0.114	0.113	0.247	-0.0248
	(0.382)	(0.311)	(0.302)	(0.313)
Birth Order	-0.0638	-0.162	-0.284*	-0.143
	(0.166)	(0.170)	(0.146)	(0.176)
Age	-0.00466	0.0148	-0.00689	-0.0314
	(0.0312)	(0.0464)	(0.0254)	(0.0363)
Gender (male = 1)	-0.212	-0.371	-0.282	0.251
	(0.229)	(0.256)	(0.172)	(0.235)
Observations	224	224	224	224
R-squared	0.051	0.088	0.116	0.044
Households	112	112	112	112

Notes: Each column reports the results of a separate regression. All models include household fixed effects as well as linear controls for age, gender, birth order of child, and a dummy variable for whether the surgery was performed by Operation Smile or another health care provider. Operation Smile dummy: 1=Received at least one OS surgery, 0=Has not received any OS surgeries. Male dummy: 1 = Male, 0 = Female. Robust standard errors clustered at the household level.

*** p<0.01, ** p<0.05, * p<0.1

Table 5: School Attendance and Completion - Estimates of Impact for Cleft Severity and Cleft Surgery

---OLS With Household Fixed Effects, Clustered Standard Errors at Household Level---

VARIABLES	(1) Currently Enrolled	(2) Days Missed in last 30	(3) Able to Count 1-20	(4) Highest Grade
# of Surgeries Required	0.0146	0.0833	-0.195	0.00603
	(0.0248)	(0.515)	(0.420)	(0.133)
# of Surgeries Received	0.0807	0.760	0.217	-0.228
	(0.0712)	(1.069)	(0.986)	(0.407)
OS Dummy	-0.202	2.042	0.689	0.481
	(0.131)	(3.078)	(1.282)	(0.761)
Birth Order	-0.0262	2.065	-0.611	0.0525
	(0.0749)	(2.030)	(0.782)	(0.387)
Age	-0.0453***	0.553	-0.0167	0.603***
	(0.0136)	(0.529)	(0.117)	(0.112)
Gender (male = 1)	-0.0639	3.278	-0.316	-0.161
	(0.104)	(2.102)	(1.113)	(0.569)
Observations	224	166	224	224
R-squared	0.208	0.188	0.021	0.558
Households	112	97	112	112

Notes: Each column reports the results of a separate regression. All models include household fixed effects as well as linear controls for age, gender, birth order of child, and a dummy variable for whether the surgery was performed by Operation Smile or another health care provider. Operation Smile dummy: 1=Received at least one OS surgery, 0=Has not received any OS surgeries. Male dummy: 1 = Male, 0 = Female. Robust standard errors clustered at the household level.
*** p<0.01, ** p<0.05, * p<0.1

Table 6: School Attendance and Completion - Estimates of Impact for Being Born with Any Cleft and Receiving One or More Cleft Surgeries

---OLS With Household Fixed Effects, Clustered Standard Errors at Household Level---

VARIABLES	(1) Currently Enrolled	(2) Days Missed in last 30	(3) Able to Count 1-20	(4) Highest Grade
Cleft Patient Dummy	-0.00976	0.446	0.684	-0.343
	(0.124)	(2.702)	(1.976)	(0.603)
Any Surgery Dummy	0.238	0.683	-2.053	0.217
	(0.149)	(3.137)	(2.230)	(0.793)
OS Dummy	-0.234*	2.451	1.541	0.269
	(0.135)	(3.350)	(1.458)	(0.735)
Birth Order	-0.0295	2.057	-0.687	0.0881
	(0.0758)	(1.913)	(0.772)	(0.392)
Age	-0.0445***	0.577	-0.0250	0.604***
	(0.0139)	(0.528)	(0.117)	(0.114)
Gender (male = 1)	-0.0410	3.316	-0.483	-0.159
	(0.102)	(2.163)	(1.117)	(0.564)
Observations	224	166	224	224
R-squared	0.205	0.174	0.035	0.556
Households	112	97	112	112

Notes: Each column reports the results of a separate regression. All models include household fixed effects as well as linear controls for age, gender, birth order of child, and a dummy variable for whether the surgery was performed by Operation Smile or another health care provider. Operation Smile dummy: 1=Received at least one OS surgery, 0=Has not received any OS surgeries. Male dummy: 1 = Male, 0 = Female. Robust standard errors clustered at the household level.

*** p<0.01, ** p<0.05, * p<0.1

Table 7: Parental Perception of Ability - Estimates of Impact for Cleft Severity and Cleft Surgery Repair

---OLS With Household Fixed Effects, Clustered Standard Errors at Household Level---

VARIABLES	(1) Smart	(2) Reading	(3) Math	(4) Academic Achievement
# of Surgeries Required	-0.0346	0.00936	0.0384	0.0730
	(0.0719)	(0.0857)	(0.0795)	(0.0626)
# of Surgeries Received	0.0840	-0.147	-0.110	-0.146
	(0.200)	(0.221)	(0.213)	(0.159)
OS Dummy	0.0446	0.0508	-0.175	-0.468
	(0.372)	(0.439)	(0.372)	(0.364)
Birth Order	0.116	0.0122	0.298	0.0665
	(0.265)	(0.196)	(0.215)	(0.195)
Age	0.0118	-0.0196	0.0162	-0.0458
	(0.0546)	(0.0365)	(0.0413)	(0.0305)
Gender (male = 1)	0.0240	0.0108	0.157	-0.331
	(0.310)	(0.333)	(0.311)	(0.308)
Observations	224	224	224	224
R-squared	0.009	0.020	0.062	0.096
Households	112	112	112	112

Notes: Each column reports the results of a separate regression. All models include household fixed effects as well as linear controls for age, gender, birth order of child, and a dummy variable for whether the surgery was performed by Operation Smile or another health care provider. Operation Smile dummy: 1=Received at least one OS surgery, 0=Has not received any OS surgeries. Male dummy: 1 = Male, 0 = Female. Robust standard errors clustered at the household level.

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 8: Parental Perception of Ability - Estimates of Impact for Being Born with Any Cleft and Receiving One or More Cleft Surgeries

---OLS With Household Fixed Effects, Clustered Standard Errors at Household Level---

	(1)	(2)	(3)	(4)
VARIABLES	Smart	Reading	Math	Academic Achievement
Cleft Patient Dummy	-0.152	0.130	0.121	0.458
	(0.350)	(0.502)	(0.465)	(0.389)
Any Surgery Dummy	0.0152	-0.470	-0.147	-0.549
	(0.470)	(0.597)	(0.545)	(0.466)
OS Dummy	0.167	0.181	-0.168	-0.316
	(0.446)	(0.450)	(0.417)	(0.411)
Birth	0.0995	0.00100	0.295	0.0419
	(0.266)	(0.195)	(0.224)	(0.193)
Age	0.0117	-0.0204	0.0165	-0.0460
	(0.0548)	(0.0359)	(0.0423)	(0.0303)
Gender (male = 1)	0.0205	-0.0199	0.155	-0.346
	(0.300)	(0.322)	(0.303)	(0.302)
Observations	224	224	224	224
R-squared	0.011	0.028	0.059	0.106
Households	112	112	112	112

Notes: Each column reports the results of a separate regression. All models include household fixed effects as well as linear controls for age, gender, birth order of child, and a dummy variable for whether the surgery was performed by Operation Smile or another health care provider. Operation Smile dummy: 1=Received at least one OS surgery, 0=Has not received any OS surgeries. Male dummy: 1 = Male, 0 = Female. Robust standard errors clustered at the household level.

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 9A: Estimated Impact of Age on Ability - Restricting Sample to (non-cleft) Siblings Only

VARIABLES	(1) Math	(2) Reading	(3) Cog Ability	(4) AndIndSibCogEd	(5) Grade Level
Birth Order	-0.221	-0.374***	-0.164	-0.0536	0.00314
	(0.135)	(0.110)	(0.117)	(0.166)	(0.428)
Age	0.0244	0.0438*	0.0349	0.106*	0.659***
	(0.0341)	(0.0250)	(0.0299)	(0.0547)	(0.111)
Gender (male = 1)	-0.170	-0.503***	-0.176	-0.389	0.277
	(0.208)	(0.179)	(0.182)	(0.284)	(0.617)
Observations	83	83	83	83	82
R-squared	0.061	0.230	0.063	0.095	0.382

Notes: Each column reports the results of a separate regression. All models include household fixed effects as well as linear controls for age, gender, and birth order of child. Male dummy: 1 = Male, 0 = Female. Robust standard errors clustered at the household level.

*** p<0.01, ** p<0.05, * p<0.1

Table 9B: Estimated Impact of Grade Level on Ability - Restricting Sample to (non-cleft) Siblings Only

VARIABLES	(1) Math	(2) Reading	(3) Cog Ability	(4) AndIndex SibCogEd
Birth Order	-0.203	-0.346***	-0.164	-0.0927
	(0.123)	(0.0961)	(0.115)	(0.166)
Current Grade	0.0689**	0.104***	0.0529*	0.110*
	(0.0313)	(0.0230)	(0.0291)	(0.0577)
Male	-0.228	-0.533***	-0.184	-0.420
	(0.202)	(0.164)	(0.180)	(0.296)
Observations	82	82	82	82
R-squared	0.123	0.351	0.088	0.108

Notes: Each column reports the results of a separate regression. All models include linear controls for age, gender, and birth order of child. Standard errors clustered at the household level. Male dummy: 1 = Male, 0 = Female.

*** p<0.01, ** p<0.05, * p<0.1

Table 10: Anderson Index Estimates of Impact for Cleft Severity and Cleft Surgery Repair

---OLS With Household Fixed Effects, Clustered Standard Errors at Household Level---

VARIABLES	(1) Parental Perception of Academic Ability	(2) ASER	(3) Cognitive Ability	(4) Total Ability (Cog + Acad)	(5) Anderson Index of Cog, Acad Abil & Parental (includes highest grade)	(6) Anderson Index of Cog, Acad Abil & Parental (excludes highest grade)
# of Surgeries Required	0.00452	-0.0363	-0.0295	-0.0372	-0.00852	-0.0224
	(0.0610)	(0.0514)	(0.0567)	(0.0536)	(0.0533)	(0.0581)
# of Surgeries Received	-0.0373	0.0105	-0.0366	-0.0160	-0.0449	-0.0196
	(0.135)	(0.154)	(0.131)	(0.139)	(0.132)	(0.138)
OS Dummy	-0.0825	0.113	0.0971	0.119	0.0237	0.0295
	(0.299)	(0.270)	(0.290)	(0.271)	(0.271)	(0.285)
Birth Order	0.125	-0.236	-0.133	-0.202	0.0251	-0.0223
	(0.183)	(0.147)	(0.160)	(0.151)	(0.182)	(0.187)
Age	-0.00451	-0.0210	0.00661	-0.00586	0.0548	-0.00163
	(0.0324)	(0.0294)	(0.0386)	(0.0339)	(0.0393)	(0.0380)
Gender (male = 1)	-0.0216	-0.0140	-0.315	-0.208	-0.0817	-0.104
	(0.238)	(0.188)	(0.242)	(0.202)	(0.211)	(0.223)
Observations	224	224	224	224	224	224
R-squared	0.025	0.046	0.062	0.063	0.055	0.014
Households	112	112	112	112	112	112

Notes: Each column reports the results of a separate regression. All models include household fixed effects as well as linear controls for age, gender, birth order of child, and a dummy variable for whether the surgery was performed by Operation Smile or another health care provider. Operation Smile dummy: 1=Received at least one OS surgery, 0=Has not received any OS surgeries. Male dummy: 1 = Male, 0 = Female. Robust standard errors clustered at the household level.
*** p<0.01, ** p<0.05, * p<0.1

Table 11: Anderson Index Estimates of Impact for Being Born with Any Cleft and Receiving One or More Cleft Surgeries

---OLS With Household Fixed Effects, Clustered Standard Errors at Household Level---

VARIABLES	(1) Parental Perception of Academic Ability	(2) ASER	(3) Cognitive Ability	(4) Total Ability (Cog + Acad)	(5) Anderson Index of Cog, Acad Abil & Parental (includes highest grade)	(6) Anderson Index of Cog, Acad Abil & Parental (excludes highest grade)
Cleft Patient Dummy	0.0591	-0.264	-0.0667	-0.170	-0.0766	-0.0885
	(0.287)	(0.294)	(0.329)	(0.298)	(0.258)	(0.301)
Any Surgery Dummy	-0.232	0.119	-0.153	-0.0409	-0.0923	-0.129
	(0.382)	(0.355)	(0.403)	(0.358)	(0.340)	(0.384)
OS Dummy	0.0419	0.122	0.130	0.145	0.0801	0.116
	(0.358)	(0.280)	(0.317)	(0.283)	(0.309)	(0.326)
Birth Order	0.109	-0.233	-0.130	-0.199	0.0202	-0.0298
	(0.187)	(0.153)	(0.159)	(0.153)	(0.186)	(0.192)
Age	-0.00475	-0.0209	0.00581	-0.00635	0.0547	-0.00201
	(0.0330)	(0.0303)	(0.0391)	(0.0349)	(0.0403)	(0.0390)
Gender (male = 1)	-0.0338	-0.0172	-0.335	-0.223	-0.0910	-0.118
	(0.230)	(0.190)	(0.247)	(0.206)	(0.208)	(0.221)
Observations	224	224	224	224	224	224
R-squared	0.031	0.056	0.061	0.065	0.059	0.021
Households	112	112	112	112	112	112

Notes: Each column reports the results of a separate regression. All models include household fixed effects as well as linear controls for age, gender, birth order of child, and a dummy variable for whether the surgery was performed by Operation Smile or another health care provider. Operation Smile dummy: 1=Received at least one OS surgery, 0=Has not received any OS surgeries. Male dummy: 1 = Male, 0 = Female. Robust standard errors clustered at the household level.

*** p<0.01, ** p<0.05, * p<0.1

Table 12: Impact of each Specific Surgery (1st, 2nd, 3rd, etc.) on Cognitive and Academic Outcomes

---OLS With Household Fixed Effects, Clustered Standard Errors at Household Level---

Variable	(1) Cognitive Indx	(2) Math	(3) Reading	(4) Count 1-20	(5) Cog&Acad Index
Requires 2 Surgeries	0.0517	0.136	-0.0995	2.173	0.339
	(0.292)	(0.242)	(0.213)	(1.318)	(0.293)
Requires 3 Surgeries	-0.148	-0.667**	-0.293	-0.287	-0.458*
	(0.304)	(0.315)	(0.266)	(1.759)	(0.275)
Requires 4 Surgeries	-0.00625	0.171	-0.0213	1.117	0.185
	(0.404)	(0.374)	(0.322)	(1.716)	(0.349)
Requires 5 Surgeries	-0.0570	-0.478	-0.229	0.610	-0.332
	(0.381)	(0.360)	(0.359)	(2.908)	(0.451)
Requires 6 Surgeries	-0.233	-0.582**	-0.338	-0.324	-0.230
	(0.362)	(0.286)	(0.319)	(3.482)	(0.354)
Requires 7+ Surgeries	0.0255	-0.315	0.448	1.253	0.396
	(0.324)	(0.309)	(0.280)	(2.673)	(0.355)
Received 1 Surgery	-0.150	-0.0960	0.148	-2.558	-0.299
	(0.306)	(0.304)	(0.279)	(1.720)	(0.319)
Received 2 Surgeries	-0.218	0.285	0.0573	-2.455	-0.0230
	(0.398)	(0.361)	(0.393)	(3.215)	(0.363)
Received 3 Surgeries	-0.0531	-0.0515	-0.301	0.864	0.0772
	(0.405)	(0.455)	(0.442)	(2.978)	(0.393)
Received 4+ Surgeries	-0.288	0.917	0.140	0.686	-0.177
	(0.395)	(0.940)	(0.400)	(3.371)	(0.389)
Operation Smile Dummy	0.0983	0.0572	-0.0841	1.055	-0.0659
	(0.255)	(0.221)	(0.238)	(1.024)	(0.221)
Birth Order	-0.143	-0.338***	-0.175	-0.747	-0.0648
	(0.119)	(0.104)	(0.115)	(0.550)	(0.127)
Age	0.00534	-0.0122	-0.0363	-0.0321	-0.00824
	(0.0277)	(0.0175)	(0.0230)	(0.0776)	(0.0242)
Gender (male = 1)	-0.327*	-0.309**	0.230	-0.587	-0.192
	(0.173)	(0.122)	(0.162)	(0.835)	(0.159)
Observations	224	224	224	224	224
R-squared	0.073	0.199	0.112	0.090	0.100
Households	112	112	112	112	112

Notes: Each column reports the results of a separate regression. All models include linear controls for age, gender, birth order of child, and a dummy variable for whether the surgery was performed by Operation Smile or another health care provider.
Robust standard errors clustered at the household level in parentheses
*** p<0.01, ** p<0.05, * p<0.1