Hope Walks: The Impact of Clubfoot Treatment on Human Flourishing in Ethiopia

Bruce Wydick[1,2,3], Gianna Camacho,[4] and Patrizio Piraino,[2]

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Abstract

Children born with severe congenital anomalies in low-income countries rank among the most disadvantaged among the global ultra-poor. We study the impact of the clubfoot disability and its treatment across multiple dimensions of human flourishing on data collected from 564 children in Ethiopia. Working with Hope Walks, an organization that funds clubfoot interventions in numerous countries, we use a quasi difference-in-differences approach that generates counterfactual outcomes from the nearest-age siblings of children born with clubfoot, nested within a family-level fixed effect. We find that clubfoot status (early treatment) results in a disability (restoration) of -1.44σ (0.91σ) in physical mobility, -1.17σ (0.79σ) in mental health, -1.07σ (0.64σ) in social inclusion, -0.48σ (0.98σ) in an education index, -0.76σ (0.42σ) in religious faith, and -1.19σ (0.79σ) in an aggregate index of human flourishing (all $p < 0.05$). We attribute the large, broad, and significant impacts from clubfoot treatment to (i) a highly effective medical intervention that is (ii) carried out in an impoverished setting with scarce existing support for children born with disabilities, which (iii) broadly generates spillover effects across key development outcomes.

Affiliations: [1]University of San Francisco, [2]University of Notre Dame, Kellogg Institute for International Studies and CEIDS; [3]Center for Effective Global Action (CEGA), University of California at Berkeley; [4] Department of Public Health, Commonwealth of the Northern Mariana Islands. Corresponding author, Email: wydick@usfca.edu, Department of Economics, University of San Francisco, San Francisco, CA 94117.
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1 Introduction

The World Health Organization (2023a) estimates approximately 1.3 billion people globally possess a significant physical disability. Because of higher congenital risk factors, disability is more prevalent among the global poor: Nine of ten children born with a congenital abnormality are in LMICs (World Health Organization, 2023b). Children born with serious congenital abnormalities in low-income countries face some of the most severe challenges among the global ultra-poor. The United Nations references the importance of addressing disabilities among the global poor in 5 of its 17 Sustainable Development Goals (United Nations Development and Disability Report, 2018). However, there has been limited work that has used rigorous quasi-experimental methods to assess the disadvantages of congenital disabilities on development outcomes and the effectiveness of health interventions designed to restore them. Our research seeks to address this gap.

Among those born with congenital abnormalities, approximately 1 in 1000 children globally are born with *talipes equinovarus*, commonly known as clubfoot, a rate similar to births with cleft lip or palate. While clubfoot is both commonly and easily treated in high-income countries, it is often left untreated in LMICs. When birth defects such as clubfoot are left untreated, the resulting disabilities may lead to higher rates of poverty in LMICs through indirect effects on social inclusion, education, employment, and earnings (Mitra et al., 2013).

To our knowledge, there has been no attempt to employ rigorous quasi-experimental methods on the effects of congenital clubfoot status and clubfoot treatment on children's life outcomes. The medical literature on clubfoot, while comprehensive in many respects, does not attempt to estimate the causal effects of either clubfoot status or treatment. Although the precise causal factors of the disease remain a subject of medical investigation (Hegazy et al., 2020), instance of clubfoot is likely to be correlated with family genetics, environment, and maternal behaviors, such as smoking (Honein et al. 2000). This means that comparisons of outcomes with the general population are unlikely to generate valid counterfactuals to either clubfoot status or treatment.

In partnership with Hope Walks, a faith-based development NGO facilitating clubfoot treatment in 14 countries, we study the causal effects of congenital clubfoot status and its treatment on an array of holistic life outcomes. We generate a novel dataset from interviewing mothers of 564 Ethiopian children, compiling information on children born with clubfoot and their nearest-age siblings. In our sample, 59.9% of children born with clubfoot were treated and 62.9% of the treated children received early treatment which, according to the existing medical literature, maximizes treatment effectiveness. Through incorporating a mother-level fixed effect and including binary independent variables for clubfoot status, treatment, and early treatment, we are able to estimate (i) the loss in standard deviations over five facets of human flourishing from congenital clubfoot status; (ii) the degree to which the clubfoot intervention restores these outcomes; and (iii) the added restoration benefits from early treatment which, based on best practices, is defined here as occurring before six months of age.

We estimate average treatment effects on the treated (ATT) across standardized indices of physical, psychological, social, educational, and faith outcomes, all outcomes of interest to our partner NGO.[1] First, our results reveal an immense threat to human flourishing, as based on these outcomes, among children born with clubfoot disability. We find stark reductions of 1.44σ in physical mobility, 1.17σ in mental health, 1.07σ in social inclusion, 0.48σ in an education index, 0.76σ in the faith of their religious community, and 1.19σ in an aggregate index of human flourishing (all significant at $p < 0.001$).

Second, we show that early treatment of clubfoot restores outcomes in each of these areas significantly closer to, but not generally equal to, those of a child's nearest-age sibling. We find that early treatment leads to a restoration of 0.91σ in physical mobility, 0.79σ in mental health, 0.64σ in social inclusion, 0.98σ in our education index (where the intervention actually yields restoration that exceeds the negative impact of the disability), 0.42σ

[1] Our data does not delineate whether a child's religious faith community is Muslim, Orthodox Christian, or Protestant Christian, the predominant religious groups in Ethiopia.

in religious faith, and 0.79σ in our aggregate index of human flourishing (all significant at $p < 0.05$).

Our results contribute to both the research literature and to health practices in LMICs. First, we quantify the tragic effects of a common congenital abnormality on the everyday lives and functioning of children in low-income countries, where aside from direct effects on physical mobility, clubfoot causes more than a standard deviation loss in both mental health and social inclusion.

Our second key contribution is in showing that the effects of clubfoot treatment initiated past infancy are not significantly different from zero. This holds true across all five of our measured dimensions of human flourishing, and strongly supports existing medical guidelines that recommend commencing treatment of clubfoot in the weeks shortly after a child is born and diagnosed.

Finally, we find that the ATT of early clubfoot intervention on a broad array of development indicators is extremely high relative to the impacts of most educational and health interventions in LMICs. For example, the estimated effects of early clubfoot treatment are both significantly higher and more precisely measured than the impacts of cleft palate surgeries carried out by Operation Smile (Wydick et al., 2022). We attribute these unusually high ATTs to both the efficacy of early-age intervention and the dire counterfactual outcomes faced by individuals with untreated congenital abnormalities in LMICs. Based on substantial welfare gains in the lives of treated children, our results suggest a significant reallocation of resources directed to early treatment of congenital abnormalities in LMICs more generally and to clubfoot treatment in particular.

In the next section, we provide background on the clubfoot condition and its treatment, as well on the origin of our data. Section 3 presents our model and ATT estimates from the Hope Walks intervention and discusses barriers to treatment as revealed in our Ethiopia survey. Section 4 reflects on our results and discusses program and policy implications.

2 Background and Data

2.1 Effects of Disabilities in LMICs

The social and economic costs of disabilities in LMICs are substantial. Filmer (2008) finds a 10-percentage point increase in the probability of falling into the two poorest quintiles of poverty in LMICs for disabled individuals, which the authors ascribe to a lack of opportunity to engage in the local economy. Disability is also found to be significantly associated with higher rates of multidimensional poverty due to low education and skill accumulation, leading to significantly reduced earnings in adulthood (Mitra et al., 2013).

Talipes equinovarus, commonly referred to as clubfoot, is an inborn three-dimensional deformity of the leg, ankle, and foot. Globally, it is one of the most common congenital deformities in newborns with about 80% of clubfoot cases occurring in LMICs (Gupta et al., 2006). Medical professionals familiar with clubfoot advise seeking treatment as early in an infant's life as possible. In high-income countries, deformities associated with clubfoot are often recognized quickly after birth, or *in utero* through ultrasound scans; treatment is widely accessible and can be carried out with no major delays. Unfortunately, this is not the case in many LMICs, leading to numerous individuals living entire lives with the discomfort and restrictiveness of untreated clubfoot. Basit and Khoshhal (2017) present evidence that uncorrected structural defects of the foot and lower leg tissues can cause abnormal positioning of the foot and ankle joints. This abnormal positioning typically results in malformation of joints and ligaments, severe discomfort, and long-lasting disability if left untreated.

Deformities associated with clubfoot can be characterized into four components: equinus at the ankle, varus at the hindfoot, forefoot adductus, and cavus (Gupta et al., 2006). All four components of clubfoot can be measured or "scored" using the Pirani Scale, a tool that assesses the severity of each of the components of clubfoot.[2] Generally,

[2]There are two categories analyzed in the Pirani Scale, the midfoot and the hindfoot, with three sections in each category. Scores range from 1 to 6, with larger numbers indicating higher severity of deformities

the goal of treatment for any form of clubfoot is to attain a functional, pain-free, plantigrade foot with good mobility (Gupta et al., 2006). Studies focused on the efficacy of alternative clubfoot treatment methods have shown that a minimally invasive and economical treatment plan, the Ponseti Method, has proved successful in achieving treatment goals (Bor et al., 2009).

Hope Walks utilizes the Ponseti method in all of its work in LMICs, where the medical intervention costs approximately $500 per patient. The Ponseti method uses several plaster casts, often combined with an Achilles tenotomy, followed by a period of nightly bracing until the age of four to maintain the foot in the corrected position (Tuinsma et al., 2018). Because it relies on bone growth to correct the effects of clubfoot, the orthopedic community consensus is that the Ponseti method is most effective when initiated as early in life as possible. It is recommended that newborns with any clubfoot deformity be referred to a clubfoot center preferably within 48 hours but no more than one week following delivery (Besselar et al., 2017). However, seeking treatment within this time frame is often impossible in LMIC contexts.

Results from Bor et al. (2009) provide evidence of the physiological success of the method, where 89.2% of feet in their sample achieved at least a "good" outcome. Ippolito et al. (2003) present a comparison between babies treated with the Ponseti Method relative to an alternative Marino-Zuco method. They show a 78% success rate in the Ponseti Method compared to a 43% success rate in the Marino-Zuco group. In addition, the Ponseti method has lower costs, increased accessibility, and overall treatment efficiency; all of which make it particularly suited for implementation in LMICs, where there are fewer orthopedic surgeons or specialists (Gupta et al., 2006).

The existing literature on clubfoot disability focuses primarily on the success of the procedure from a medical/physiological perspective. Studies in this literature, however, generally fail to establish valid controls and/or counterfactuals, thus falling short of es-

(Dryer & Davis, 2006).

tablishing a basis for understanding the causal effects of congenital clubfoot status and clubfoot interventions. In addition, most studies report medical results from treatment, with limited evidence on both the impact of clubfoot disability on life outcomes more generally, and on the degree and nature of restoration of these life outcomes with treatment. Our study is both the first quasi-experimental study on clubfoot intervention and the first to estimate effects across a broad array of child's life outcomes. The outcomes we study are also important as a check on the mission objectives of Hope Walks as a non-profit organization. Hope Walks is an NGO whose stated mission extends beyond clubfoot repair to a broader conception of human flourishing nested in the general framework of "integral human development" common to the faith-based NGO community today.

2.2 Data

We interviewed parents through Cure International hospitals in the Addis Ababa region and the surrounding areas of Adama and Hawassa. We designed surveys to be carried out via phone interviews due to the COVID-19 pandemic. All of the 564 children about whom we collected data were either past patients or were on the waitlist for treatment with Hope Walks from these partner hospitals. The first wave of data was collected between November 2021 to March 2022, while the second wave was collected from September to December 2023.

There are two distinct sample groups within this study. The first group includes treated patients and their nearest age sibling. To be included in the treated group, children must have been between six and eighteen years of age and born with congenital clubfoot. Additionally, they should have been fully treated or at least in the final stages of casting in the Ponseti intervention to be considered "treated".

The second group that was examined in our sample were yet untreated patients and their respective nearest-age siblings. Individuals in this group must have been between the ages of six and eighteen years old and born with congenital clubfoot, and had not yet begun treatment but were scheduled to begin treatment with one of the associated organizations. To find these individuals, we used a roster of patients who were scheduled to start treatment within the upcoming calendar year. The information on patients and their siblings, for both treatment groups, was obtained over the phone, at the same time, in the same location, and using the same survey to ensure that there were no confounding factors influencing the responses.

Our survey consisted of two main sections, the first of which aimed to develop a respondent profile by asking about basic demographic data as well as questions about the treatment plan and physical health of the sibling born with clubfoot. In this section, we record their contact information, the number of children in the family unit, languages spoken, and any religious affiliations. Additionally, the survey respondent was also asked about the child's initial diagnosis, such as the age at diagnosis and initial Pirani score. To conclude this section, we noted their current stage of treatment.

The second section of the survey focused solely on life outcomes. The first data gathered within this section relate to physical and mobility capabilities. We asked parents to rate their child with clubfoot and their nearest age sibling on a formal six-point mobility scale used commonly to assess clubfoot severity. Other questions in this domain include how easily their children can complete everyday activities, such as walking or partaking in sports. The following sub-section focused on psychological and faith questions. Parents were asked about the hopes and aspirations of their children. We also asked about the prevalence of anxiety, depression, and nervousness in children, as well as happiness, and involvement with their family's religious community. The last two domains analyzed within this section relate to social and educational outcomes. Parents were asked about the social behavior of their children and about the degree of social inclusion their children have within the community. We then collected information on children's educational attainment–i.e., if currently enrolled in school, when and why they dropped out of school (if applicable), and academic performance relative to other children their age.

3 Empirical model and results

3.1 Theory of Causal Change

A Directed Acyclic Graph (DAG) illustrating our empirical research framework and theory of change is given in Figure 1. The current body of medical knowledge attributes clubfoot to genetic, and possibly environmental and parental characteristics, such as maternal smoking and nutrition levels (Dobbs and Gurnett, 2009). Household characteristics may also lead to treatment (and the timing of treatment), which then affects the severity of the disability. The severity of the clubfoot disability (mitigated by treatment and proper timing of treatment) affects the appearance of a child's feet and legs and a child's mobility, which then jointly affect social, psychological, economic (including education) and faith variables, all of which relate to human flourishing in the integral human development framework adopted by Hope Walks.

To identify the effects of clubfoot status and clubfoot treatment, it is necessary to account for the backdoor path to the severity of disability through genetic, environmental, and household factors. This can be done through a household-level fixed effect if we assume that siblings share common genetic makeup, maternal behaviors and environmental exposure.

3.2 Empirical Model

We analyze the causal effects of clubfoot status and its treatment on five facets of human flourishing using a cross-sectional difference-in-differences method, nested within a household fixed effect. Our estimation compares adolescent life outcomes with treated clubfoot to the life outcomes of their nearest-age sibling. This difference is then compared to the difference between the adolescent life outcomes of untreated clubfoot patients and their own nearest-age siblings.

This identification framework requires three assumptions for obtaining unbiased ATT estimates of the effect from the intervention. The first assumption is that the occurrence of clubfoot occurs randomly to a sibling i within a given household j. Second, any factors (positive or negative) that affect both a child's selection into clubfoot treatment and life outcomes are common to all siblings. Third, the potential outcomes for clubfoot patients and siblings are constant and independent of clubfoot or treatment status–i.e., the stable-unit-treatment-value (SUTVA) assumption. Below, we discuss implications for our estimates from violations of these assumptions.

We estimate the following OLS equation using family-level fixed effects:

$$Y_{ij} = \alpha + \beta B_i + \tau_1 T_i + \tau_2 ET_i + X_i' \gamma + \theta_j + \epsilon_{ij} \tag{1}$$

where Y_{ij} represents outcomes that include physical/mobility, psychological health, social inclusion, education, and religious faith. T_i is a binary variable indicating clubfoot treatment, ET_i is a binary variable for early treatment (commencement of treatment before six months of age), X_i is a vector of controls that include age, birth order, and gender, θ_j is a family-level fixed effect, and ϵ_{ij} is the error term.

3.3 Threats to Identification

The main threats to the identification of average treatment effects on the treated in our estimates are (i) non-random instances of clubfoot across our sample population that are correlated with life outcomes; and (ii) violations of the stable unit treatment value (SUTVA) assumption, where instances of clubfoot, its treatment, and/or the age at treatment depend on the treatment status of others in the sample.

With respect to the first issue, both the genetic and environmental factors that are believed to cause clubfoot (Dobbs and Gurnett, 2009) should be common among siblings. As a result, we have little reason to doubt that clubfoot emerges randomly among siblings, conditional on mother-level characteristics absorbed in the fixed effect.

With respect to spillovers, the counterfactual generated in our estimation is the outcome of the nearest-age sibling of a child born with clubfoot, where the nearest-age sibling could be either younger or older. Unbiased estimation thus requires satisfying the SUTVA assumption. While it is difficult to construct an argument for *positive* spillovers from congenital clubfoot status onto a nearest-age sibling, it is conceivable that *negative* spillovers could exist. For example, siblings might be expected to help provide care; or perhaps their own mental health and/or social inclusion might be affected by their sibling's clubfoot status. If such negative spillovers exist onto siblings from children born with clubfoot, this would also create positive spillovers from clubfoot treatment of a sibling. These spillovers would tend to bias *downward* both the estimated disadvantage of congenital clubfoot status and the restorative effect of treatment. Thus to the extent that these types of spillovers exist, they would render our estimates to be lower bounds of true effect sizes.

3.4 Descriptive Statistics

Table 1 gives summary statistics for our sample of Ethiopian children. Our sample consists of pairs of siblings, one born with clubfoot and this child's nearest age sibling. Table 1 column (1) gives the mean values for children whose sibling is an untreated child with clubfoot. The mean outcomes for the untreated sibling are displayed in column (2). Column (3) gives the outcomes for the sibling of a treated child, who can then be compared to their treated sibling in column (4). The table shows that families of untreated children tend to be poorer and more rural than those with treated children, differences we control for through the household-level fixed effect.

3.5 Impacts on Human Flourishing Outcomes

Here we estimate the impact of both clubfoot status and clubfoot treatment on physical mobility, psychological outcomes, social inclusion, education, and religious faith. Each of these are created from an index of individual outcomes from our survey data. A more detailed analysis of the impacts of clubfoot status and treatment within each of these areas can be found in the Appendix. From these five main outcome areas we create an index of overall human flourishing using the method of Kling et al.(2007), which consists of the standardized sum of each of these standardized indices.

As seen in Table 2, clubfoot status causes an enormous reduction in physical mobility of 1.44σ ($p < 0.001$). Physical mobility (col. 1) is comprised of an index of the distance a child is able to walk, comfort in walking, ability to participating in and enjoy sports, and frequency of reports of tired legs and feet. Early treatment does not fully restore physical mobility, but does so substantially by 0.91σ ($p < 0.001$). Table 2 also shows that treatment initiated past six-months of age does not display any statistically significant impact on restoration of physical mobility.

Clubfoot status also causes starkly lower levels of mental health, reducing a psychological health index based on sub-indices of parental reports of self-esteem, aspirations, anxiety, and depression by 1.17σ ($p < 0.001$). Again, early treatment is essential and restores mental health by 0.79σ ($p < 0.001$), or about 68% of the decline in mental health caused by clubfoot birth status.

Table 2 shows the dramatically lower levels of social inclusion faced by children born with clubfoot in our Ethiopian sample. Untreated clubfoot causes a 1.07σ ($p < 0.001$) reduction in social inclusion, which is an index created from questions related to the number of other children a child would call a friend, frequency of leaving the home to be with friends, inclusion in social circles, whether a family is "proud to have the child in the family", and frequency of bullying. Early clubfoot treatment restores about 60% of this social inclusion index, with a positive impact of 0.64σ ($p < 0.001$).

We find somewhat smaller (but still precisely measured) impacts from clubfoot birth status on education. Our index of educational outcomes consists of whether a child attended any school before the first year of primary school (pre-school or kindergarten), current enrollment status, current grade level, and academic performance. Our estimates show a 0.48σ loss in our education index from clubfoot status but a 0.98σ (both $p < 0.001$) gain from early clubfoot treatment, more than closing the gap with the education outcomes of nearest-age siblings. We speculate that this may be related to children with remaining physical challenges finding a comparative advantage in education and vocations for which physical labor is less essential.

Hope Walks is a faith-based NGO with missional objectives related to a conception of human flourishing that includes faith outcomes. An important question for the organization is the extent to which being born with a disability such as clubfoot prevents a person from participating in their religious community or perhaps even causes them to question the values, faith, or religious beliefs of their family and community. Participants in our study were from three religious groups: Muslim (27.1%), Orthodox Christian (47.9%), and Protestant Christian (25.0%). Our survey questions were general and were intended to be applicable to all of these groups. Our faith index is comprised of questions that asked about the degree of involvement of a child in their local faith community, the importance of religious belief in the child's life, and whether the child participates in religious youth activities. Clubfoot status causes a decline in this index of 0.76σ.[3] Early clubfoot treatment restores most of this negative impact (0.42σ, $p < 0.05$), but less fully (55.2%) than other outcome areas.

Clubfoot status among children reduces our aggregate human flourishing index by 1.32σ ($p < 0.001$); early treatment restores the index by 0.94σ ($p < 0.001$), a restoration of human flourishing of 71.0%. Again we note that all significant impacts that we see across areas of human flourishing, including the aggregated index, are driven by early treatment. Figure 2 shows kernel density functions of this human flourishing index across treatment status. In the lower panel of Table 2, we show estimations that combine treatment at all stages, where the coefficients on treated clubfoot retain precision but are now substantially lower, as a result of including children treated after six months of age.

[3] Appendix Table A10 shows all of the faith sub-areas to be significantly and negatively impacted, with simple participation in the faith community showing the largest negative impacts.

3.6 Robustness Checks

As a robustness check, we regenerated each of our mobility, psychological health, social inclusion, faith, and education indices using the method of Anderson (2008). This method corrects for covariance between components, weighting down variables that are highly correlated with others in the index, and weighting up variables that show higher unique variation. As seen in Table A11 none of our results or levels of significance substantially change for any of these indices. Our human flourishing index gives somewhat smaller point estimates, especially on the impact of clubfoot status, 1.06σ ($p < 0.001$). The impact of early treatment is 0.88σ ($p < 0.001$) and the restoration percentage increases to 81.5%. We also carried out robustness checks using alternative sets of control variables, trimming our sample to closer age bands, and running estimations conditional on different levels of income. In each of these checks, we find strongly congruent impacts on our outcome indices from clubfoot status and treatment, with similarly high levels of significance.

3.7 Heterogeneous Effects

Estimations in Appendix Table A12 show little evidence in support of heterogeneous treatment effects by gender for either clubfoot status or treatment. Clubfoot is about twice as common among male children (also roughly true in our sample). Our impact estimates show that boys are slightly less affected by congenital clubfoot status, although the coefficient is only strongly statistically significant for social outcomes and is marginally significant in the overall IHD index. Early treatment also appears to be more important for boys. The table also shows that there is no systematic evidence for heterogeneous treatment effects by income level.[4]

[4]Eighteen of our estimated coefficients interacted with income are of relatively low magnitude and none reach statistical significance.

3.8 Barriers to Treatment

Given the tragic declines across key life outcomes from untreated clubfoot and the effectiveness of early treatment, one may wonder why such a large portion of children born with clubfoot remain untreated. In LMICs, numerous barriers hinder individuals from seeking essential health treatments, exacerbating the burden of both disease and congenital abnormalities. The global health literature has highlighted a series of prominent obstacles: financial constraints, geographical frictions, perceptions of sub-standard care, cultural beliefs, and social stigmas surrounding certain illnesses.

Drew et al. (2016) use a socio-ecological model to study five interrelated factors that affect patient access and engagement with clubfoot treatment in LMICs: intrapersonal, interpersonal, institutional, socio-cultural, and public policy barriers. They find the most binding factors to be intrapersonal, institutional, and public policy barriers. Intrapersonal barriers included a lack of cash needed for treatment and the additional responsibilities associated with clubfoot care. Institutional barriers include long distances to treatment centers and insufficient information about treatments, and the challenges of maintaining home treatment. At the public policy level, the two-tiered healthcare system often present in LMICs, such as Ethiopia, have made it impossible for some groups to access timely care (Drew et al., 2016).

As part of our fieldwork, we investigated which obstacles to clubfoot treatment, across these different areas, carried the most weight within our Ethiopian sample. Informed by the literature and guided by the insight of our NGO partner, we developed a series of questions on barriers to clubfoot treatment that we administered to a subset of our sample (N=136). Responses were collected on a total of 14 questions relating to distinct factors that could prevent seeking treatment. These factors were: (1) cost, (2) distance, (3) knowledge that condition is treatable, (4) knowledge about the severity of the condition, (5) knowledge of availability of treatment, (6) time, (7) social pressure, (8) belief that disability is part of a Divine plan, (9) trust in traditional healers, (10) feelings of shame associated with treatment, (11) fear of ineffective treatment, (12) false belief that the condition had been treated, (13) worry about quality of clinics, and (14) long wait times.

Table 3 shows that of the fourteen barriers we included in our survey, there were six that the majority of mothers (i.e. more than half) listed to be a strong deterrent to seeking treatment: lack of knowledge about the availability of treatment (76.47%); living too far away from available clubfoot treatment centers (70.59%); lack of time for treatment due to other obligations (66.91%); inability to afford costs associated with treatment (64.71%); lack of knowledge that condition is treatable (63.97%); and lack of knowledge about severity of the condition (56.62%).

The responses from our sample point to logistical and informational barriers as a greater obstacle for accessing clubfoot treatment relative to socio-cultural factors. At least in our Ethiopian context, this suggests a largely informational and supply-side challenge, as opposed to constraints deeply rooted in cultural beliefs or social norms. These responses also portend well for the impact of additional resources allocated to increasing both information and access, where high impact is likely to be matched by high take-up, making impact at an "intent-to-treat" (ITT) level likely to be high. Moreover, it provides a rationale for development NGOs and specialized government ministries seeking to make treatment of congenital birth defects such as clubfoot available in remote regions. By addressing tangible hurdles such as the dissemination of information about treatment options and access to treatment facilities, the volume of treatment of a substantively life-changing intervention might be significantly increased.

4 Discussion

While addressing issues of inequity and inclusion in LMICs for those coping with disabilities is a theme throughout the U.N.'s Sustainable Development Goals, there is a lack of research documenting the causal impacts of congenital abnormalities and the impacts of treatment across human life outcomes. Our paper helps to close this gap in the literature by establishing valid counterfactuals on life outcomes for congenital clubfoot status and for the Ponseti clubfoot treatment. We summarize here our main conclusions:

First, we estimate that untreated congenital clubfoot causes an enormous 1.19σ decline in a holistic human flourishing index, mediated by large and statistically significant declines in physical mobility, mental health, social inclusion, educational, and faith outcomes. To provide a sense of this magnitude, the negative impacts we estimate from untreated clubfoot are approximately three times larger than those found from untreated cleft palate which, in a study of the work of Operation Smile in India, saw a loss in a similar index of human flourishing of 0.37σ (Wydick et al., 2022).

Second, we find the Ponseti clubfoot intervention to realize large and significant impacts across all of our five facets of human flourishing. Overall, we estimate that early treatment restores between 71-82% of human flourishing lost from congenital clubfoot in our Ethiopian sample depending on the type of summary index. Hope Walks lists its cost of the intervention at approximately $500 per patient in the low-income countries where it operates. We find impacts on human flourishing from clubfoot surgery to compare favorably to those from cleft palate repair (Wydick et al., 2022), which carries a similar cost to health NGOs in low-income countries. Cataract surgery has also been shown to have far-ranging impacts across many life outcomes, including employment and wages (Flessa, 2022). The estimated cost of cataract surgery (and follow-up) in LMICs ranges between US$300-400 (Meltzer et al., 2017; Flessa, 2022), which is slightly lower than for clubfoot intervention. However, it is difficult to make a direct comparison of impacts on human flourishing outcomes with the cataract research, which does not use similar causal methods and studies a different set of categorical outcomes.[5]

[5]Beyond surgical interventions, deworming programs targeting children have been celebrated as a benchmark health intervention for cost-effectiveness, with estimates as low as $0.50 per child treated [WHO]. Hotez et al. (2007) found that mass deworming interventions in children led to significant improvements in cognitive function and school attendance. Hamory et al. (2021) find significant impacts from early deworming on key life outcomes 20 years after initial intervention. Deworming programs, however, often require large campaigns, high levels of compliance, and sustained intervention.

Interventions that realize large, clear, and broad effects on human outcomes are uncommon, and we believe the reason for these unusually large effects lies in several factors. One is that the Ponseti method is a medically proven intervention, used throughout western medicine as an extremely effective method for treating clubfoot to such an extent that world-class athletes born with clubfoot have excelled at the highest levels of athletic achievement after receiving the Ponseti treatment.[6] However, as the data in our sample illustrate, the counterfactual to proper clubfoot treatment in a low-income country such as Ethiopia is tragically bleak. Indeed one could argue that individuals with untreated congenital abnormalities from impoverished households in low-income countries may be among the most disadvantaged persons on a global level. Thus the combination of an extremely dire counterfactual combined with a very effective treatment, even when applied imperfectly, creates the scope for extremely large treatment effects.

Importantly, our results on the impacts of clubfoot treatment on facets of human flourishing find early treatment ($\leq$ six months) to be essential for significant impact on later-life outcomes. Indeed, we find no evidence of life outcome impacts for clubfoot intervention that is commenced after this point. A clear implication from this is the importance of informational campaigns in rural and remote areas that identify children born with clubfoot so that they can be treated in early infancy.

[6] Olympic figure-skating champion Kristi Yamaguchi, football quarterback Troy Aikman, and U.S. soccer player Mia Hamm were each born with congenital clubfoot.

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Figures

Figure 1: DAG: How Clubfoot Status and Treatment Affect IHD Outcomes

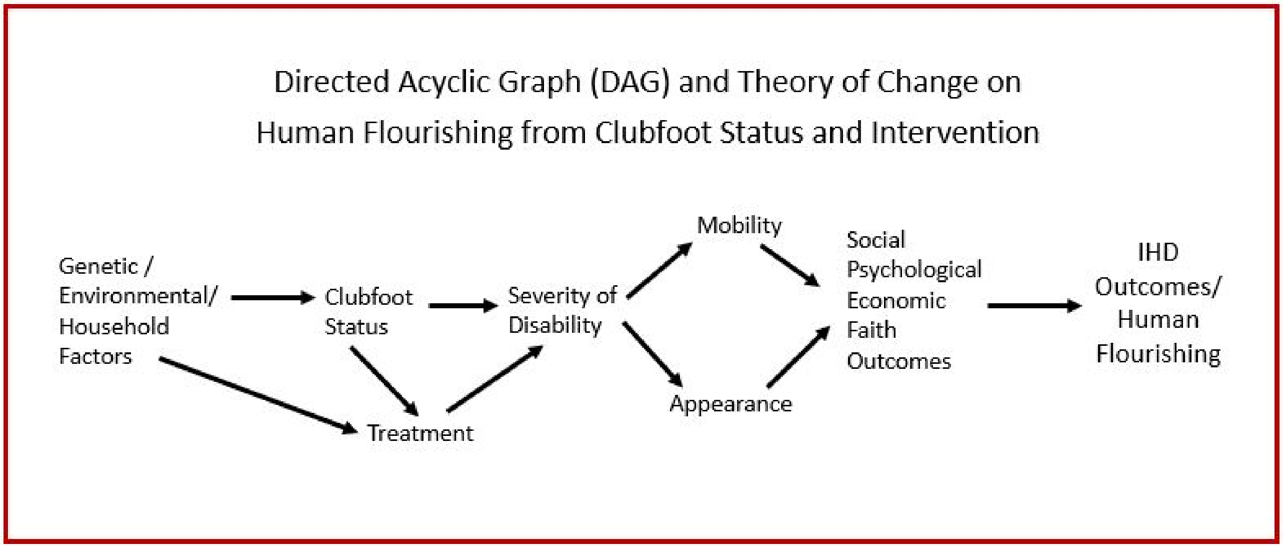
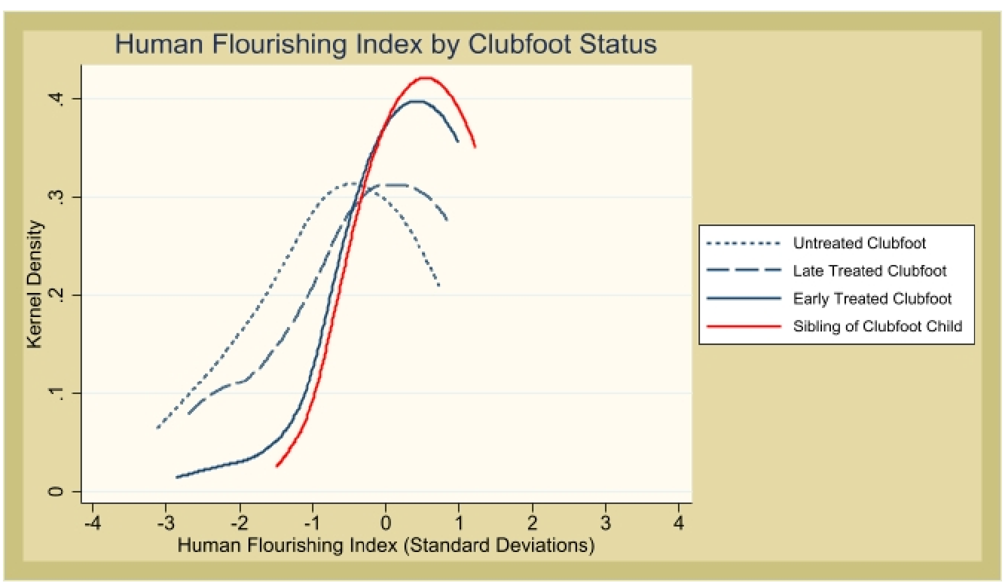


Figure 2: Human Flourishing Index Across Clubfoot Treatment Status



Tables

Table 1: Summary Statistics: Hope Walks

	(1) Sib, Untreated		(2) Untreated CF		(3) Sib, Treated		(4) Treated CF	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age of Child	8.95	4.75	11.40	3.25	10.32	4.68	7.92	2.03
Male Gender	0.62	0.49	0.62	0.49	0.56	0.50	0.66	0.48
Birth Order	2.67	1.66	2.83	1.86	1.82	1.08	2.10	1.25
Monthly Income (Birr)	3,142	2,407	3,223	2,404	5,905	11,215	5,750	10,712
Family in Agriculture	0.80	0.40	0.80	0.41	0.62	0.49	0.62	0.49
Mobility index	0.61	0.36	-0.80	0.89	0.61	0.23	-0.43	1.19
Psychological Health index	0.51	0.31	-0.65	1.07	0.43	0.39	-0.30	1.25
Aggregate Social index	0.47	0.61	-0.61	1.07	0.39	0.64	-0.26	1.13
Education Outcomes index	0.19	0.89	-0.09	1.03	0.20	0.81	-0.25	1.14
Faith Outcomes index	0.47	0.71	-0.27	1.15	0.21	0.80	-0.31	1.06
IHD Index	0.59	0.42	-0.68	0.98	0.50	0.39	-0.39	1.20
Observations	112		116		163		173	

Table 2: Summary Outcomes: Human Flourishing

	(1) Physical	(2) Psych	(3) Social	(4) Educ	(5) Faith	(6) HF Index
Born Clubfoot	-1.443***	-1.171***	-1.071***	-0.477***	-0.762***	-1.320***
	(0.0893)	(0.0922)	(0.0892)	(0.116)	(0.0942)	(0.0836)
Treated Clubfoot	-0.188	-0.117	-0.0368	-0.420	-0.0721	-0.183
	(0.196)	(0.176)	(0.165)	(0.238)	(0.156)	(0.180)
Early Treat	0.905***	0.790***	0.642***	0.980***	0.415*	0.937***
	(0.212)	(0.167)	(0.172)	(0.249)	(0.160)	(0.189)
Born Clubfoot	-1.413***	-1.145***	-1.050***	-0.445***	-0.748***	-1.29***
	(0.0886)	(0.0914)	(0.0888)	(0.115)	(0.0937)	(0.0822)
Treated Clubfoot	0.310*	0.317*	0.316**	0.120	0.156	0.332**
	(0.135)	(0.129)	(0.120)	(0.167)	(0.120)	(0.124)
N	564	564	564	564	564	564
MotherFE	Yes	Yes	Yes	Yes	Yes	Yes

Upper regression includes control for early treatment; lower regression does not control for early treatment.
Standard errors clustered at the household level in parentheses.
Regressions control for age, gender, and birth order of children.
Percent restoration of human flourishing index with early surgery = 71.0%
Joint (Index) Test of Clubfoot + Treatment + Early Treatment, -0.57, $p < 0.01$.
Joint (Index) Test of Clubfoot + Treatment, -0.96, $p < 0.01$.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3: Barriers to Clubfoot Treatment

No.	Barrier	Prevalence (%)	N
1	Treatment availability	76.47	136
2	Distance	70.59	136
3	Time	66.91	136
4	Cost	64.71	136
5	Doubt clubfoot treatable	63.97	136
6	Unclear clubfoot severity	56.61	136
7	Shame	36.76	136
8	Treatment ineffective	34.56	136
9	Wait time	28.67	136
10	Pressure	20.59	136
11	Assumed treated	19.12	136
12	Belief availability	18.38	136
13	Traditional healers	7.35	136
14	Clinic quality	5.15	136

Note: Respondents were allowed to list as many barriers to treatment as applicable in their context.

Online Appendix

In the appendix we provide a more detailed analysis of the outcomes in each of our specific areas of human flourishing with accompanying figures and tables.

Physical Outcomes

Figure A1 shows a kernel density function showing clubfoot and treatment status related to physical mobility. The figure shows siblings of children born with clubfoot (who themselves were not born with clubfoot) to clearly have the highest level of mobility, followed by children with early treated clubfoot, children with late treated clubfoot, and children born with clubfoot who remained untreated at the time of the survey. Early treatment appears to function particularly well at reducing the left tail of the distribution, though density at the peak levels of mobility is lower than children born without clubfoot.

Table A1 references results from foot appearance and size. Children born with clubfoot score 0.73σ lower on a scale relating to being able to fit into shoes of their choice. Mothers are much less likely to report that their child's feet are the same size (column 2), that they appear to others as being of a different size (column 3), that their feet appear "normal" to others (column 4). An index of foot appearance lies 1.5σ below children without clubfoot. Early treatment for clubfoot does not erase perceptions of foot disfigurement or size, but significantly mitigates these problems, particularly in the perceptions that feet appear "normal" to others. We find no significant impact from late treated clubfoot (initiation of treatment after six months of age) on foot appearance. In our estimations, early Ponseti treatment restores 52.1% of our index of foot appearance, and a joint F-test of the three coefficients (born with clubfoot, treatment, and early treatment) rejects full restoration at $p < 0.01$, although it is clear that the intervention is effective at mitigating about half the magnitude of problems related to foot-appearance resulting from clubfoot.[7]

[7] An index of foot pain, not shown in the table, increases by 1.35σ and is reduced by early treatment by 0.34σ.

Children born with clubfoot in the Ethiopian sample unsurprisingly report 1.09σ lower on the commonly used mobility scale.[8] As can be seen in Table A2, congenital clubfoot reduces every facet of mobility in our survey by over a standard deviation: mobility scale, distance able to walk, comfort walking, ability to play sports, enjoyment of sports, and complaints of tiredness of feet and legs when active. Late-treated clubfoot has no significant impact on later mobility, and while early treatment does not restore full mobility (p ¡ 0.01) on average it restores 50.1% of mobility based on our mobility index.

Psychological Outcomes

Figure A2 shows the density function for mental health of children treated early for clubfoot to nearly replicate the density across mental health outcomes of their siblings, while late-treated and untreated children display density functions that lie increasingly further to the left, respectively. Table A3 shows the great toll to which a disability such as clubfoot inflicts on the mental health of children in a low-income country. Based on Likert scale questions, mothers indicate that when children born with clubfoot are mistreated, they are far more likely to believe that they deserve the mistreatment. Prevalence of worrying (1.06σ) and self-criticism (1.51σ) are more than a standard deviation higher, feeling respected (-1.15σ) and comfortable with their appearance (-1.64σ) more than a standard deviation lower with an index of self-esteem -1.53σ lower than nearest-age siblings. Late treated clubfoot shows no significantly positive impact on self-esteem except perhaps in comfort with one's appearance, while early treatment has large effects on restoring self-esteem (66.4%) although not fully ($p < 0.01$).

Impacts of congenital clubfoot and clubfoot treatment on hope and aspirations are in Table A4. These relate to believing that they will finish secondary school, obtain a university degree, have a ”good job” in the future, be ”happily married”, and ”have dreams and

[8] The mobility scale grades on a scale of 1-use of wheelchair only; 2-use of walker; 3-use of crutches; 4-use of sticks; 5-independent on level surfaces to 6-independent mobility on all surfaces.

plans for a good life". They indicate that the effects of both clubfoot status and treatment are somewhat lower on children's hope and aspirations than on self esteem and show impacts in the -0.3σ to -0.7σ range, but that early treatment is able to partially restore (p ¡ 0.01) most of these hopes and aspirations by about 0.3σ to 0.4σ standard deviations, overall 62.4% of the damage to these areas caused by clubfoot.

Table A5 gives results for impacts on anxiety, specifically for Likert scale responses related to a child's general nervousness, anxiety about specific life events, or fear of an unknown tragic event. Negative impacts from congenital clubfoot on the prevalence of anxiety are smaller than the effects on self-esteem, but greater than the effects on hope and aspirations, lying in the 0.7σ to 0.9σ range with the impact on the aggregated anxiety index at 0.83σ. Children with late-treated clubfoot actually seem to have *higher* rates of anxiety than untreated children, but the impacts from early treatment are such that they are able to mitigate 40.7% of clubfoot-induced anxiety.

Along with lowering self-esteem, hope, and aspirations and raising levels of anxiety, we find that clubfoot also gives rise to depression. Table A6 shows our index of depression, which consists of children having low motivation, feeling "down, depressed or hopeless", feeling "bad about themselves", and feeling unhappy. Depression increases by 1.04σ with congenital clubfoot, but decreases by 0.79σ with early treatment, although later treatment is associate with slightly higher (though mostly statistically insignificant) increases in depression. Overall, our estimates show early treatment is able to mitigate 69.32% of this depression. Our overall psychological health index (column 7 in Table A6) decreases by 1.17σ from clubfoot, where our estimates show early treatment is able to restore 57.3% of the decline in mental health resulting from clubfoot status though we can reject full restoration at $p < 0.01$.

Social Outcomes

The first row of Table A7 shows the impact on various facets of children's social inclusion: hours per day playing outside the home, number of friends, leaving the house in the company of friends, the extent to which a child feels included in society, quality of a child's relationships, frequency of bullying and teasing, and the extent to which the extended family are "proud and happy to have the child as a family member". There is no significant effect of clubfoot on the number of friends a child has, but there are large effects on any measure of social inclusion that requires mobility outside the home. Negative effects on social inclusion display a wide range, from insignificant (friendships) to 1.4σ (frequency of bullying), where the impact on the overall social inclusion index is -1.15σ.

We estimate that early clubfoot treatment restores 56.5% of the loss of social inclusion due to congenital clubfoot, where the impact on the reduction in bullying is especially notable. Even late treatment reduces approximately half (49.6%) of bullying from clubfoot, but early treatment reduces 86.7% of bullying, obviously creating an immense positive impact on the lives of children in one of the areas most negatively affected by clubfoot status. Figure A3 shows the marked difference in clubfoot treatment status, where raw outcomes from early treatment are virtually identical to nearest-age siblings and late treated and untreated children show lower modes and much thicker left tails.

Table A8 shows results on pro-social behavior, where congenital clubfoot causes problems with children meeting new people (-0.53σ), choosing to remain alone (0.98σ), sharing food, toys and other things with others (-0.40σ), feeling nervous around new people (-1.08σ). Clubfoot status has no significant effect on a child being helpful to others when someone else is feeling upset or ill. In areas of pro-social behavior where there are negative impacts from clubfoot, late treatment is statistically ineffective, but early treatment on average restores 57.2% of pro-sociality.

Educational Outcomes

Figure A4 shows kernel density outcomes over an educational outcomes index. Impacts from both clubfoot and clubfoot treatment on education are lower than physical, psychological, and social outcomes, but are significantly manifest in the data. Modes in educational outcomes in the figure are relatively similar, but many late-treated and untreated children born with clubfoot display a far higher prevalence of outcomes that are 2-3σ below the mean.

Impact results are shown in Table A9 and show significantly lower attendance at prekinder schools and kindergarten, which typically occurs before primary school begins at age 7 in Ethiopia. Children born with clubfoot are less likely to be enrolled in school, slightly more likely to be enrolled at a lower level in school than others their age, and have lower levels of school performance, although the latter two outcomes do not reach statistical significance. An education index of these outcomes shows an impact of -0.48σ on education outcomes ($p < 0.01$).

Impacts on educational outcomes from early treatment are substantial, more than fully restoring age-appropriate status for school level such that early clubfoot status restores 117% of outcomes in our schooling index. It is possible that this may be due to a combination of factors.

While early treatment significantly restores mobility, it only partially restores it generally (see Table A2), but fully restores it with respect to enrollment in school. This may create a scenario for some children in which their ability to attend school combined with their remaining (somewhat) lower ability to play sports leads them to spend more time in study, thus accounting for the very substantial (0.56σ) impact (see column 4) on school performance from early treatment.

Faith and Spirituality Outcomes

Figure A5 shows kernel densities across clubfoot status for faith and spirituality outcomes, where outcomes show higher levels of spiritual belief and engagement in religious activities for children born without clubfoot and early-treated children relative to late treated and untreated children.

Table A10 shows that these results appear to be driven at least partially by the ability of children to be physically present at religious gatherings, where there are large impacts from early treatment on faith community involvement and participation in youth activities. We find that clubfoot treatment, regardless of timing, restores spiritual belief: Clubfoot status results in a difference in a 0-10 degree index to the question "How important is religious faith and the local faith community in this child's life?" of -0.54σ. Treatment for clubfoot restores this degree of importance of religious faith by a nearly identical 0.53σ, where the timing of treatment (early or late) yields no significant difference to impact.

Figure A1: Physical Mobility Across Clubfoot Treatment Status

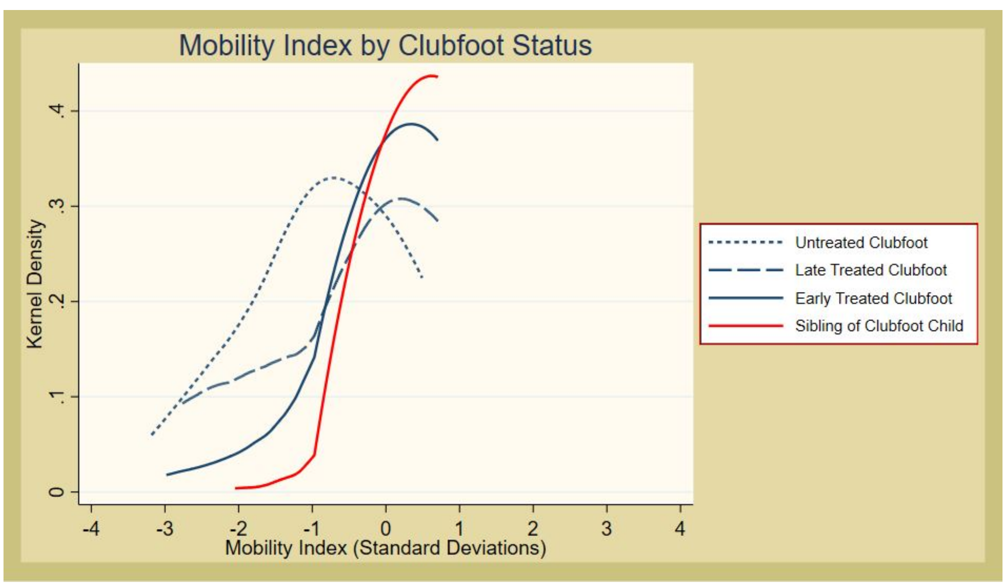


Figure A2: Psychological Health Index Across Clubfoot Treatment Status

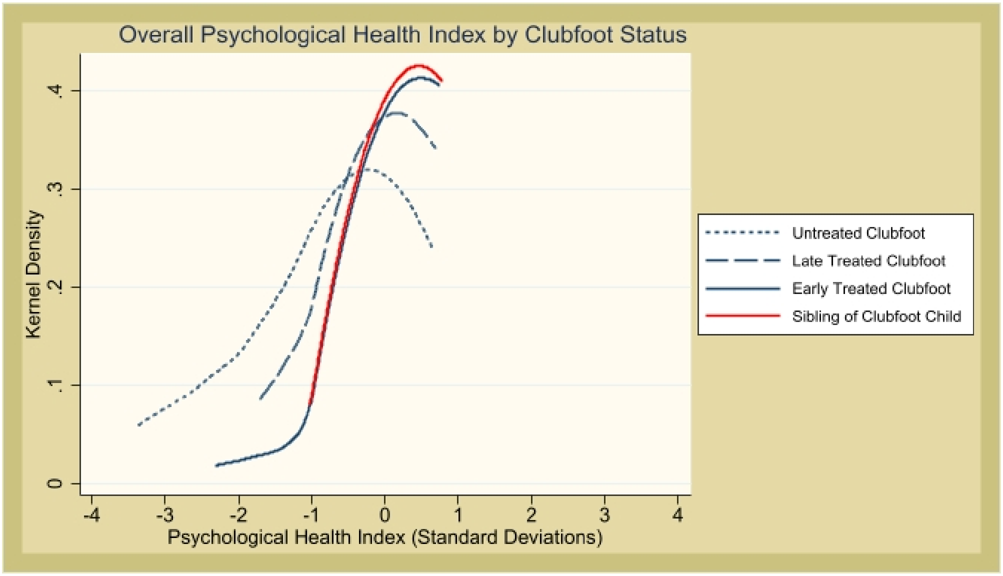


Figure A3: Social Inclusion Index Across Clubfoot Treatment Status

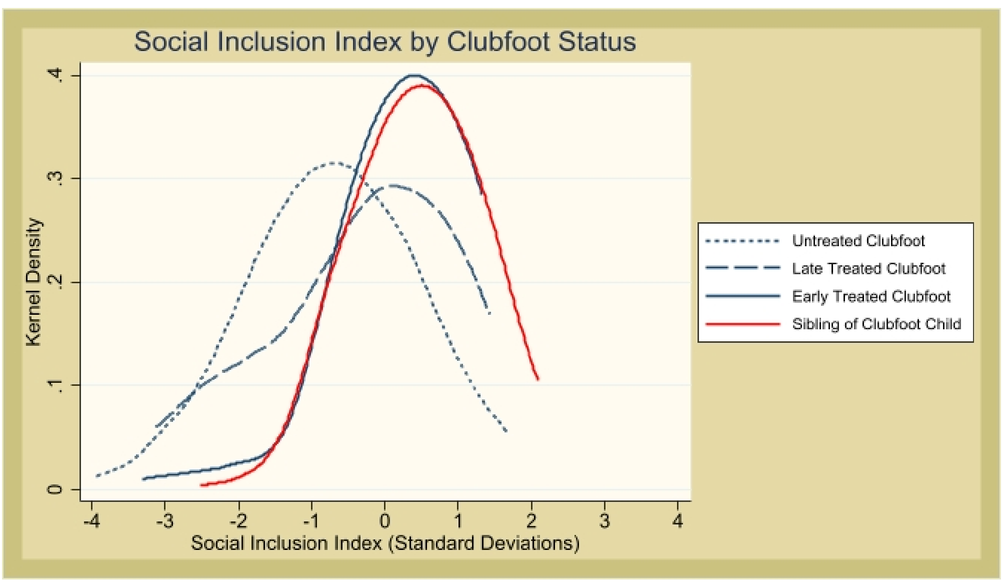


Figure A4: Education Index Across Clubfoot Treatment Status

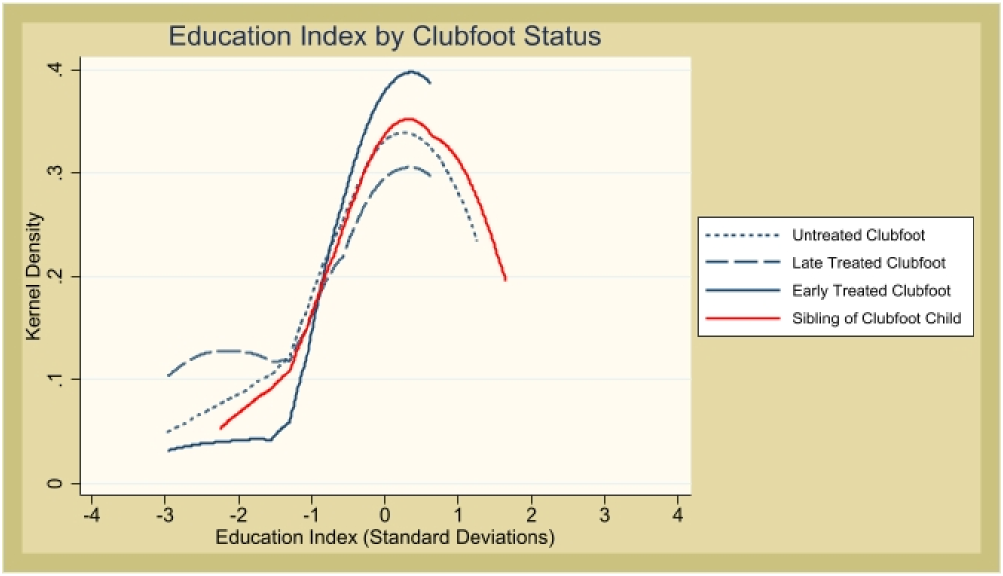


Figure A5: Faith and Spirituality Index Across Clubfoot Treatment Status

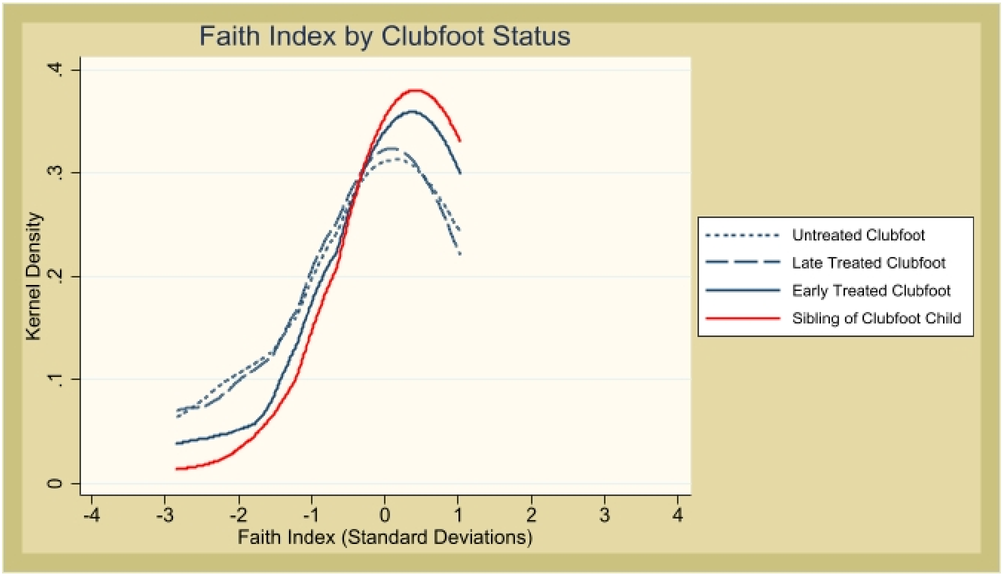


Table A1: Foot Symmetry and Appearance

	(1) Shoes Fit	(2) Feet Symm	(3) Appearance	(4) Perception	(5) Foot Index
Born with Clubfoot	-0.726***	-0.605***	-1.672***	-1.746***	-1.479***
	(0.129)	(0.124)	(0.0924)	(0.0843)	(0.0955)
Treated for Clubfoot	-0.537*	-0.384	0.256	0.184	-0.150
	(0.259)	(0.247)	(0.185)	(0.172)	(0.209)
Early Treatment	0.926***	0.476*	0.745***	0.798***	0.917***
	(0.234)	(0.227)	(0.192)	(0.183)	(0.206)
N	564	564	564	564	564
MotherFE	Yes	Yes	Yes	Yes	Yes

Clustered standard errors at the household level are in parentheses.
Regressions control for age, gender, and birth order of children.
Percent restoration of index with early surgery = 52.1%
Joint (Index) test of Clubfoot + Treatment + Early Treatment = -0.71, $p < 0.01$
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A2: Mobility and Participation in Sports Activities

	(1) Mobility	(2) WalkDis	(3) WalkCom	(4) SptAbl	(5) SptEnj	(6) Tired	(7) Mob. Index
Born Clubfoot	-1.086***	-1.254***	-1.012***	-1.432***	-1.546***	1.120***	-1.443***
	(0.110)	(0.112)	(0.115)	(0.101)	(0.0991)	(0.110)	(0.0893)
Treated Clubfoot	-0.388	-0.212	-0.521*	-0.0825	0.00835	-0.224	-0.188
	(0.232)	(0.213)	(0.219)	(0.190)	(0.187)	(0.218)	(0.196)
Early Treat	0.836**	0.821***	1.046***	0.818***	0.879***	-0.271	0.905***
	(0.253)	(0.216)	(0.221)	(0.199)	(0.198)	(0.207)	(0.212)
N	564	564	564	564	564	564	564
MotherFE	YES	YES	YES	YES	YES	YES	YES

Standard errors clustered at the household level in parentheses.
Regressions control for age, gender, and birth order of children.
Percent restoration of index with early surgery = 50.1%
Joint (Index) test of Clubfoot + Treatment + Early Treatment, -0.72, $p < 0.01$
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A3: Self-Esteem

	(1) Mistreats	(2) Worries	(3) Respected	(4) Appearance	(5) Selfcritic	(6) Self-Est. Index
Born Clubfoot	0.937***	1.058***	-1.157***	-1.638***	1.515***	-1.526***
	(0.130)	(0.139)	(0.115)	(0.102)	(0.112)	(0.0946)
Treated Clubfoot	-0.108	-0.309	0.154	0.452*	-0.638***	0.402*
	(0.201)	(0.206)	(0.182)	(0.180)	(0.187)	(0.162)
Early Treat	-0.518**	-0.409*	0.604***	0.551**	-0.432*	0.608***
	(0.183)	(0.181)	(0.159)	(0.182)	(0.179)	(0.165)
N	564	564	564	564	564	564
MotherFE	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at the household level in parentheses.
Regressions control for age, gender, and birth order of children.
Percent restoration of index with early surgery = 66.4%
Joint (Index) test of Clubfoot + Treatment + Early Treatment, -0.52, $p < 0.01$
* $p < 0.05$), ** $p < 0.01$, *** $p < 0.001$

Table A4: Hope and Aspirations

	(1) SecondSch	(2) University	(3) GoodJob	(4) HapMarried	(5) Dreams	(6) Aspir Index
Born Clubfoot	-0.668***	-0.746***	-0.271*	-0.625***	-0.695***	-0.785***
	(0.107)	(0.111)	(0.123)	(0.0949)	(0.100)	(0.108)
Treated Clubfoot	0.0919	-0.0886	0.212	-0.0164	0.0224	0.0578
	(0.173)	(0.181)	(0.227)	(0.149)	(0.167)	(0.176)
Early Treat	0.334*	0.516***	-0.0392	0.414***	0.412**	0.428**
	(0.137)	(0.148)	(0.213)	(0.123)	(0.134)	(0.150)
N	564	564	564	564	564	564
MotherFE	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at the household level in parentheses.
Regressions control for age, gender, and birth order of children.
Percent restoration of index with early surgery = 62.4%
Joint (Index) test of Clubfoot + Treatment + Early Treatment, -0.30, $p < 0.01$
* $p < 0.05$),** $p < 0.01$, *** $p < 0.001$

Table A5: Anxiety

	(1) Nervous	(2) Anxiety	(3) Fear	(4) Anxiety Index
Born Clubfoot	0.748***	0.875***	0.820***	0.835***
	(0.122)	(0.123)	(0.122)	(0.123)
Treated Clubfoot	0.679**	0.653*	0.602*	0.661**
	(0.250)	(0.255)	(0.252)	(0.252)
Early Treat	-0.939***	-1.049***	-0.938***	-1.000***
	(0.216)	(0.223)	(0.217)	(0.220)
N	564	564	564	564
MotherFE	Yes	Yes	Yes	Yes

Standard errors clustered at the household level in parentheses.
Regressions control for age, gender, and birth order of children.
Percent restoration of index with early surgery = 40.7%
Joint (Index) test of Clubfoot + Treatment + Early Treatment, -0.50, $p < 0.01$.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A6: Depression

	(1) Low Motiv	(2) Depressed	(3) FeelFailure	(4) Happy	(5) Depr Index	(6) Psych Index
Born Clubfoot	0.408***	0.870***	0.911***	-1.375***	1.042***	-1.171***
	(0.0618)	(0.122)	(0.137)	(0.0996)	(0.101)	(0.0922)
Treated Clubfoot	0.0249	0.598*	0.0469	-0.0778	0.218	-0.117
	(0.127)	(0.255)	(0.241)	(0.194)	(0.193)	(0.176)
Early Treat	-0.280**	-0.992***	-0.637***	0.797***	-0.791***	0.790***
	(0.104)	(0.219)	(0.181)	(0.184)	(0.175)	(0.167)
N	564	564	564	564	564	564
MotherFE	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at the household level in parentheses.
Regressions control for age, gender, and birth order of children.
Percent mitigation of depression with early surgery = 69.2%
Percent restoration of psychological health index with early surgery = 57.3%
Joint (Index) test of Clubfoot + Treatment + Early Treatment, -0.50, $p < 0.01$.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A7: Social Inclusion

	(1) Play	(2) Friends	(3) Outside	(4) Incl'd	(5) Relat	(6) Bullied	(7) FProud	(8) SocInc Index
Bn CF	-0.630***	0.0915	-0.453***	-0.983***	-1.085***	1.426***	-0.278*	-1.152***
	(0.120)	(0.132)	(0.0945)	(0.115)	(0.0980)	(0.121)	(0.108)	(0.0957)
T'ed CF	-0.512*	-0.267	0.100	-0.314	-0.226	-0.709***	0.0136	-0.143
	(0.215)	(0.220)	(0.171)	(0.205)	(0.187)	(0.186)	(0.156)	(0.188)
Early Trt	0.822***	0.0593	-0.133	0.854***	0.916***	-0.527**	0.178	0.785***
	(0.243)	(0.218)	(0.203)	(0.197)	(0.184)	(0.159)	(0.150)	(0.200)
N	564	564	564	564	564	564	564	564
MotherFE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at the household level in parentheses.
Regressions control for age, gender, and birth order of children.
Percent restoration of index with early surgery = 56.5%
Joint (Index) test of Clubfoot + Treatment + Early Treatment, -0.51, $p < 0.01$.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A8: Pro-Social Behavior

	(1) MeetPeople	(2) ChooseAlone	(3) Helpful	(4) Shares	(5) NervMtg	(6) SocBehav Index
Born Clubfoot	-0.525***	0.977***	-0.100	-0.402*	1.077***	-0.826***
	(0.0883)	(0.122)	(0.109)	(0.156)	(0.120)	(0.0955)
Treated Clubfoot	0.0575	-0.0292	0.249	0.132	0.187	0.0752
	(0.134)	(0.193)	(0.183)	(0.223)	(0.203)	(0.151)
Early Treat	0.259*	-0.449**	-0.168	0.195	-0.756***	0.400**
	(0.120)	(0.169)	(0.152)	(0.179)	(0.193)	(0.148)
N	564	564	564	564	564	564
MotherFE	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at the household level in parentheses.
Regressions control for age, gender, and birth order of children.
Percent restoration of index with early surgery = 57.2%
Joint (Index) test of Clubfoot + Treatment + Early Treatment, -0.35, $p < 0.01$.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A9: Education

	(1) Pre-Kinder	(2) Current School	(3) School Level	(4) School Perf	(5) Education Index
Born Clubfoot	-0.194***	-0.189***	-0.111	-0.182	-0.477***
	(0.0394)	(0.0382)	(0.124)	(0.115)	(0.116)
Treated Clubfoot	-0.162*	-0.140	-0.0626	-0.297	-0.420
	(0.0794)	(0.0771)	(0.204)	(0.223)	(0.238)
Early Treat	0.264***	0.216**	0.569*	0.902***	0.980***
	(0.0773)	(0.0793)	(0.220)	(0.238)	(0.249)
N	564	564	564	564	564
MotherFE	Yes	Yes	Yes	Yes	Yes

Standard errors clustered at the household level in parentheses.
Regressions control for age, gender, and birth order of children.
Percent restoration of index with early surgery = 117.4%
Joint (Index) test of Clubfoot + Treatment + Early Treatment, 0.08, $p = 0.67$.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A10: Faith and Spirituality

	(1) Faith Community	(2) Faith Important	(3) Youth Activities	(4) Faith Index
Born Clubfoot	-0.880***	-0.544***	-0.528***	-0.762***
	(0.105)	(0.113)	(0.0759)	(0.0942)
Treated Clubfoot	-0.431*	0.536*	-0.290	-0.0721
	(0.196)	(0.216)	(0.151)	(0.156)
Early Treat	0.776***	-0.0428	0.329*	0.415*
	(0.196)	(0.196)	(0.163)	(0.160)
N	564	564	564	564
MotherFE	Yes	Yes	Yes	Yes

Standard errors clustered at the household level in parentheses.
Regressions control for age, gender, and birth order of children.
Percent restoration of index with early surgery = 44.7%
Joint (Index) test of Clubfoot + Treatment + Early Treatment, -0.42, $p < 0.01$.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A11: Summary Outcomes: Human Flourishing using Anderson Index

	(1) Physical	(2) Psych	(3) Social	(4) Educ	(5) Faith	(6) HF Index
Born Clubfoot	-1.326***	-1.208***	-0.760***	-0.519***	-0.702***	-1.067***
	(0.0924)	(0.0917)	(0.0961)	(0.119)	(0.0928)	(0.0976)
Treated Clubfoot	-0.199	-0.0745	-0.00500	-0.385	0.0312	-0.218
	(0.202)	(0.180)	(0.179)	(0.231)	(0.151)	(0.192)
Early Treat	0.811***	0.779***	0.405*	0.917***	0.297*	0.888***
	(0.218)	(0.169)	(0.191)	(0.244)	(0.154)	(0.202)
N	564	564	564	564	564	564
MotherFE	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors in parentheses.
Regressions control for age, gender, and birth order of children.
Joint (Index) Test of Clubfoot + Treatment + Early Treatment, -0.71, $p < 0.01$.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table A12: Heterogeneous Treatment Effects by Gender and Poverty Level

	(1) Physical	(2) Psych	(3) Social	(4) Educ	(5) Faith	(6) IHD Index
Born Clubfoot	-1.602***	-1.429***	-1.566***	-0.590**	-0.849***	-1.584***
	(0.163)	(0.191)	(0.207)	(0.211)	(0.221)	(0.199)
Male_x_BornCF	0.278	0.233	0.621**	0.301	0.211	0.396*
	(0.185)	(0.216)	(0.229)	(0.224)	(0.265)	(0.255)
LowInc_x_BornCF	-0.114	-0.0495	0.179	-0.114	0.136	0.068
	(0.182)	(0.222)	(0.199)	(0.196)	(0.216)	(0.188)
Treated Clubfoot	0.198	0.0813	0.588	0.103	0.142	0.295
	(0.363)	(0.430)	(0.402)	(0.436)	(0.345)	(0.372)
Early Treat	0.722*	0.887*	0.611	0.635	0.377	0.897*
	(0.375)	(0.398)	(0.386)	(0.425)	(0.337)	(0.353)
Male_x_Treated	-0.925*	-0.861	-1.232**	-0.363	-0.707	-1.035*
	(0.401)	(0.446)	(0.420)	(0.445)	(0.387)	(0.405)
Male_x_EarlyTreat	0.675	0.667	0.729	0.0327	0.478	0.665
	(0.418)	(0.407)	(0.410)	(0.445)	(0.388)	(0.398)
LowInc_x_Treated	0.300	0.470	-0.156	-0.529	-0.326	-0.141
	(0.407)	(0.448)	(0.414)	(0.428)	(0.390)	(0.404)
LowInc_x_EarlyTreat	-0.416	-0.425	0.0861	0.297	0.259	0.040
	(0.446)	(0.418)	(0.424)	(0.447)	(0.408)	(0.418)
N	564	564	564	564	564	564
MotherFE	No	No	No	No	No	No

Standard errors in parentheses

Regressions control for household income and age, gender, birth order of children.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$