Effect of Slum Redevelopment on Child Health Outcomes: Evidence from Mumbai

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Abstract

As the population of urban poor living in slums increases, governments are trying to relocate people into government-provided free housing. Slum redevelopment affects every part of a household's livelihood, but most importantly the health and wellbeing of younger generations. This paper investigates the effect of slum redevelopment schemes on child stunting levels. Data was collected in forty-one buildings under the slum-redevelopment program in Mumbai. The study demonstrates through a fixed effect regression analysis that an additional year of living in the building is associated with an increase in the height-for-age Z-score by 0.124 standard deviations. Possible explanations include an improvement in the overall hygienic environment, sanitation conditions, indoor air pollution, and access to health and water facilities. However, anecdotal evidence suggests that water contamination, loss of livelihood and increased expenses could worsen health outcomes for residents. This study prompts more research on the health effects of slum redevelopment projects, which are becoming increasingly common in the rapidly urbanizing developing world.

JEL: O12; O15; O17; O18; O22

Keywords: Urban infrastructure; Microeconomic Analyses of Economic Development; Child health; Informal settlements; Project Analysis

I. Introduction

Booming economic activities and growth in Indian cities has led to a surge in migrant population without a concurrent increase in housing capacity, making housing a distant dream for most of the cities' poor. Slums are proliferating with an estimated population rise to 104 million by 2017, concentrated in mega metros like Mumbai and Delhi. Census data shows that in 2011, 41.3% of Mumbai's population lived in the slums (Dash, 2013). It is also estimated that by 2030-2040, two billion slums will be housing about one-third of all urban population (Restrepo, 2010). However, slums are a threat to the "planned city" and with high levels of poverty and crime, slum redevelopment has become a priority with many developing country governments. Hence, through ongoing slum redevelopment programs, this slum population is gradually being relocated from slums to buildings under the Slum Redevelopment Authority (SRA) in Mumbai. There are many socio-economic implications of relocating such a massive slum population, which include the cost of civic services, health, housing, mounting crime and social tensions, and changes in quality of life for all. This paper investigates the effect of slum redevelopment schemes on child health outcomes, by answering questions such as: Is there is an improvement in child health status due to an improved housing option? Or is the situation becoming worse due to higher population density, water quality or some other factor?

Residents of the redeveloped colonies state that the end goal still seems to revolve around removing people from slums as quickly as possible, rather than relocating them to a place with higher standards of living. Anecdotal evidence also points to the fact that slum redevelopment is not centered on its people, rather around the policy makers who need projects completed. Based on SRA's priorities, different slum types are relocated at various times. Slums are located in different types of areas in the city: alongside railway tracks, sidewalks, near gutters, water

pipelines and below bridges. These slums have varying characteristics as well, in terms of sanitation facilities, water supply, cooking stoves, access to health facilities, and so on. While slum redevelopment is in full swing in mega-cities, such as Mumbai and Delhi, there are many problems associated with the schemes and the buildings provided to slum residents (Chaplin, 2011). While the authorities make their decisions without community consultation, they also do them hastily where "good intentions in theory turn ugly in practice" (Patel, 1996). Relocating people to localities where the municipalities would need to cater to new demand for water supply and sanitation is a monumental task for which the authorities do not prepare for.

At the same time, according to a Survey Report 2011 (HUNGaMA), about 58.8 per cent of children below five years of age are stunted in India. Stunting is defined as height of children below minus two standard deviations from the median height of the reference population (WHO, 2014). Stunted children tend to be at a greater risk for illness and death. Stunting is a cumulative process that begins in utero till about three years after birth (Edward A. Frongillo, 1999). In this paper, I test to see whether children who have been living in redeveloped buildings for longer periods of time have improved child-stunting levels relative to those who relocated more recently. I compare between siblings (household fixed effect) and between households (random effects).

Despite India's high economic growth, the situation for stunted children has only worsened in the last ten years. The government's response has come mainly in the form of legislation and distribution of nutrient-fortified supplements and meals to children to target the issue of malnutrition. The government even passed the National Food Security Act in 2013 to make sufficient food grains available to satisfy the domestic demand and improve access through a Public Distribution System (PDS) (Dobe, 2015). However, better nutrition cannot be achieved

only with measures to improve what a child eats because the child also be able to retain and absorb the nutrients in the body. Indian children are chronically malnourished not only because of insufficient food but also because of recurring bouts of dysentery, diarrhea, and parasitic infections. Hence, the crux of the problem may be lack of proper sanitation rather than food security. If the slum redevelopment scheme provides a healthier environment for the child, then theoretically, we should see improved child health outcomes in the study. If that is not the case, this study should inform future policy decisions regarding slum redevelopment.

Data were collected in four slum-redeveloped colonies in Mumbai and three slum areas, totaling 882 children with the help of National Slum Dwellers Federation. Using a mother fixed effect regression analysis, the study demonstrates that more exposure to slum redevelopment (i.e. more years spent in the building) has a highly positive and significant correlation with height-for-age Z-scores, controlling for birth order of children. Hence, slum redevelopment indeed seems to be beneficial for improving stunting levels of children. However, other health outcomes that are repeatedly claimed to be worse in buildings than in slums (such as water-borne diseases) are not captured in this study. While the data in this study cannot conclusively define the channel of impact on health, it provides some evidence that one significant mechanism may be through improvements in sanitation facilities.

The remainder of the paper is as follows. Section II provides the literature review of studies conducted on the effects of slum redevelopment. Section III discusses data collection methods, which is followed by the empirical specification in Section IV. There I develop simple and categorical fixed effects models with sibling, building, and age fixed effects. In Section V, I present the study results, starting with summary statistics and regression findings. To provide a more comprehensive understanding of the research methods, in Section VI, I discuss threats to

validity for the results. Section VII explains the causal channels by which slum redevelopment could affect child health outcomes. Finally, Sections VIII and IX provide the discussion, conclusion and recommendations for policy makers involved in slum redevelopment.

II. Literature Review

While much of the narrative of slum redevelopment revolves around policies for housing provision (Mukhija, 2001), there is little evidence about people's quality of life after relocating to buildings. A majority of the existing studies are focused on conditions within slum communities (Subbaraman, 2012). Attempts to study redeveloped colonies have large biases, heterogeneity and evidence gaps that prevent them from drawing firm conclusions on the effect of slum upgrading strategies on health and socio-economic well being (Turley, 2013). "Despite the explicit call and need for urban environmental interventions, relatively little research has focused on health outcomes and infrastructure development in urban areas" (Butala, 2010). Not only is there a lack of data in slum-redeveloped buildings, there has been no comprehensive census or survey of all slum dwellers in the urban region (Nijman, 2010). This implies that it would be extremely difficult for the slum redevelopment authorities to know which households are eligible and should be relocated in the buildings. Hence, there could be bias and subjectivity involved in shifting some people into buildings. Nevertheless, this will not impact mother fixed effect results in this study.

i. Benefits of slum redevelopment

I first discuss studies that demonstrate the benefits of slum redevelopment. The most common health and socio-economic outcomes reported are communicable diseases and indicators of financial poverty. Diarrheal disease incidence and water related expenditures seem to have decreased consistently due to slum redevelopment across studies in the Turley (2013)

systematic review. The authors suggest the availability and use of reliable, comparable outcome measures to determine the effect of slum upgrading on health, quality of life, and socio-economic wellbeing (Turley, 2013). Stunting is an objective measure of health outcomes, and existing literature suggests that open defecation, poor water quality and intestinal parasitic infections can increase child-stunting levels (Nguyen, 2012). Some studies have tried to understand the relationship between stunting and open defecation, such as Spears (2013) that found that a 10 percent increase in open defecation was associated with a 0.7 percentage point increase in both stunting and severe stunting. In another study by Spears (2013), he uses 140 Demographic Health Surveys from 65 countries and by comparing between countries he demonstrates that sanitation alone can explain more than 50 percent of variation across country-years. Hence, sanitation seems to be a plausible mechanism by which slum redevelopment could improve stunting levels. By relocating to buildings with a more hygienic environment, stunting levels should theoretically reduce. I mention in Section IV in more detail why height-for-age Z-scores are effective outcome measures for health outcomes for children.

Mukhija (2001) concludes that other than tenure status, policy makers should focus on the physical conditions within settlements that could affect the success of upgrading strategies. Another study conducted in Ganesh Nagar slum redevelopment in Mumbai, which relocated people from the slum to building in the same area, demonstrates that it did not create a loss in livelihood. Often, the criticism against slum redevelopment is that people sell their apartments and move back to the slums, as it is a more attractive financial investment. However, the Restrepo (2010) study challenges the claim and finds, through an exhaustive household survey in Mumbai (n=510 households in five rehabilitated sites and five to-be rehabilitated sites), that "poverty recycling" is not very common. He concludes that slum rehabilitation actually serves as

a platform for better living conditions. The same resonated in my focus group discussions with residents of buildings in this study who stated that even though renting apartments can be common, people do not necessarily do it by choice. There are many merits to living in the building that people have to forego by moving back to slums. For instance, living in the building gives people an address proof and formal identification that they did not have earlier. Their children are in safer localities, and they have a toilet, water and other amenities that they did not have earlier. While slum redevelopment has many benefits, it also has some drawbacks.

ii. Disadvantages of slum redevelopment

Coercing people to move away from what has been their house for centuries in the slums to a seven-floor building 50 kilometers away is bound to change their lives drastically. People lose their livelihoods, common household purchases become more expensive, and health facilities become further away (Butala, 2010). Income is the primary consideration for most families when deciding where to live. People do not come to Mumbai to live on the streets; they come to get a better job, and due to the high property prices, they live in slum settlements. Hence, by relocating people to a different housing facility instead of focusing on employment opportunities, the government authorities are not tackling the crux of the problem. People continue to move back into slums from the buildings, as they are closer to their jobs. In fact, in some of the buildings where the survey was conducted for this research, up to 70 percent of the residents had moved back, renting out their apartments to low-middle income households. Further, social networks in slum communities break apart when people are isolated to individual apartments that constrain the interaction between neighbors, as stated by some residents in our focus group discussions.

The second problem people face is that of water contamination, which is associated with most diseases that are prevalent in slum-redeveloped colonies. People have access to illegal, but clean water in slum areas, but in the poorly constructed buildings, they have to drink the legal, but contaminated water[2]. Water is more essential than even food, but with poor water pipeline construction and maintenance, people find it difficult to obtain water when they initially move into the buildings. A study in Indore is in line with this anecdote of water contamination, as with slum upgrading there was an increase in waterborne illnesses, possibly due to choked sewage drains (Verma, 2000). However, Butala et al. (2010) use a novel empirical strategy to demonstrate a causal relationship between basic infrastructure improvement in water supply and sanitation in urban slums and reduction in incidence of waterborne illness. They use micro-health insurance claims as a proxy for illness incidence to measure the health impact of slum upgrading in Ahmedabad, India, and find a statistically significant decrease in waterborne illness claims in areas that were upgraded.

Local health clinic and hospital visits revealed that there was a much higher incidence of TB, Asthma and water borne diseases due to lack of maintenance in the buildings and poor ventilation. Kreiger & Higgins (2002) also find that crowding and lack of hygiene have long been identified as contributors to the spread of infectious disease, such as TB and respiratory infections. Conversely, improved hygiene and water quality at point of use, adequate sanitation and solid waste management, have shown to reduce waterborne disease (Curtis & Cairncross, 2010). However, the causal link between household water supply and sanitation with waterborne

[2] I heard many instances of how water pipelines would merge with sewer lines as the pipelines were poorly constructed and had leakage. While the buildings were constructed by a government agency, any complaints about the building could not go to the same agency, as the responsibility of maintaining the buildings was under another government agency, which was usually never defined. Hence, after moving into the buildings, people did not know if the problems they had, such as contaminated water, leaking toilets, and so on, would ever be heard. With lack of clarity on these matters, people often found it easier to move back to the slum.

disease reduction is still unclear, due to methodological problems in previous studies. A review by Northridge, Sclar and Biswas (2003) illustrates that there is insufficient evidence to support the view that improved housing is a means to improved physical health. Policymakers have very little evidence of the success or failures of their redevelopment interventions with regards to health outcomes. This evidence might not exist either because other hazards specific to slums may undermine the benefits provided by redevelopment, or studies to assess the benefits of household infrastructure improvements are difficult to conduct. The complex nature of urban slums makes it difficult to attribute outcomes to specific exposures or interventions. Their heterogeneity also makes it difficult to compare outcomes across populations or across time, with the lack of longitudinal data (Butala, 2010).

The present study attempts to build on the existing literature in three ways. First, it uses quantitative data collected from buildings under a slum redevelopment program and from existing slums to provide evidence about the effect of the program on child health, as measured by height for age Z-score. In my knowledge, effect of slum redevelopment has not been explored on objective health outcomes, such as height-for-age Z-scores. Second, the study provides anecdotes and qualitative insights into the positive and negative effects of slum redevelopment programs on child health and livelihood across more than forty buildings. Third, this will be the first study to investigate the effects of an ongoing government intervention of slum redevelopment on child health in Mumbai while providing some insight into the mechanism by which slum redevelopment can improve health.

III. Setting

By definition, the SRA upgrading strategy provides a set of seven interventions: household connections to water supply, underground sewage, indoor toilets, storm water

drainage, stone paving of internal and approach roads, solid waste management, and street lighting (Butala, 2010). In addition, each house has a liquefied petroleum gas (LPG) connection and electricity. Given this complexity, it would be difficult to separate the effect of the improvement of a single amenity, as all houses were identical (Turley, 2013). After the houses are given to the people for free, the SRA withdraws from the projects completely. The maintenance of the buildings, which includes collecting the garbage dumps daily and ensuring constant water supply and electricity, becomes the responsibility of another government agency. However, with asymmetric information and lack of coordination between the government bodies, no one assumes that responsibility, at the cost of building residents. Some buildings create their own societies to maintain their buildings and ask everyone to pay around Rs. 300/- into the collective fund per month. Housing co-operatives are highly encouraged for maintaining the building projects, as seen from the Ganesh Nagar development program. However, quantitative data, alongside qualitative information would be highly useful in understanding the types of interventions that work and for whom they work.

I gathered qualitative insights by conducting focus group discussions and surveys. In the survey, although many people said that they now have better access to health facilities than when they lived in the slum, they referred to having better access to a private doctor (as explicitly asked in the survey). Most of the buildings are far from government hospitals. Hence, possibly a distinction between the two could have been made that could have revealed different results. Government hospitals are used for major illnesses and disabilities, as the treatments for those are very expensive in private clinics. Further, the private clinics that are more accessible to the people in the buildings are run by non-medical degree doctors, making those treatments less effective or reliable. The fees for each visit is about Rs. 60/- per visit, while the government

hospital only charges for some medications. Hence, overall the households may be visiting the doctor fewer times now that the government hospitals are too far. Another interesting finding from the survey was that many of the households had first been relocated to transit camps and then to the buildings. In many cases, they lived in transit camps for about six years. However, for the purposes of this research study, I pooled the transit camp experience as a slum due to the similarity in the nature of the two locations. As I had not anticipated this earlier, transit camp was not explicitly mentioned in the survey. However, understanding the environment from which people shifted from slum to transit camp to building may be equally important.

Almost all slum resettlement programs in Mumbai in the last 20 years have moved people to Mankhurd, Govandi and Chembur areas in Mumbai where there is not a single large hospital in the vicinity. With no hospital in walking distance, a cancer patient would need to go to TATA hospital via public transport. Though train is the cheapest method to travel, they are crowded and it could risk the cancer patient's life. Hence, the family would need to take the patient to the hospital by taxi for which the fare would be about Rs. 1000/- per trip. Even though the SRA has promised the relocated of over a million people to this area, they have not ensured the construction of a single health facility that has appropriate machinery and equipment to handle the influx of people. All major hospitals are located within the city centers where the slums are located. Hence, if a cancer patient needs to be treated, the family will not want to pay expenses for every trip to the hospital and lose their daily wage by not being able to go to work. So they would find it much more convenient to locate close to the hospital, even if that means going back into the slum.

IV. Data

i. Data collection

My eligibility criteria for selecting the sample in the building is as follows:

a. At least 2 children of the same mother present at the time of the survey
b. Household shifted from the slum community and was relocated by the government, not living in the room on rent

Including only households with more than one child of the same mother is necessary for analyzing the data using mother fixed effects. Further, as the study is trying to understand the effect of redevelopment on children who were shifted from slum areas, the households that were not directly relocated from slums did not participate in the study. While I tried to only select households in which children within a household have been differentially exposed to different locations (slums, buildings), this was difficult since the existing selection criteria is quite restrictive. People have been relocated from slum areas to buildings since the early 1990s. Hence, I needed to take the time trend into account when selecting the building colonies by stratifying the list of slum-redeveloped colonies in Mumbai by the year of shift. I randomly selected four colonies from the stratified sample of buildings that have been shifting people from slums for the last 15, 10 and five years from the data provided by the National Slum Dwellers Federation. In all, I surveyed in four colonies, 41 buildings, 350 households, and with 680 children in the slum redeveloped buildings. In addition, I conducted a survey of 201 children in two slum areas from where people had shifted into buildings. The slum survey serves as a validation point to demonstrate the before and after status of the health outcomes of children, and provides insights about the mechanism by which slum redevelopment can affect child health.

First, I hired and trained five surveyors from National Slum Dwellers Federation and the six of us collected anthropometric data on the child's height and weight for every child in the household that is below 18 years of age, using a measuring tape and weighing scale[3]. The age of the child can be determined through the household survey, and both the age and height measurements will be used to calculate the height-for-age Z-score that would be included in the regression analysis. The advantage of surveying in slum-redeveloped buildings is that each household has legal documentation about household members, the date at which they were moved and the slum from which they were relocated. Hence, in most cases, finding out the age of a child was not as difficult as it would be in rural areas.

In my second step, I conducted household surveys (consisting of around fifty questions) in households currently living in current slum areas from where some people had been randomly relocated: Koliwada, Mahatma Gandhi Nagar and Shivaji Nagar. I compare the heights of older siblings who may have spent a higher percentage of their lives in the building with the heights of their younger siblings. Further, I held some focus group discussions with members from each of the four building colonies- Indian Oil, Maharashtra Nagar, Vashi Naka and Lullubhai Compound- to understand the challenges and benefits of relocating to the slum redeveloped building.

Third, the surveyor team and I compared the collected data with information provided to me by the Slum Redevelopment Authority (SRA), the government body responsible for relocating most of these slum residents from the slums to the buildings, for validation. National Slum Dwellers Federation (NSDF), with whom I partnered with to conduct this research, is actively involved with these governing groups as well.

[3] The surveys were conducted over a five-week period from May 6th to June 14th, 2015. Each interview took around 40 minutes. I had a team of five other surveyors collecting the data as well. To test for the mother's education status, I conducted a short literacy test, asking them to read a simple sentence in their mother tongue.

V. Empirical Specification

I estimate the effect of slum redevelopment on child health outcomes by using anthropometry, the study of human body measurements, to proxy for child stunting. Child malnutrition can be measured most commonly by three indices: weight for height (wasting), height for age (stunting) and weight for age (underweight) (Raj, 2015). Physical height has become increasingly common for economists studying development, as it is a persistent summary measure of early life health; early life health predicts adult height (Hammer, 2013). Further, child height is more correlated with cognitive achievement in India than in the US, which suggests a greater impact of early life disease in India. A child's weight responds quickly to illnesses so if the child had diarrhea recently, which is common in this context, then the reported weight on the day of the survey would be lower than usual. Hence, weight is not as reflective of the effect of the longer-term exposure to slum redevelopment. Low levels of nutrition and health investment early in life can irreversibly stunt an individual's height, but the effect can be different between boys and girls. Hence, in this study, I focus on height-for-age Z-scores as the primary outcome variable.

Simple Fixed Effects Model

The empirical strategy seeks to examine the impact of slum redevelopment on child stunting, using height-for-age Z-scores with respect to the heights of children (i) in household (h) of the same age (a) and gender (g). Thus, I use $Z_{a,g}^{i,h}$, as the outcome variable. The height-for-age Z-score should be understood as the number of standard deviations of the actual height of a child from the median height of the children of their age as determined from the sample. Hence, if the actual height of the child is exactly equal to the median determined for his or her age, the Z-score is zero. If child's height is more than the median, it will be reflected by a positive sign (+) and if

it is lower than the median, it will be reflected with a negative sign (-) of the Z-score. A score of <-2 for the height of age Z-score is “stunting”, weight for height z-score <-2 is “wasting”, and weight for age z-score <-2 is “underweight”.

I begin my analysis with an ordinary least squares model to look at the correlation between exposure to slum redevelopment, as recorded by the total number of years spent in the building, and height-for-age Z-scores, controlling for child’s age at the time of shift and birth order. I add an indicator for whether they had a toilet in the slum as a proxy for sanitation levels before shifting into the building, and a proxy for wealth (including indicators for ownership of a refrigerator, bicycle, 2-wheeler motorcycle, and car). I also include religion in the regression, as the stunting levels could be affected by traditional practices in each religion.

As this simple OLS model would compare children across households and buildings, there could be a lot of confounding factors explaining the differences in the Z-scores that may be unrelated to slum redevelopment exposure directly, such as socio-economic indicators, genetic variation, proximity to health services, health seeking behavior, and so on. Further, community or city level changes need to be accounted for as overall economic development and increased incomes could cause improvements in child stunting levels even without slum redevelopment. Since siblings would be subjected to the same community level changes, these factors could be controlled for and it would eliminate the need to compare the heights of the children based on Indian standardized heights, as all the children would be benchmarked against the same international standards. Conducting a multivariate regression model by adding controls accommodates random imbalance between the older and younger children and siblings. Hence, these naïve estimates may be biased, but can be addressed by comparing siblings with mother fixed effects (children of the same mother), as within household comparisons reduce selection

bias. Many of the households had more exposure to slum redevelopment because they were shifted into buildings earlier; hence, mother fixed effects corrects these biases. As elder siblings would have spent a different part of their lives in the building (and maybe more years), comparing between siblings could demonstrate the differential effect of slum redevelopment on height-for-age Z-scores of siblings of different ages. I compare the recorded measurements with the medians set by the WHO for each age group though the WHO medians may not accurately hold true for children in India, as they are shorter in height on average. Since I am comparing all children to their siblings using the same metric, whether this is a WHO or an Indian median should not matter greatly.

I estimate the following primary fixed effects model:

$$Z^{i,h}_{0\leq a\leq 18i} = \beta_0 + \beta_1 ageatshift_i + \beta_2 childbuilding_i + \beta_3 firsttwo_i + \mu_j + \varepsilon_{i,j} \quad (1)$$

Here $Z^{h}_{0\leq a\leq 18}$ is the height-for-age Z-score, $ageatshift_i$ is the age when the child moved to the building (that is equal to zero if the child was born in the building), $childbuilding_i$ is the total number of years spent in the building, $firsttwo_i$ is a control dummy for whether the child was one of the first two children born, and μ_j is the mother fixed effect. With the inclusion of the fixed effect in the regression equation, only the variables that are different between siblings are valid. μ_i, mother fixed effect, may not necessarily be the household fixed effect as there can be multiple mothers living as part of the same household. This is especially common in houses where the husband has more than one wife or if extended family members stay in the same house as part of a joint family. Birth order is an important indicator of resource sharing between children that could impact their nutritional status differentially as the older child may have had more resources for themselves at a younger age than the younger siblings who may have had to

share the same resources among more people. The results could be biased downward without birth order in the model.[4]

As the effect of slum redevelopment, in the form of toilets or improved cooking stoves or another mechanism, could be greater on child health outcomes in the first few years life, it is not sufficient to use the number of years of exposure to slum redevelopment, but also age at shift into the building. Another method of calculating the exposure to slum redevelopment variable is to use fraction of life spent in the building, or exposure as a percentage of life (divided by age groups) as discussed in the footnotes below. Though I considered using the fraction variables, the nature of the slum redevelopment program makes the total number of years lived in the building a more ideal measure to use, as it shows the cumulative effect over the years. The slum redevelopment program is an absorptive state (as can be noticed in Figure 2 in Appendix 4), where the move to the building is one-directional. Though in reality, some people who relocated to the building moved back to the slums (for various reasons), my sample is only restricted to those households that made the move to the buildings permanently. Hence, this one-directional event asserts that: where if the fraction of life spent in the building for any age, $\alpha = 1$, then all α afterwards will also equal 1. It would seem intuitive to consider fraction of life, but in the slum redevelopment scenario, it could give the confusing result that the effect of the building exposure would be the same for a child who spends a hundred percent of his life in the building but is only

[4] The effect of slum redevelopment exposure on the same health outcome can also be represented by the following fixed effects regression:

$$Z^{i,h}_{0\le a\le 18i} = \beta_0 + \beta_1 \frac{yearsredev_{0\le a\le 5i}}{age_{0\le a\le 5i}} + \beta_2 \frac{yearsredev_{6\le a\le 10i}}{age_{6\le a\le 10i}} + \beta_3 \frac{yearsredev_{11\le a\le 18i}}{age_{11\le a\le 18i}} + \beta_4 firsttwo_i + \mu_j \quad (2)$$

Here $\frac{yearsredev_{0\le a\le 5i}}{age_{0\le a\le 5i}}$ is the average fraction of years of exposure to slum redevelopment in the first five years of life, $\frac{yearsredev_{6\le a\le 10i}}{age_{6\le a\le 10i}}$ is the average fraction of years of exposure to slum redevelopment for children when they were between 6 and 10 years, $\frac{yearsredev_{11\le a\le 18i}}{age_{11\le a\le 18i}}$ is the average fraction of years of exposure to slum redevelopment for children when they were between 11 and 18 years.

two years old, and another child who also spends a hundred percent of his life in the building but is ten years old. The effect of spending ten years in the building is greater than that of two years, and that distinction is captured in regression equation (1) with the number of years spent in the building variable, while the time of shift is captured by the age at shift variable. Regression equation (1) can only demonstrate the correlation between health outcomes and slum redevelopment in general. Since the facilities provided in the buildings are standardized for every house, it is difficult to distinguish between the effects of toilets, improved cooking stoves, improved water quality, or changes in the environment on child health[5].

VI. Results

To analyze my data, I used *zanthro*, an application on STATA that calculates the height-for-age Z-score directly from the child's age and height data. *Zanthro* uses the average height-for-age Z-score from the WHO growth charts. Hence, the distribution of the Z-scores in India should lie to the left of the normal distribution. Further, I collected data on the weight of the children to calculate the weight-for-height z-score that could complement the height-for-age z-score.

1. Summary Statistics

To understand the sample better, both in slum-redeveloped buildings and in the slums, I summarize the results in Table 1. The table lists basic characteristics about the households, the reasons for relocation, and child characteristics. The colony codes result reveals that most of the households in the sample were living in Colonies 1, 3, and 4. 44 percent of households had been

[5] As child malnutrition levels simply measured in terms of their anthropometric measurements are incomplete measures of health, I included other outcome variables for the slum redevelopment exposure status in a separate regression. For instance, major illnesses such as TB, Malaria, Jaundice, Typhoid, and so on, are good indicators of the poor health status of the children. However, as the data collected for these other health outcomes was not robust, I dropped it from this study, though this is a research topic for future research studies.

relocated from the footpath, while only 5 percent from the Tata power plant location. From the household characteristics variables, we see that there is an almost equal divide between the Hindus (0.48) and Muslims (0.43) in the building, but about 70 percent of people in the slums are Muslim. However, upon further analysis (see Table 6 in Appendix 5) we find that more Hindus had relocated in previous years than Muslims, while more Muslims were being relocated more recently. This difference could play a role in creating a differential impact of slum redevelopment on child health if religious practices play a large role in people's health-seeking behavior.

While 83 percent of people in the building sample mentioned that they had a toilet in the slum they came from, only 31 percent of people in the slums actually had a toilet inside the house. As many of the households in the building sample relocated from the surveyed slum sample, this could mean that majority of the people used public toilets that were located away from their houses. Mother's age at time of child's birth seems similar, but the slum mean is lower at 22.25, suggesting women have children earlier in the slums, which is expected[6]. The mother's age at time of marriage variable shows that about 33 percent of girls were married before they turned 18 years old in the building sample. Total number of family members, and ownership of cycle and two-wheelers are very similar for both the building and slum data. Interestingly, 39 percent of households in the slums had refrigerators, while only 8 percent did in the building. However, when collecting the data, in the building survey, surveyors often forgot to ask the refrigerator question to the households, so it could be a result of inaccurate data collection. It also seems that households in the buildings have more alcohol (0.29) and tobacco (0.43) consumption than the households in the slums. More people in the slums have a bank account (0.86) and an Adhaar card (0.99) than in the building.

[6] Poorer the family, the more likely they are to get their daughters married early and hence have children early.

Reiterating the qualitative interviews that suggested that health care expenditures have increased after shifting into the building, Table 1 illustrates that the average monthly health expenditure for a household in the building is Rs. 2088/- ($31), whereas that in the slum is Rs. 1399/- ($21). This means that after shifting into the building, on average monthly health expenditure has increased by around 50 percent, which is a massive increase in the context of a low-income community. One explanation for this could be that the family size increased when people moved into the building and had more children, as the average number of children in the slum is 2.77 and in the building is 3.10. However, that still could not account for the entire 50 percent increase, which could also include higher private health care fees and higher levels of illness. If the latter were true, indeed slum redevelopment may to some extent be correlated with poor child health outcomes (assuming the increase in health expenditure is for the child). More women gave birth in hospitals in the building sample (0.82) than in the slum sample (0.62), suggesting this as one reason for higher health expenditure, but also improved health outcomes. It also seems that more women in the buildings had normal deliveries while giving birth than the sample in the slum. Birth weight is similar for children in the building and slum, but height-for-age Z-scores are slightly worse in the building sample (-1.80). This could also be because the sample size for the building is 559 as compared to 160 in the slum, and hence the difference may be due to random error. Nutrition levels for children in the building look slightly better (3.10), but the difference is very small.

2. Findings from the building dataset

I begin my analysis by regressing height-for-age Z-score on exposure to slum redevelopment, as a result of the findings in Table 1. To control for bias due to differences

between children across households, in column (1) I use mother fixed effects[7] to estimate regression equation (1) in my preferred model. The result is positive (0.124) and highly statistically significant (p-value=0.000) for the number of years spent in the building, controlling for age at first exposure and being the first or second child in the house. Hence, this implies that if the child stays in the building for an additional year, their height-for-age Z-score increases by 0.124 standard deviations. Further, the negative coefficient (-0.038) on age at first exposure suggests that if a child shifts into the building a year later, the height-for-age Z-scores could be worse. Those results are consistent with each other, as the later a child shifts into the building, the fewer years they get to spend in the building. Therefore, the earlier a child shifts into the building, the higher their height-for-age Z-score (i.e. less stunting), indicating that slum redevelopment could be beneficial to a child's health. However, in the fixed effects model, we are ignoring many other factors that could also explain children's stunting levels. More specifically, in column (2) of Table 2, I add a wealth index of the household and a dummy for whether they had a toilet in the slum in a simple OLS model without fixed effects. The result is still positive (0.086) and highly statistically significant (p-value=0.000) for the number of years spent in building. With an additional year spent in the building, the child's height-for-age Z-score is higher by 0.086 standard deviations. The indicators for first or second child (0.247; p-value=0.083), wealth of the household (0.298; p-value=0.005) and presence of toilet in the slum (0.311; p-value= 0.065) have positive and significant coefficients. Hence, this implies that when comparing children across households, being the first or second child is correlated with lower stunting levels. Further, children from higher income households and those from households that

[7] Mother fixed effects suggest a fixed effect for sets of siblings of the same biological mother.

had toilets in the slums they came from have lower levels of stunting[8]. In column (3), I add religion to the regression and find that it may not have a significant effect on a child's stunting levels in the building, but having a toilet in the slum becomes stronger and more significant. The coefficient on the number of years spent in the building remains consistently positive (0.093), but is lower, and highly significant. Columns (4) and (5) include building fixed effects and add more control variables. In column (4), the coefficient on number of years spent in the building is of a similar magnitude (0.128) as that in column (1), suggesting that the additional variables added in the regression are not very closely related to the primary independent variable of interest. Age at first exposure again has a negative coefficient, as expected. Coefficients on first two children (0.295), wealth (0.305), presence of toilet in the slum (0.500), other religion (0.924), and having a disease in the building[9] (0.406) are all positive and significantly correlated with height-for-age Z-scores. While it seems plausible that being the first or second born child in the house could be beneficial for health outcomes as one has to share resources with fewer children, and that higher wealth and having a toilet in the slum could boost the height-for-age Z-scores, it is difficult to explain the positive effect of having a disease at the time of arrival to the building on the Z-scores. One would expect that if the household had any diseases due to water when first shifted into the building the children would have higher levels of stunting. However, the question about disease was asked for the general household; so if the father was sick with a water-borne illness, it could be independent of the height-for-age Z-score of the child, and hence I am cautious in interpreting this result. In column (5), disease in the building becomes insignificant. As the number of people in the household increases, few resources have to be shared amongst more

[8] Whether or not the slum they came from had a toilet was asked to the households in the survey (not from a government database).

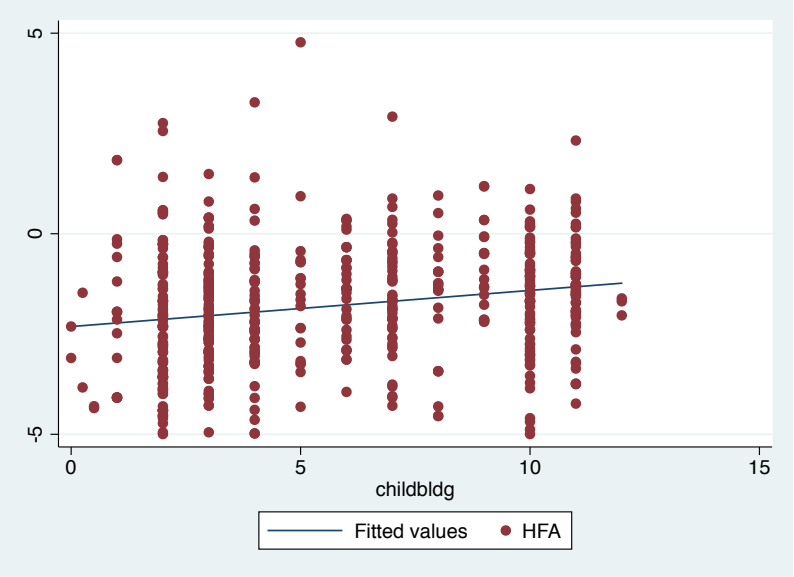
[9] The households were asked, "Did you have any diseases due to water when you first shifted into the building?" to see if there were any illnesses due to water contamination when people first re-located. In focus group discussions, people complained a lot about water contamination and instant rise in water-borne illnesses after arrival.

members and one would expect lower Z-scores with this variable, which is observed in columns (4) and (5). In (5), the coefficient on number of years spent in the building is even higher, at 0.178, and highly significant (p-value=0.000). Hence, controlling for many factors, an additional year in the building can increase height-for-age Z-scores by 0.178 standard deviations. Mother's education, birth weight, institutional delivery, normal delivery (no birth complications), and dummy for boiling water at home are added, to present a more holistic picture of other factors that could affect a child's growth[10]. Birth weight is highly correlated with the height-for-age Z-score (0.287; p-value=0.002), as is the behavior of boiling water at home (0.550; p-value=0.012), suggesting that the children that drink boiled water may have better health (either because the water is cleaner, or because the households that boil water are generally more healthy so take other measures to keep themselves healthy).

To validate the data, Figure 1 demonstrates the positive correlation between the number of years the child lives in the building with the height for age Z-scores. The graph below shows an upward trend in the height for age Z-scores as the number of years the child has lived in the building increases. This is consistent with the regression result that more exposure to slum redevelopment causes an improvement in child stunting levels. Therefore, the results are consistently positive, demonstrating that slum redevelopment had a beneficial effect on stunting levels for younger siblings, controlling for birth order.

[10] Variables such as immunization levels and nutrition were measured inaccurately, so were not a large part of my analysis. Immunization level was measured in three categories, as people often could not recall which immunizations they had given their children: none, some, or all. Most people fell in the "some" category, which ranged from having received one vaccination to having received almost all vaccinations, which is not very indicative of health seeking behavior or health status. Nutrition was measured by asking families to recall which of the food groups did each child eat in the last 24 hours. However, many households interpreted this as eating the foods in their lifetime, or claimed their children ate everything, which may not have painted an accurate picture of reality.

Figure 1: Number of years child lives in building with the height for age Z-scores



3. Findings from the slum dataset

However, these results must be taken with caution, as there are many other factors that could have changed over time for children overall, making the effect of exposure to slum redevelopment for younger children seem larger than it may be. While this data set is not longitudinal, data was collected in three slum areas as well to see if the height-for-age Z-scores in the slums for younger siblings have also improved over time. If children's heights improved overall due to economic development in Mumbai and higher standards of living for all, then we should see that younger siblings in the slums have a significantly higher height for age Z-score than older siblings in slums. However, results in columns (1), (2), and (3) of Table 3 indicate that there is no significant effect of birth order on the height-for-age Z-score. In fact, the sign on the dummy for being the first or second born child is positive, indicating that being the eldest or second-eldest child is better for stunting levels. Even when each birth order is looked at separately, the result is similar. Hence, this data seems to propose that younger children may not

have been better off generally, so at least some of the differential effect on stunting levels between siblings could be due to the slum redevelopment program. On the other hand, Table 2 demonstrates that there is a significant effect on height for age Z-score of being born first or second in the building dataset (in columns (2) and (4)), which could mean that slum redevelopment may have altered the height for age Z-scores beyond the expected time trend without the program.

While we have established that there seems to be a strong positive correlation between living in the building and height for age Z-scores (as seen in Figure 2), we need to understand how slum redevelopment truly affects child health. To explore the different mechanisms by which slum redevelopment could have this impact, we can draw some conclusions from the data collected in the slums. Columns (1) and (2) in Table 3 illustrate that having a toilet inside the house has a highly significant positive effect (1.133, 1.357 respectively; p-value=0.000) on the height-for-age Z-score, even when controlling for other variables, such as wealth, nutrition and mother's age at child's birth, birth weight, number of people in the household, religion and household expenses on health per month. This suggests that children from households that shifted to buildings from slum areas with toilets could have had better height-for-age Z-scores than those that shifted from slum areas without toilets. Hence, the effect of slum redevelopment is expected to be lower on the households that shifted from slums with toilets.

To test for this, I ran another regression on the building data with the condition that the households had toilets in the slums. Table 4 displays the effect of the number of years spent in the building on height-for-age Z-scores in the sample where people re-located from slums with and without toilets, and with and without mother fixed effects. The coefficient of number of years spent in the building is higher in the random effects model in the second column (0.120),

which includes only households that moved from slums without toilets, than in the first column (0.082) that includes households who moved from slums with toilets. This reaffirms the hypothesis that the effect of slum redevelopment should be higher on households who moved from slums without toilets. However, when including the mother fixed effect, the coefficient in column (4) is not statistically significant, though the magnitude is higher (0.210) than in the situation with toilets in the slum (0.110). The result should be interpreted cautiously as the sample size for the households without toilets in the slum of origin is 90 (as compared to 469 for the ones with toilets); hence, a combination of a small sample size and mother fixed effects may not yield accurate results in column (4).

VII. Measurement Errors

The slum redevelopment program would be a good quasi-experiment had it relocated people randomly from across the city into buildings. However, in reality most of the redevelopment programs were restricted to certain slum segments where the populations were sometimes not similar to populations that were not relocated. According to the Slum Rehabilitation Act of 2000, only people who had started to live in a slum community before 2000 and had relevant documents were allowed to relocate to buildings. (Suryawanshi, 2015) That policy could exclude some people in the lower socio-economic class. Further, many of the buildings had a large proportion of people living there illegally (usually low-middle income families) by buying houses from relocated slum residents. As these families tended to be wealthier, the overall standard of living was higher[11]. Both these factors serve as selection bias into the buildings and could skew the results upward if the better off households moved to buildings where they increase the average child height for age Z-score (also through positive

[11] Though these households did not meet the study eligibility criteria and were not included in the sample, they could contribute to positive externalities that could improve the living atmosphere for everyone.

externalities), making the slum redevelopment program look better than it may be. They could also create a downward pressure on the estimated effect of slum redevelopment as if the households were better off to begin with, slum redevelopment would help them less than it would to a household that was poorer. To control for this, I include building fixed effects that would capture idiosyncratic issues in a building. Generally, people from the same slum were relocated to the same buildings in a similar time period; hence, people from a higher socio-economic stratum would most likely they would all be moved to the same building or set of buildings. Through qualitative interviews, I found that some buildings had more water contamination issues than others, and some did not have a housing society for maintenance of the building (SHG). Hence, the differences in the ways the buildings are maintained and operated could have an effect on health outcomes of households living in the building, which would be captured through a building fixed effects model (in columns (4) and (5) of Table 2).

With non-experimental methodologies, a main issue that arises is that they contain large and unknown biases as a result of specification errors[12]. While it was straightforward to calculate the number of years a child has lived in a building and height-for-age Z-scores, other control variables were difficult to measure and could be much less accurate. For instance, for the wealth indicator, which is captured by proxies, such as the ownership of a two-wheeler vehicle, a car, bicycle, and fridge would have been very useful, had similar results across households. Almost all households had a TV, cell phones, and some amount of furniture in the house, so the only observable differences were in ownership of vehicles (such as 2-wheeler scooters, bicycles, and cars) and a refrigerator. Majority of households did not own any of these additional proxies for wealth, but could have been wealthy; hence, using these measures does not necessarily

[12] Additionally, alongside slum redevelopment, sometimes there were complementary programs happening at the same time, such as health care NGOs establishing in the slum-redeveloped colony.

differentiate between the households. Although wealth is an important measure, I am cautious in interpreting the result. Further, while the result on birth weight is positive and highly significant, suggesting that higher the birth weight, lower the levels of stunting. This result is as expected as health early in life determines health later in life. However, this also suggests that birth weight is a health outcome and hence may not be a suitable right hand side variable. Not only can slum redevelopment affect children after they are born, but can also have an effect while in the fetal stage. Understanding the complex relationship between pregnancy, birth weight and slum redevelopment could be an interesting topic for a future research study.

Valuable cross-sectional information, such as religion, income level, and caste are lost in the mother fixed effects model. Hence, in addition to the full sample, the regressions could be conducted for each of those groups separately. Table 5 demonstrates the results of categorical regressions by religion. As about half the sample was Hindu and the other half Muslim (and very few people of other religions), the results can be compared on sample size. There is a consistently positive coefficient on the number of years lived in the building, but it increases from column (1) that is for Hindu households (0.101; p-value=0.000) to column (2) that is for Muslim households (0.121; p-value=0.000). This means that across households, living longer in the buildings was more beneficial for Muslim children than for Hindu children. However, the situation is reversed after including mother fixed effects. Only Hindu children seem to benefit from the buildings (0.140; p-value=0.015), while the value for Muslim children is statistically insignificant under fixed effects. One explanation for these results is that since on average Hindus moved into the buildings long before the Muslims, they have been more exposed to slum redevelopment. However, there are many other factors not controlled for in the regression (such

as nutrition, wealth, immunization, and so on) due to inaccurate data that could change the results.

VIII. Causal Channels

As discussed earlier, there are multiple mechanisms by which slum redevelopment can improve child health outcomes. This section explains some of them briefly.

i. Toilet use and ownership

As slum redevelopment ensures that all relocated households are given ownership of individual toilets, this could possibly play a large role not just in improving health outcomes, but also in ensuring safety and dignity of females. The World Bank's Water and Sanitation Program declared in 2010 that improper sanitation facilities were diminishing India's GDP in 2006 by 6.4 per cent, or $52.8 through premature deaths and hygiene related diseases (Dobe, 2015). Therefore, if poor sanitation is indeed one of the factors that could lead to child stunting, the topic of slum redevelopment is of high economic importance. Open defecation and lack of toilet use can lead to stunting through indirect (contaminated water source) or direct means through a process called Environmental Enteropathy[13]. This can lead to malnutrition, stunting, cognitive deficits and even diarrhea. There is evidence to support that nutritional deficiency can reduce body's immune function and hence decrease resistance to disease and increase susceptibility to intestinal parasites (Papier, 2014).

ii. Improved cooking stoves

While some families may have had improved cooking stoves in their houses in the slums, most probably did not. Hence, after relocating and being provided with improved cooking stoves, the improved indoor air quality could improve child health outcomes (Hazra, 2014).

[13] Environmental Enteropathy is a disorder caused by repeated fecal contamination causing germs to make the small intestine more permeable to pathogens and hindering the absorption of essential nutrients in the body (Spears, 2012).

iii. Distance to health facility

Further, the buildings where people are relocated may be over 40 kilometers away from the slum they come from and possibly placed in the outskirts of the city. These city outskirts have fewer health facilities and distances to the closest hospital may be much longer. Hence, there may be a shift in access to healthcare when people are in the slum-redeveloped buildings.

iv. Population density

While slums are densely populated, in some cases the slum-redeveloped buildings may be even more densely populated due to the vertical orientation of the buildings where everyone is housed in small rooms. Increased population density could lead to the spread of communicable diseases, which could affect the child's height in the long run.

v. Water quality and schedule

When discussing child health outcomes in the context of India, it is crucial to monitor water quality and schedule. If drinking water quality is poor in the slum-redeveloped buildings, children could be worse off than in the slums (where they may have purchased illegal, but clean drinking water) due to water-borne diseases, of which Diarrhea is most common. Water schedule needs to be tracked as well, as even if the water quality is high, it may come very irregularly. Some households boil their water while other households do not, which means that can be heterogeneity in boiling water within buildings, and can be linked with other cautious behaviors.

vi. Environment

In theory, slum redevelopment should create a cleaner ambiance than the conditions in slum settlements. However, if people do not take ownership of the land outside their apartments and dump garbage on the narrow lanes between buildings, the atmosphere is more concentrated

in bad odor and disease. Hence, it is not clear whether slum redevelopment is beneficial for children's health, or if the way in which its residents maintain the buildings is a culprit.

It is important to distinguish the primary mechanisms for the effect of slum redevelopment on child health outcomes to inform correct policy decisions.

IX. Discussion

The goal of this study is to demonstrate the effects of slum redevelopment programs on the health of its participants, in the light of qualitative interviews stating an increase in disease incidence and poor health outcomes due to the relocation. The results demonstrate that slum redevelopment has a highly significant and positive effect on child stunting levels, which contradicts some of my qualitative data. In this section, I explore the qualitative data results, as well as try to explain how positive effects on child stunting and worsening of other health outcomes can co-exist.

In this study, we rely on anthropometric measurements as the primary health outcome to measure the effect of slum redevelopment due to lack of objective measures for self-report illnesses. Even though height-for-age Z-scores are ideal to capture cumulative effects of exposure to a certain program, they are cannot capture short-term illnesses, such as typhoid, jaundice, malaria, or other severe illnesses such as TB that may not leave a permanent scar on one's height[14]. Hence, while we notice a consistently positive effect of slum redevelopment on child health outcomes, even after controlling for various factors and under mother and building fixed effects, we cannot rule out the possibility of children being unhealthy due to other diseases that are not reflected in their height.

[14] Causes of stunted height include poor nutrition, chronic illnesses, bone disorders, intrauterine growth retardation, failure to thrive and genetic conditions. This does not typically include diseases such as TB, typhoid or water-borne diseases.

Further, qualitative interviews and other survey questions reveal that while services in the slums the people came from were free, in the buildings they have to pay for all those services, pay higher private school fees, private doctor fees, higher vegetable prices (as food was cheaper near the slums, but is more expensive near these buildings), increased travel costs to work place, and so on. The survey data demonstrates that around 64 percent of the households mentioned "job-related" problems as the biggest concern after moving into the building. Without jobs, they earned no income and could not pay education, electricity or health bills. However, if they kept their previous job from the slum and continued to live in the building, their traveling costs could be almost equal to their daily wages. Hence, many were dissuaded from continuing their previous jobs and finding new ones, which takes time and comes with much uncertainty. They claim that the biggest benefit they have had after moving into the building is that of safety (66 percent) and of having a toilet (32 percent). While in the slums they had to spend most of their income on food, water and sanitation, in the buildings they have to pay more on food, electricity and hospital costs. It is unclear if this increase in hospital costs is due to increasing fees, more illness, or some combination of both. More people visited public hospitals in the slum than in the buildings due to the further distance to a hospital from the buildings, so private hospital costs could be one reason for the increase. When relocated, people lose their source of income and live in a more expensive place, which is a huge burden on them.

Nevertheless, there seems to be a positive effect of the shift on child stunting (hence improving long-term cognitive ability) and on overall sanitation, hygiene, and safety. Some households complained of high living costs, loss of job and health problems in the buildings and wanted to shift back to the slum, but others felt blessed to have been given ownership of a house that is cleaner and safer for their children in the building. Some doctors I interviewed asserted

that incidence of TB has been rising rapidly due to lack of ventilation in the building structure and children's health has deteriorated due to water-borne diseases. For many households, the amount of water they receive in the buildings has halved and is contaminated[15]. Further, I cannot conclude about the mechanism by which slum redevelopment improves child stunting, as there are so many factors at play together. Future studies should try to understand these mechanisms better, which can inform future policies.

Recommendations

If stunting levels are improving as people move into buildings, assuming that there is not another factor that could be systematically different between people in the slums and those that shifted into the buildings, relocating people seems to be beneficial for children's health. Further, the study demonstrates that it is important to relocate children when they are young so that they can maximize the number of years they spend in the building. Hence, the study implies that the redevelopment process should continue, but with some alterations to their current scheme (as suggested by qualitative interviews). As discussed in previous sections, high costs and lack of jobs can put households in a desperate situation where they cannot pay for their health bills. That coupled with water contamination issues, lack of ventilation, increase in population density, and so on in the buildings, can increase the incidence of disease greatly, which people cannot afford to pay for. Hence, provision of public health centers or hospitals with highly subsidized medicines could alleviate some of the financial burden on health care. Ideally, slums should be redeveloped and the residents should be given a place to stay on the same redeveloped land, so they do not lose their jobs or their community, or need to spend any additional cost on travel.

[15] 30 percent of the sample in the buildings boiled their water, possibly due to fear of contamination, but I could not test for water contamination; hence, I cannot validate those claims with the current data.

While the quantitative part of this study only provides a small piece of empirical evidence on the topic of slum redevelopment, focus group discussions with the community members and literature review call for further actions from policymakers and government agencies. The solution has to be multi-faceted with several policy reforms and projects happening simultaneously. Due to the immense expanse of slums settlements in Mumbai, it is more feasible to provide basic infrastructural facilities to those settlements, rather than clear them entirely and shift everyone to buildings, as that would take a long time (Gandhi, 2012). One also needs to look at long term strategies that would incentivize the private sector to provide affordable housing along with the provision of necessary infrastructure (of roads, sanitation and water). In a democratic manner, the Mumbai housing policies should be people-centric and the redevelopment process should be based on majority vote.

X. Conclusion and Implications

Slum redevelopment is an important and rapidly increasing phenomenon of large cities in many emerging markets around the world. However, in an attempt to rapidly urbanize, policy makers are conducting massive redevelopments without fully comprehending its consequences. This paper is an attempt to explain some of the health related consequences for the children, which could become worse due to water contamination, lack of ventilation, increased population density, and so on. Even though focus group discussions and anecdotal evidence suggest that water contamination, loss of livelihood and increased expenses have worsened the health outcomes for the residents, this is not reflected in the regression results of this study. This could be because most of the diseases that are caused by the anecdotally narrated factors may not translate into stunting, and hence are not captured by the outcome of the study. The results of the study call for further investigation to point to the exact age or age group where the effect of slum

redevelopment is the largest, if there is such a golden age, and the ideal conditions under which this could be true. While height for age Z-score is only one indicator of health, there are many others that may be more subjective, but paint a more comprehensive picture of the reality of slum redevelopment and should be a research topic for future studies.

Even though stunting levels seem to have improved with slum redevelopment exposure, the mechanism by which the programs benefit the children is unclear. There are still many other types of non-health impacts to measure, such as on education, as change of location to areas without public schools creates increased expenses on private schooling that deters people from sending their children to school, and livelihoods, in terms of loss of income generating activities. Slum redevelopment should be thoroughly planned, with involvement from the community members themselves, and their effects studied and followed-up on. If the future of cities is relocating people to formal housing, the prospects of living in this new type of housing should be beneficial for its residents for the program to be successful. It becomes imperative that policymakers in the urban age not try to hide the in-equality in the city but be sensitive to it and reveal it in their design. They should accommodate everyone in a way that truly improves the socio-economic, psycho and biological wellbeing of people. With increased standards of living, India will be able to tap into its immense potential and create a healthier, more productive workforce who can expedite its economic development.

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Table 1: Summary Statistics

	(1)	(2)	(3)	(4)
	Building data		**Slum data**	
	Mean	***n***	***Mean***	***n***
Colony codes				
Colony 1	0.31	674	-	-
Colony 2	0.07	674	-	-
Colony 3	0.30	674	-	-
Colony 4	0.32	674	-	-
Reason for relocation				
Footpath	0.44	674	-	-
Bridge	0.31	674	-	-
Gutter	0.31	674	-	-
Tata power	0.05	674	-	-
Railway	0.27	674	-	-
Others	0.18	674	-	-
Household characteristics				
Hindu	0.48	674	0.29	201
Muslim	0.43	674	0.70	201
Toilet in slum	0.83	614	0.31	201
Mother's age at birth	23.04	635	22.25	195
Mother married before age 18	0.33	589	0.29	201
Total number of members	6.81	665	6.07	198
Number of children <18 years	3.10	655	2.77	201
Number of years since shift	7.25	674	-	-
Cycle	0.06	674	0.01	201
Two wheeler	0.12	674	0.11	201
Four wheeler	0.07	674	-	-
Fridge	0.08	674	0.39	201
Water boil	0.30	674	-	-
Alcohol consumption	0.29	647	0.09	201
Tobacco consumption	0.43	636	0.21	198
Bank account	0.77	609	0.86	195
Adhaar Card	0.90	642	0.99	201
Closer to hospital	0.50	609	-	-
LPG	-	-	0.49	201
Electricity	-	-	0.98	201
Water supply at home	-	-	0.92	201
Health expenses/month	2087.63	608	1398.80	199
Child Characteristics				
Birth weight	2.78	613	2.76	196
Height for Age Z-score	-1.80	559	-1.73	160
Nutrition	3.10	422	2.98	194
Delivery in hospital	0.82	626	0.62	186
Normal delivery	0.84	592	0.77	172
Age of child	8.47	674	8.00	200

Table 2: Building Results

Dependent Variable: Height–for-Age Z-Score

	(1)	(2)	(3)	(4)	(5)
Number of years spent in building	0.124*** (0.046)	0.086*** (0.019)	0.093*** (0.020)	0.128*** (0.030)	0.178*** (0.034)
Age at first exposure	-0.038 (0.032)	0.011 (0.016)	0.011 (0.016)	-0.023 (0.021)	-0.021 (0.028)
First two children	0.292 (0.220)	0.247* (0.142)	0.230 (0.142)	0.295* (0.160)	0.021 (0.198)
Wealth		0.298*** (0.105)	0.296*** (0.105)	0.305** (0.119)	0.500*** (0.147)
Toilet in slum		0.311* (0.168)	0.334** (0.168)	0.500** (0.202)	0.370 (0.249)
Muslim			0.169 (0.131)	0.168 (0.189)	0.321 (0.226)
Other religion			0.756* (0.404)	0.924* (0.556)	0.953* (0.544)
Disease in building				0.406** (0.157)	0.250 (0.191)
Number of people in HH				-0.074** (0.032)	-0.025 (0.040)
Mother's education					0.002 (0.019)
Birth weight					0.287*** (0.105)
Delivery in hospital					0.108 (0.230)
Normal delivery					-0.203 (0.239)
Boil water at home					0.550** (0.234)
Fixed Effects	Mother	-	-	Building	Building
Adj.R-squared	0.037	0.062	0.067	0.099	0.205
Observations	559	530	530	498	312

*Standard Errors in parenthesis. *Significant at the 15% confidence interval. **Significant at the 10% confidence interval. ***Significant at the 1% confidence interval.*

Table 3: Slum Results

Dependent Variable: Height–for-Age Z Score

	(1)	(2)	(3)
First two children	0.220	0.290	0.571
	(0.397)	(0.434)	(0.382)
Toilet inside home	1.133***	1.357***	
	(0.375)	(0.422)	
Wealth	0.287	0.277	
	(0.184)	(0.233)	
Health expenses/month	0.032	0.021	
	(0.030)	(0.032)	
Nutrition	-	0.002	0.250
		(0.219)	(0.274)
Mother's age at birth	-	0.004	
		(0.037)	
Birth weight	-	-0.129	-0.042
		(0.275)	(0.299)
Number of people in HH	-	0.060	
		(0.062)	
Muslim		-0.593	
		(0.433)	
Fixed Effects	-	-	Mother
Adj.R-squared	0.152	0.155	0.027
Observations	118	109	125

*Standard Errors in parenthesis. *Significant at the 15% confidence interval. **Significant at the 10% confidence interval. ***Significant at the 1% confidence interval.*

Table 4: Causal Mechanisms

Dependent Variable: Height–for-Age Z Score

	(1)	(2)	(3)	(4)
Number of years spent in building	0.082***	0.120**	0.110**	0.210
	(0.021)	(0.046)	(0.049)	(0.148)
Age at first exposure	0.005	-0.002	-0.038	-0.012
	(0.017)	(0.035)	(0.037)	(0.069)
First two children	0.388**	-0.211	0.426*	-0.326
	(0.158)	(0.319)	(0.246)	(0.493)
Fixed Effects	-	-	Mother	Mother
Sample Restrictions	Toilet in slum	No toilet in slum	Toilet in slum	No toilet in slum
Adj.R-squared	0.041	0.046	0.043	0.050
Observations	469	90	469	90

*Standard Errors in parenthesis. *Significant at the 15% confidence interval. **Significant at the 10% confidence interval. ***Significant at the 1% confidence interval.*

Table 5: Restricted regressions

Dependent Variable: Height–for-Age Z Score

	(1)	(2)	(3)	(4)
Number of years spent in	0.101***	0.121***	0.140**	0.101
building	(0.025)	(0.031)	(0.057)	(0.077)
Age at first exposure	0.026	-0.002	0.028	-0.074
	(0.024)	(0.022)	(0.049)	(0.046)
First two children	0.052	0.444	-0.119	0.501
	(0.196)	(0.214)	(0.307)	(0.332)
Fixed Effects	-	-	Mother	Mother
Sample Restrictions	Hindu	Muslim	Hindu	Muslim
Adj.R-squared	0.047	0.067	0.050	0.042
Observations	274	243	274	243

*Standard Errors in parenthesis. *Significant at the 15% confidence interval. **Significant at the 10% confidence interval. ***Significant at the 1% confidence interval.*

Slum Redevelopment 2015– Household Survey

##. Survey Start Time	: AM / PM	Date	/ /2015

Colony and Code		Building and Code		Household Number		1-Surveyor Name/Code		2- Surveyor Name/Code	
	☐		☐☐☐		☐☐☐		☐		☐

H0. Number of families in the house	

H1. GENERAL INFORMATION: Applicable to all persons eating regularly from one kitchen

H1.1 Ration Card Color (Circle one)		H1.2 Religion (Circle one)		H1.3 Caste (Circle one)		H1.4 Number of persons eating from one kitchen		H1.5 Date of shift into building	☐☐/☐☐/☐☐
White	1	Hindu	1	SC	1	Total number of family members	☐☐	H1.6 Slum Origin	
Orange	2	Muslim	2	ST	2	Number of children below 18 years	☐☐	H1.7 Village, State Origin	
Yellow	3	Other	3	Other	3	Number of mothers with children below 18 years	☐☐	H1.8 Reason for shifting	
Comments								H1.9 Mother Serial Number	☐
								H1.10 Survey Respondent (circle one or circle both if both answering together)	Mother / Grandmother If Grandmother, why?

H1.11 Objects in the house (Circle those available)	Yes	No	Don't Know
1. Television	1	2	99
2. Radio	1	2	99
3. Mobile phone	1	2	99
4. 4-wheeler	1	2	99
5. 2-wheeler	1	2	99
7. Cycle	1	2	99

H1.12 List of mothers with children below 18 years		
S.L.	Name	Number of children below 18 yrs
1		
2		
3		
4		

H1.13 Water Quality (Put circle if applicable to any member of family)	Yes	No	Don't Know
1. Is the water safe to drink?	1	2	99
2. Do you boil/use advanced filter/use Cl packets to treat your water at home?	1	2	99
3. Do you pay for water through water tankers, etc?	1	2	99
4. How many hours in the day do you get water?	☐☐		

H1.14 Consumption of liquor and tobacco (Put circle if applicable to any member of family)	Yes	No	Don't Know
1. Does any family member consume alcohol?	1	2	99
Comments			
2. Does any family member consume tobacco? (cigarette, gutkha)	1	2	99
Comments			

H1. 15 Questions about shifting	
1. What has been the biggest benefit to shifting into building?	Safety – 1 Toilet – 2 Cleanliness – 3 Ownership of house – 4 None – 5 Other – 6 *Comments*
2. What has been the biggest problem of shifting into building?	Job-related – 1 School-related – 2 Water – 3 Garbage – 4 None – 5 Other – 6 *Comments*
3. Did you have any diseases due to water when you shifted in the building?	Yes – 1 No – 2 Don't Know – 99
If yes, which ones?	Typhoid – 1 Pelia (Jaundice) – 2 Malaria/Dengue – 3 TB – 4 Chicken Pox – 5 Leprosy – 6 Other – 7 *Comments*
4. How did the shift into building help your children?	Safety – 1 Respect – 2 Toilet – 3 Better health – 4 None – 5 Other – 6 *Comments*
5. How did the shift into building harm your children?	School-related – 1 Drugs – 2 Poor health – 3 None – 4 Other – 5 *Comments*

H1.16 Past Maternal Information (Circle whichever is applicable to any member of the family) *(If answer lies anywhere in the range, circle Yes)*	**Yes**	**No**	**Don't Know**
1. Were you pregnant when you shifted from slum to building?	1	2	99
2. Did you use any toilet in the slum?	1	2	99
How far was the toilet in the slum? Comments?			
3. Did you have any serious illness in the slum? (TB, Dengue, etc)	1	2	99
Comments			
4. Did you use a chula (stove) in the slum?	1	2	99
5. What were your major household expenses in the slum? *Comments*	Food – 1 Water – 2 Electricity – 3 Toilet – 4 Hospital – 5 Maintainence – 6 Other - 7		
6. How much did you spend on healthcare treatment or check-ups for your children in the slum? *Comments*	Rs. ☐ /-		
7. When your child fell ill in the slum, where did you take him/her? If not taken to health care professional, why not? *Comments*	Gov health center/hosp– 1 Private MBBS doctor – 2 Untrained health worker – 3 Home or traditional remedy – 4 Other – 5 NA (child did not fall sick) - 6 Don't Know – 99		

H1.17 Present Maternal Information (Circle whichever is applicable to any member of the family)	**Yes**	**No**	**Don't Know**
2. Do you have an Adhaar card? (ask to see it)	1	2	99
4. Are you a member of Self-Help Group?	1	2	99
5. Do you have better access to a health facility after shifting?	1	2	99
Comments			
6. Do you have a bank account of your own?	1	2	99
5. What were your major household expenses in the slum? *Comments*	Food – 1 Water – 2 Electricity – 3 Toilet – 4 Hospital – 5 Maintainence – 6 Other - 7		
6. How much have you spent in healthcare treatment or check-ups for your children since you shifted into the building? If this is more than in the slum, why is that? (due to distance, prices, more illnessnes, etc) If this is less than in the slum, why is that? (less disease?) If it is the same, why is that? *Comments*	Rs. ☐ /-		
7. When your child last fell ill, where did you take him/her? If not taken to health care professional, why not? *Comments*	Gov health center/hosp– 1 Private MBBS doctor – 2 Untrained health worker – 3 Home or traditional remedy – 4 Other – 5 NA (child did not fall sick) - 6 Don't Know – 99		

H.2 CHILD INFORMATION: Ask questions to any mother.

H2.1 Information about the mother and father	**Mother serial number**	**Name**	**Age** (Approx)	**Highest grade completed** (If class 1-10, to go column 6)	**Can read** (If 0 in column 4)	**Were you less than 18 years old when you married?**
	1	2	3	4	5	6
1. Mother					Yes – 1 No – 2	Yes – 1 No – 2
2. Father					Yes – 1 No – 2	

Note: In column 4, write 0 if no schooling, 1 for Grade 1, 2 for Grade 2, 3....., 9 for class 9, and 10 for class 10 and above

H2.2 Name of Child (Only children below 18, from older to younger)	**H2.2.1 Name**	**H2.2.2 Name**
a. Gender	a. Male – 1 Female – 2	a. Male – 1 Female – 2
b. Date of birth (day/month/year)	b. ☐☐/☐☐/☐☐	b. ☐☐/☐☐/☐☐
c. Accurate date of birth (Circle applicable one)	c. Day – 1 Month – 2 Year – 3	c. Day – 1 Month – 2 Year – 3
d. Birth sequence (For eldest child in living children, put 01)	d. ☐☐	d. ☐☐
e. Institutional delivery (If No (2), to go to f) or midwifery	e. Yes – 1 No – 2 Midwife – 3 In village - 4	. Yes – 1 No – 2 Midwife – 3 In village - 4
e.1. If institutional delivery, circle the appropriate option	e.1. Operation– 1 Pre-term delivery– 2 Ordinary delivery– 3	e.1. Operation– 1 Pre-term delivery– 2 Ordinary delivery– 3
f. Was your child weighed at birth? If Yes, what was the weight in kg? (Ask for birth certificate or immunization card)	f. ☐.☐ kg Did not weigh – 96 Don't know – 99	f. ☐.☐ kg Did not weigh – 96 Don't know – 99
g. Did the child suffer from 4iarrhea, cold/cough in the last 1 week? Note: Diarrhoea is at least 3 times stools like water in a day. (Circle all that apply)	g. Diarrhoea – 1 Fever/cough – 2 Did not have – 3 Don't know – 99 *Comments*	g. Diarrhoea – 1 Fever/cough – 2 Did not have – 3 Don't know – 99 *Comments*
h. Did the child suffer from a major illness when he/she was younger? (Circle all that apply)	h. Typhoid/Jaundice – 1 TB/other bacterial – 2 Other – 3 Did not have – 4 Don't know – 99 *Comments*	h. Typhoid/Jaundice – 1 TB/other bacterial – 2 Other – 3 Did not have – 4 Don't know – 99 *Comments*
o. Weight – If the child cannot stand alone on the machine, weigh with an adult. Notes: - Remember to weigh the adult alone first - Record weight to the closest 100 gms - Surveyor to record weight in **a** and **b** OR in **c** only. That is, if a and b are recorded, then c will NOT be recorded	1st measurement / Final measurement With adult: o. Adult alone ☐☐.☐ kgs; b. With child ☐☐.☐ kgs; Adult alone (final) ☐☐.☐ kgs; b. With child (final) ☐☐.☐ kgs Alone: c. Child's weight ☐☐.☐ kgs; c. Child's weight (final) ☐☐.☐ kgs	i. 1st measurement / Final measurement With adult: o. Adult alone ☐☐.☐ kgs; b. With child ☐☐.☐ kgs; Adult alone (final) ☐☐.☐ kgs; b. With child (final) ☐☐.☐ kgs Alone: c. Child's weight ☐☐.☐ kgs; c. Child's weight (final) ☐☐.☐ kgs
j. Height –Measure standing up.	j. ☐☐☐.☐ cm	j. ☐☐☐.☐ cm
l. What is the child's grade in school? Note: For LKG/UKG put 0L or 0U	l. ☐☐	l. ☐☐
m. How many income earners were there at the time of child's birth?	m. ☐☐	m. ☐☐
n. Which immunizations has the child received? (Ask to view immunization card	n. BCG – 1 Polio – 2 MMR – 3 Tetanus – 4 Other – 5 *Comments*	n. BCG – 1 Polio – 2 MMR – 3 Tetanus – 4 Other – 5 *Comments*

o. Is the child anemic?	o.	Yes – 1		No – 2		Don't know - 99	
p. What was the child's first food (drink) after birth? (If 2 / 3 / 98 then go to LEVEL 2, or else go to question 2)	p.	1 Breastfeeding	2 Formula (e.g. tin milk, Cerelac)	3 Traditional feed (e.g. honey, sugar)	98 Other	99 Don't know	
q. How many times have you visited the doctor for check-up since you shifted in the building? (circle one number)	q.	1 2 3 4 5 6 7 8 9 10 >10 *Comments*					
r. How many days of school has the child missed in the last year? If more than 5 days, why did the child miss school?	r.	*Comments* ☐					
s. In the last 24 hours, what foods did your child eat?	s.	1 Grains (rice, wheat, millet)	2 Milk, curd	3 Eggs, nuts, pulses, meat, chicken	4 Vegetable and fruit	5 Processed foods (e.g. biscuits, bread)	6 N/A – Child on breastmilk

o.	Yes – 1		No – 2		Don't know - 99	
p.	1 Breastfeeding	2 Formula (e.g. tin milk, Cerelac)	3 Traditional feed (e.g. honey, sugar)	98 Other	99 Don't know	
q.	1 2 3 4 5 6 7 8 9 10 >10 *Comments*					
r.	*Comments* ☐					
s.	1 Grains (rice, wheat, millet)	2 Milk, curd	3 Eggs, nuts, pulses, meat, chicken	4 Vegetable and fruit	5 Processed foods (e.g. biscuits, bread)	6 N/A – Child on breastmilk

H2.2 Name of Child (Only children below 18, from older to younger)	**H2.2.3 Name**	**H2.2.4 Name**
a. Gender	a. Male – 1 Female – 2	a. Male – 1 Female – 2
b. Date of birth (day/month/year)	b. ☐☐/☐☐/☐☐	b. ☐☐/☐☐/☐☐
c. Accurate date of birth (Circle applicable one)	c. Day – 1 Month – 2 Year – 3	c. Day – 1 Month – 2 Year – 3
d. Birth sequence (For eldest child in living children, put 01)	d. ☐☐	d. ☐☐
e. Institutional delivery (If No (2), to go to f) or midwifery	e. Yes – 1 No – 2 Midwife – 3 In village - 4	. Yes – 1 No – 2 Midwife – 3 In village - 4
e.1. If institutional delivery, circle the appropriate option	e.1. Operation– 1 Pre-term delivery– 2 Ordinary delivery– 3	e.1. Operation– 1 Pre-term delivery– 2 Ordinary delivery– 3
f. Was your child weighed at birth? If Yes, what was the weight in kg? (Ask for birth certificate or immunization card)	f. ☐.☐ kg Did not weigh – 96 Don't know – 99	f. ☐.☐ kg Did not weigh – 96 Don't know – 99
g. Did the child suffer from Siarrhea, cold/cough in the last 1 week? Note: Diarrhoea is at least 3 times stools like water in a day. (Circle all that apply)	g. Diarrhoea – 1 Fever/cough – 2 Did not have – 3 Don't know – 99 *Comments*	g. Diarrhoea – 1 Fever/cough – 2 Did not have – 3 Don't know – 99 *Comments*
h. Did the child suffer from a major illness when he/she was	h. Typhoid/Jaundice – 1 TB/other bacterial – 2 Other – 3	h. Typhoid/Jaundice – 1 TB/other bacterial – 2 Other – 3

Slum Redevelopment 2015– Household Survey

##. Survey Start Time	:	AM / PM	Date	/ /2015

Slum and Code		Area Code		Household Number		1-Surveyor Name/Code		2- Surveyor Name/Code	

H0. Number of families in the house	

H1. GENERAL INFORMATION: Applicable to all persons eating regularly from one kitchen

H1.1 Ration Card Color (Circle one)		H1.2 Religion (Circle one)		H1.3 Caste (Circle one)		H1.4 Number of persons eating from one kitchen		H1.5 Year of shift to slum from village	
White	1	Hindu	1	SC	1	Total number of family members		H1.6 Village, State Origin	
Orange	2	Muslim	2	ST	2	Number of children below 18 years		H1.7 Reason for migrating	
Yellow	3	Other	3	Other	3	Number of mothers with children below 18 years		H1.8 Mother Serial Number	

H1.9 Survey Respondent (circle one or circle both if both answering together)	Mother / Grandmother If Grandmother, why?

H1.11 Objects in the house (Circle those available)	Yes	No	Don't Know
1. Television	1	2	99
2. Water supply at home	1	2	99
3. Mobile phone	1	2	99
4. Electricity at home	1	2	99
5. 2-wheeler	1	2	99
7. Cycle	1	2	99
8. Fridge	1	2	99
9. LPG (gas connection)	1	2	99
10. Toilet inside house	1	2	99
11. Bathroom inside house	1	2	99

H1.12 List of mothers with children below 18 years		
S.L.	Name	Number of children below 18 yrs
1		
2		
3		
4		

H1.12 Occupation of Mother and Father	
Mother	
Father	

H1.13 Water Quality (Put circle if applicable to any member of family)	Yes	No	Don't Know
1. Is the water safe to drink?	1	2	99
2. Do you boil/use advanced filter/use Cl packets to treat your water at home?	1	2	99
3. Do you pay for water through water tankers, etc?	1	2	99
4. How many hours in the day do you get water?			

H1.14 Consumption of liquor and tobacco (Put circle if applicable to any member of family)	Yes	No	Don't Know
1. Does any family member consume alcohol?	1	2	99
Comments			
2. Does any family member consume tobacco? (cigarette, gutkha)	1	2	99
Comments			

(Child questions remain the same as in the Building household survey)

H1. 15 Questions about shifting	
1. Do you often have any diseases or health problems in the slum?	Yes – 1 No – 2 Don't Know – 99
If yes, which ones?	Typhoid – 1 Pelia (Jaundice) – 2 Malaria/Dengue – 3 TB – 4 Chicken Pox – 5 Leprosy – 6 Other – 7 *Comments*
2. What are your biggest problems living here?	Disease – 1 Unsafety – 2 Dirty – 3 No toilet – 4 No ownership of house – 5 None – 6 Other – 7
3. Do your children have enough place to play here?	Yes – 1 No – 2 Don't Know – 99
3. Do you want to shift to a building provided by BMC or MMRDA?	Yes – 1 No – 2 Don't Know – 99
4. If you were shifted into a building from this slum, what benefits do you think you will have in the building?	Safety – 1 Toilet – 2 Cleanliness – 3 Ownership of house – 4 None – 5 Other – 6 *Comments*
5. What do you think will be the biggest problem of shifting into building?	Job-related – 1 School-related – 2 Water – 3 Garbage – 4 None – 5 Other – 6 Travel - 8 *Comments*

H1.17 Maternal Information 1 (Circle whichever is applicable to any member of the family)	**Yes**	**No**	**Don't Know**
2. Do you have an Adhaar card? (ask to see it)	1	2	99
4. Are you a member of Self-Help Group?	1	2	99
5. Is there is hospital/clinic nearby?	1	2	99
Comments			
6. Do you have a bank account of your own?	1	2	99
7. What is the mother's age?			
8. What is the mother's highest grade completed in school?			
9. Was the mother less than <18 years when married?	1	2	99
10. What is the father's highest grade completed in school?			

H1.16 Maternal Information 2 (Circle whichever is applicable to any member of the family) *(If answer lies anywhere in the range, circle Yes)*	**Yes**	**No**	**Don't Know**
1. Do you use any toilet in the slum?	1	2	99
How far is the toilet in the slum? Comments?			
3. Did you ever have any serious illness? (TB, Dengue, etc)	1	2	99
Comments			
4. Which of these do you use for cooking?	Chula – 1 Stove – 2 Gas – 3 Other – 4		
5. What are your major household expenses spent on? *Comments*	Food – 1 Water – 2 Electricity – 3 Toilet – 4 Hospital – 5 Maintainence – 6 Other - 7		
6. How much do you spend on healthcare treatment or check-ups for your children per month? *Comments*	Rs. ☐ /-		
7. When your child falls ill, where did you take him/her? If not taken to health care professional, why not? *Comments*	Gov health center/hosp– 1 Private MBBS doctor – 2 Untrained health worker – 3 Home or traditional remedy – 4 Other – 5 NA (child did not fall sick) – 6 Don't Know – 99		

Appendix 3: Formulas for constructing independent variables

1)

$$No.of\ years\ since\ shift = 2015\ (year\ of\ survey) - year\ of\ shift$$

2)

$$Child\ building = \begin{cases} No.of\ years\ since\ shift, & Age \geq No.of\ years\ since\ shift \\ Age, & Age \leq No.of\ years\ since\ shift \end{cases}$$

$$Number\ of\ years\ child\ lived\ in\ the\ building = Child\ building$$

3)

$$Age\ at\ shift = Age - Child\ building$$

$$Fraction\ of\ life\ in\ building = \frac{Child\ building}{Age}$$

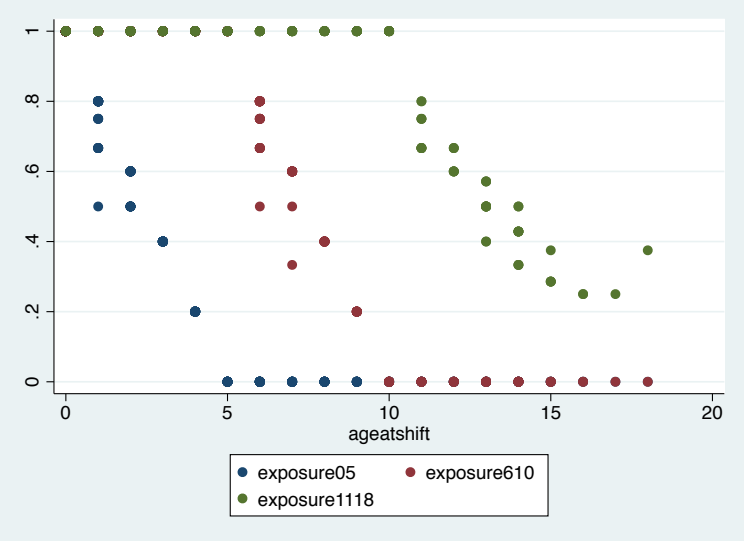
$$= Age - \frac{Age\ at\ shift}{Age}$$

$$= 1 - \frac{Age\ at\ shift}{Age}$$

Though the exact date of the shift was recorded, many of the households were unclear on the date and month of shift (also because it was a more gradual process for some of them, as they moved to transit camps first and then into the buildings). Hence, only the year of shift was included for analysis, although that forgoes some of the nuances of differences between households who moved at the beginning and end of the year.

Appendix 4: Discrepancy in fraction variables to measure slum redevelopment

1. **Figure 1:**

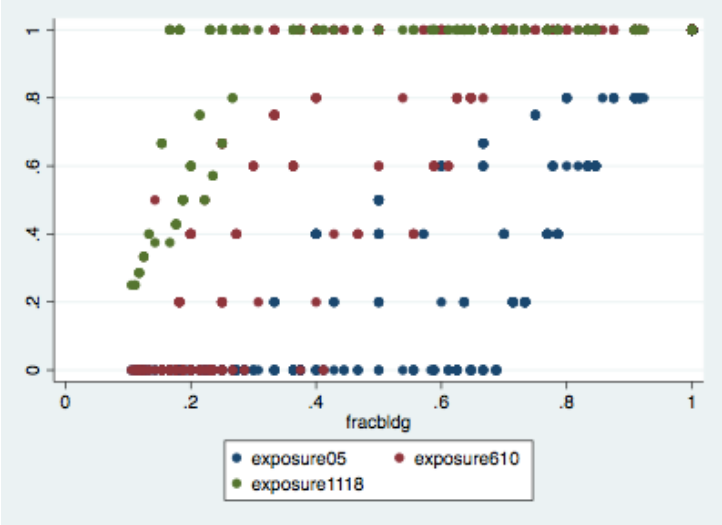


The figure demonstrates that as the age of shift into the building increases, the exposure to slum redevelopment within each of the age groups defined decreases. We see that for the children above 11 years of age who shifted into the building before they were 11, the exposure in the age group 11 to 18 years is 100% as moving into the building is an absorptive state (once one shifts into the building one cannot move back out).

The average number of years spent in the building for a child more than or equal to 11 years of age is 7.4 years. For a child between the ages of 6 and 11, the average is 5.5 years; that for a child below 6 years, is 2.6 years. Hence, in the regression with the variable, exposure between the ages of 11 and 18 included, the number of observations drops to 203 from 559, including only children who are more than or equal to 11 years old. On average, this sample is a lot more exposed to slum redevelopment, which can lead to the observed highly significant and

positive result on child stunting due to the accumulated effect of exposure to slum redevelopment over the years.

2. **Figure 2:**



There seems to be a discrepancy when correlating the fraction of life spent in the building with exposure to the building (also measured as a fraction) within certain age groups. Hence, I chose to use number of years spent in the building to measure the exposure to slum redevelopment.

Appendix 5: Additional summary statistics divided by older and younger children

Table 6: Summary Statistics

	(1)	(2)	(3)	(4)	(5)
	Child age ≤5 years		**Child age>5 years**		
	Mean	***n***	***Mean***	***n***	***t-statistic***
Household Characteristics:					
Hindu	0.41	214	0.51	467	2.39**
Muslim	0.49	214	0.40	467	-2.16**
Toilet in slum	0.81	187	0.88	374	0.63
Mother's age	28.02	204	31.87	396	12.35***
Mother married before age 18	0.27	186	0.37	410	2.20**
Number of families	1.20	214	1.15	467	-1.09
Total number of members	7.21	214	6.59	459	-2.65***
Number of children <18 years	6.65	214	3.15	454	1.57
Number of years since shift	6.65	214	7.55	467	2.92***
Cycle	0.06	214	0.06	467	-0.02
Two wheeler	0.13	214	0.12	467	-0.31
Four wheeler	0.09	214	0.06	467	-1.31
Fridge	0.06	214	0.08	467	0.85
Water boil	0.31	206	0.32	448	0.40
Alcohol consumption	0.32	207	0.27	447	-1.39
Tobacco consumption	0.43	205	0.42	438	-0.16
Bank account	0.67	188	0.81	427	3.75***
Adhaar Card	0.81	197	0.94	452	5.17***
Closer to hospital	0.47	190	0.51	426	0.93
Child Characteristics:					
Birth weight	2.67	193	2.82	427	2.32**
Height for Age Z-score	-2.31	151	-1.62	410	4.98***
TB	0.00	214	0.01	467	0.98
Typhoid-Jaundice	0.04	214	0.07	467	1.51
Nutrition	2.97	137	3.16	288	1.98**