HHS Public Access

Author manuscript

Popul Dev Rev. Author manuscript; available in PMC 2016 March 01.

Published in final edited form as:

Popul Dev Rev. 2015 March ; 41(1): 59–84. doi:10.1111/j.1728-4457.2015.00026.x.

Slum Definitions in Urban India: Implications for the Measurement of Health Inequalities

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Abstract

Half the population of low- and middle-income countries will live in urban areas by 2030, and poverty and inequality in these contexts is rising. Slum dwelling is one way in which to conceptualize and characterize urban deprivation but there are many definitions of what constitutes a slum. This paper presents four different slum definitions used in India alone, demonstrating that assessments of both the distribution and extent of urban deprivation depends on the way in which it is characterized, as does slum dwelling's association with common child health indicators. Using data from India's National Family and Health Survey from 2005–2006, two indictors of slum dwelling embedded in the survey and two constructed from the household questionnaire are compared using descriptive statistics and linear regression models of height- and weight-for-age z-scores. The results highlight a tension between international and local slum definitions, and underscore the importance of improving empirical representations of the dynamism of slum and city residents.

INTRODUCTION

Background

More than half of the world's population lives in urban areas and by 2030 it is projected that over half of residents in low- and middle-income countries (LMICs) will reside in cities (Montgomery, 2008). As rural residents move to urban areas in search of jobs and villages are overtaken by expanding urban agglomerations, many low- and middle-income countries are increasingly concerned with the urbanization of poverty (Pradhan, 2012). The rapid and large scale of urban growth has raced far ahead of the provision of services (Yach et al., 1990) and has precipitated a proliferation of informal settlements – and the development of new, smaller cities (Montgomery, 2009) – without access to water and sanitation, garbage collection or security of tenure.

Concentrated urban poverty and deprivation is often characterized by residential crowding, exposure to environmental hazards, and social fragmentation and exclusion (Wratten, 1995), all components of a cluster of conditions frequently referred to with the catch-all term of "slum dwelling". Indeed, policy and media rhetoric on urban issues tends to focus on slums because of their intuitive appeal and relatively natural conceptual summarization of what constitutes concentrated deprivation in urban areas.

The word “slum” was first used in London at the beginning of the 19th century to describe a “room of low repute” or “low, unfrequented parts of the town”, but has since undergone many iterations in meaning and application (UN-HABITAT, 2003b). While early definitions of slum dwelling combined physical, spatial, social and even behavioral aspects of urban poverty (UN-HABITAT, 2003a), the spread of associations has more recently narrowed. Indeed, a slum has been re-defined by the United Nations Program on Human Settlements (UN-HABITAT) as “a contiguous settlement where the inhabitants are characterized as having inadequate housing and basic services. A slum is often not recognized and addressed by the public authorities as an integral or equal part of the city” (UN-HABITAT Urban Secretariat & Shelter Branch, 2002). The United Nations (UN) even incorporated slums into the Millennium Development Goals as part of Goal 7, to Ensure Environmental Sustainability: target 7.D is to “Achieve, by 2020, a significant improvement in the lives of at least 100 million slum dwellers” (United Nations, 2013), putting area-level deprivation and urban poverty on the development agenda.

In the most recent report on progress towards the MDGs it was found that Target 7.D had been met (United Nations, 2013), and international and multilateral attention has subsequently turned elsewhere. There are a number of concerns regarding this optimistic assessment, however. First, it is not clear that achieving this goal is the significant accomplishment the UN is touting it to be because the goal was most likely developed based on an underestimation of the worldwide slum population, making it significantly less aspirational than it may appear to be. Additionally, unlike other targets, 7.D is an absolute number, not a proportion, meaning that it can be met even as slum populations continue to grow in absolute size. This has indeed taken place; the UN estimates there were 650 million slum dwellers in 1990; this number grew to 760 million in 2000 and 863 million in 2012. The most important issue with the UN’s finding that target 7.D has been reached, however, is the challenge of establishing, in practice, what actually constitutes a slum.

Slum definition

The definition of what constitutes a slum, like that which constitutes an urban area more generally (Dorélien et al., 2013), differs by country (United Nations, 2014), state (Ministry of Housing and Urban Poverty Alleviation, 2008) and even city (O’Hare et al., 1998). Recent research has also indicated that slums may be more heterogeneous than is often assumed (Goli et al., 2011, Chandrasekhar and Montgomery, 2009, Agarwal and Taneja, 2005); many poor people like pavement dwellers do not live in slums and are therefore not “counted” by the standard definitions (Agarwal, 2011).

The UN operationally defines a slum as “one or a group of individuals living under the same roof in an urban area, lacking in one or more of the following five amenities”: 1) Durable housing (a permanent structure providing protection from extreme climatic conditions); 2) Sufficient living area (no more than three people sharing a room); 3) Access to improved water (water that is sufficient, affordable, and can be obtained without extreme effort); 4) Access to improved sanitation facilities (a private toilet, or a public one shared with a reasonable number of people); and 5) Secure tenure (*de facto* or *de jure* secure tenure status and protection against forced eviction) (UN-HABITAT, 2006/7).

While this definition of what constitutes a slum was used by the UN to evaluate whether target 7.D had been met, it is quite different than those which are used by individual countries for their own policy and planning purposes. Uganda, for example, in a document outlining a slum upgrading strategy and action plan from 2008, defines slums as having one or more of the following attributes: 1) Attracting a high density of low income earners and/or unemployed persons with low levels of literacy, 2) An area with high rates/levels of noise, crime, drug abuse, immorality (pornography and prostitution) and alcoholism and high HIV/AIDS prevalence, or 3) An area where houses are in environmentally fragile lands, e.g. wetlands (Ministry of Lands, 2008). Applying the UN's slum definition to Ugandan cities results in 93% of the urban population living in slums.

In India, notification, or legal designation, as a slum settlement is central to the recognition of slums by the government and over time is intended to afford residents rights to the provision of potable water and sanitation. But many communities exhibiting distinctly slum-like characteristics are never notified (Subbaraman et al., 2012); Delhi, for example, has notified no new slums since 1994 (Bhan, 2013). The UN definition incorporates legality, however, and would presumably identify all deprived areas, and not just those recognized as slums by the government, likely leading to disagreement over the distribution and absolute number of slum residents in India.

These differences, as well as the absolute nature of MDG target 7.D, can lead to divergent priorities between the international community and local governments, complicating the assertion that target 7.D has been met and that this development agenda item should be put aside. The tension between multilateral and country-level definitions of what constitutes a slum precipitates the central research question of this paper: does it matter how slums are defined? In other words, do different definitions simply tap into the same underlying construct of concentrated urban deprivation and identify the same areas as slum dwelling? This paper will investigate slum dwelling in one context in particular – that of India – for the following reasons:

1. The definition and identification of slums is of current policy and programmatic importance to the Government of India, which is increasingly concerned with growing poverty, inequality and poor health among its 400 million urban residents. The Indian government has developed policy initiatives such as the *Rajiv Awas Yojana*, which envisages a "slum free India" (Ministry of Urban Housing and Poverty Alleviation, 2010) and may benefit from further guidance regarding documentation and measurement of the distribution and extent of its urban poor population.
2. Urbanization in India, like any widespread phenomenon in a country of over a billion people, is a massive planning and policy challenge. After economic liberalization in the early 1990s, India's urban population grew by almost 32% in a decade (Agarwal et al., 2007). The McKinsey Global Institute estimates that by 2030 about 590 million Indians will live in cities, which is almost twice the US population today (Sankhe et al., 2010); the UN projects that by 2030 the country will be majority urban. The study of urban phenomena in India is therefore large in both absolute size and importance.

3. Relatedly, India's cities have been called the engine of the country's growth and development. But poor living conditions like those found in slums likely have consequences for productivity and human capital development. Slum residents have been found to pour immense time and resources into obtaining water and waiting to use public toilets, for example, which has severe economic and even mental health consequences (Subbaraman et al., 2014). Lack of infrastructure and security in slums may reduce residents' involvement in the labor force and their participation in society, both of which may exact a toll on the country's development trajectory.

4. The National Family and Health Survey (NFHS), India's Demographic and Health Survey, from 2005–2006, includes information from both the Census and the survey enumerators regarding whether the household is located in a slum area, allowing for the comparison of slum definitions and their association with indicators of wellbeing. Population-based sampling frames drawn from Census for nationally representative surveys like the Demographic and Health Surveys (DHS) are almost never stratified by slum status (Montana et al., forthcoming) and the inclusion of these data in the most recent NFHS makes the comparison of multiple definitions of slum dwelling in the Indian context possible.

There are a number of empirical studies that have worked with the two definitions of slum dwelling included in the NFHS. Swaminathan and Mukherji find that the association between slum dwelling and under- and overweight among adults in eight urban areas in India yielded different results both in terms of significance and magnitude depending on the definition used (Swaminathan and Mukherji, 2012). Dev and Balk combine the two definitions, identifying households as residing in slums when they met either of two criteria (Dev and Balk, under review). Most other researchers have simply chosen to focus on the Census (Gaur et al., 2013, Hazarika, 2010) or the NFHS (Rooban et al., 2012) definitions exclusively, however, with little justification. But the slum definitions embedded in the NFHS are not the only manner in which to empirically characterize slum dwelling. Günther and Harttgen use survey respondents' reported characteristics of their household and its surroundings to characterize families as living in a slum or not in Sub-Saharan Africa (Günther and Harttgen, 2012), and Fink and colleagues employ a similar methodology across 73 countries to compare the health of rural, urban and slum residents (Fink et al., 2014). This paper unifies these different definitional approaches by comparing *four* definitions of slum dwelling – two already embedded in the NFHS questionnaire, and two constructed from respondent's reports about their surroundings – to characterize intra-urban inequality and its implications in urban India.

Identifying, comparing, and assessing definitions of what constitutes slum dwelling is not only important from an urban planning and agenda-setting perspective, but also because of the significant literature documenting the effect of area-level poverty on health, much of which is based in the urban Indian context (Agarwal, 2011).

Urban Deprivation, Slums, and Health

Although the mechanisms – social interactive, environmental, geographic, or institutional, just to name a few (Galster, 2010) – by which community-level poverty may be associated with poor health outcomes are still under investigation, poor health in slum areas has been found mainly in Sub-Saharan Africa (Bocquier et al., 2011, Günther and Harttgen, 2012) and South Asia, particularly Bangladesh (Gruebner et al., 2011) and India (Gaur et al., 2013, Hazarika, 2010). Close living quarters, poor sanitation, and lack of access to potable water (Sclar et al., 2005), all characteristics of "slum-like" communities, are likely to produce poor health over and above the effects of simply living in a poor household and other individual-level characteristics (Rice and Rice, 2009). Crowding, for example, tends to promote the transmission of infectious diseases like pneumonia, diarrhea, and tuberculosis (Unger and Riley, 2007) and neighbors' open defecation has been found to be negatively associated with child height (Spears, 2013).

These health challenges are exacerbated by the illegality and social exclusion experienced in slum settlements (de Snyder et al., 2011, Subbaraman et al., 2012), poorly regulated and ineffective health services (Agarwal et al., 2007), exposure to environmental hazards (Unger and Riley, 2007), and a lack of clarity regarding which level of the Indian Government (local, State, etc.) is responsible for protecting and promoting the health of the poorest urban residents (Nolan et al., 2014). Taken together, the possibility of an "urban mortality penalty", such as that which occurred during industrialization in European and American cities in the 20th century, is not unlikely (Konteh, 2009).

In order to investigate the implications of slum dwelling, this paper will focus on one indicator of human and economic wellbeing, that of child health (Strauss and Thomas, 1998). We use child height to investigate the effects of past epidemiological and nutritional environment (Deaton, 2007), and weight to look more at acute and current health, and nutritional stressors. About half of India's children are undernourished, and lower height for age in particular has been associated with reduced cognitive and educational achievement (Hoddinott et al., 2011) as well as lower wages and labor market productivity over the life course (Case and Paxson, 2008). Evidence from India indicates that economic growth has not brought about improved child nutrition (Deaton and Dréze, 2009) and almost half of children under five are stunted (UNICEF, 2013). Undernutrition not only directly affects children's physical and cognitive growth, but it is also implicated in deaths from infectious diseases such as malaria, pneumonia and measles, making the underlying condition responsible for over 20 percent of the country's burden of disease (Gragnolati et al., 2005).

Most studies of the health of slum dwellers investigate this topic within one slum in particular (Subbaraman et al., 2013), in one city (Fotso et al., 2013, More et al., 2013) or across many countries employing a standardized definition of what constitutes slum dwelling (Fink et al., 2014). While one paper by Montgomery and Hewett investigated neighborhood socio-economic status' effect on height for age (Montgomery and Hewett, 2005) using the NFHS, the association between slum dwelling and child height and weight has, to the author's knowledge, not yet been systematically investigated in the Indian context.

DATA AND METHODS

Data

This study uses data from the third wave of India's National Family and Health Survey (NFHS), collected in 2005–2006, the first and only demographic and health survey to include multiple measures of slum designation at the primary sampling unit (PSU) level. Slum designation is only available for eight cities, however: Chennai, Delhi, Hyderabad, Indore, Kolkata, Meerut, Mumbai, and Nagpur (International Institute for Population Sciences (IIPS) and Macro International, 2007). While the NFHS is a nationally representative repeated cross sectional survey of demographic and health indicators, the analyses presented here use only data from these eight cities, which are relatively well distributed around the country as shown in Figure 1, in order to take advantage of their inclusion of multiple definitions of slum designation. This allows for comparison across four different slum definitions; two embedded in the individual-level data as factor variables and two constructed from the household questionnaire. The four definitions are described extensively in Tables 1 and 2. By way of summary, the "Census" definition emphasizes legality, the "NFHS" definition is based on survey enumerator observation, the "UN" definition is comprised of universally recognized components of a healthy environment (UN-HABITAT, 2006/7) and the "Committee" definition has been tailored to the Indian context as recommended for the 2011 Census in a Report to the Committee on Slum Statistics/Census (Ministry of Housing and Urban Poverty Alleviation, 2008).

The Census and NFHS dummy variables (0 - not slum; 1- slum) are embedded in the individual-level questionnaire at the primary sampling unit (PSU) level, which suffices as a proxy for the neighborhood in which respondents live. In rural areas, PSUs are villages. In urban areas, the NFHS uses a slightly more complex procedure: Wards were first selected systematically from the 2001 Census and then one census enumeration block of about 150–200 households was selected from each ward (both selections were done with probability proportional to size). A household listing was done for each enumeration block and on average, 30 households were targeted for interview, with a minimum and maximum of about 15 and 50 households, respectively. The NFHS data are not geo-referenced and there is no other manner in which to operationalize spatial proximity (International Institute for Population Sciences (IIPS) and Macro International, 2007). There are 597 PSUs in the eight cities that have non-missing values for the four slum designations included in these analyses.

The UN and Committee definitions are built from the household questionnaire and based on reports of family's living circumstances. First, each of the four indicators for the UN definition (lack of access to improved water, improved sanitation, sufficient living area, and durable housing) were coded 1 if the household displayed the slum-related deprivation and 0 if not. When summed, households with a score of 1 or more were designated as slum-like:

$$\text{UN Slum} = \sum_{i=1}^{i=4} d_{i\,UN} > 1$$

Where $d_{i\ UN}$ indicates deprivations i = 1 through 4 from the UN definition. This analytical operationalization differs slightly from that which is employed by Fink and colleagues (2014) who found that defining slum dwelling in this manner across 74 different countries resulted in an "implausible" proportion of households living in slums. This prompted the authors to use a more stringent coding of slum dwelling, defined as a household experiencing *two or more* of the four deprivations (Fink et al., 2014), reducing substantially the proportion living in slums. The objective of the current paper is to operationalize as faithfully as possible the four different slum definitions, however, and for this reason households were designated as slum-like if they exhibited only one of the four deprivations as indicated by the UN definition. A similar approach was taken for the Committee definition: each of the three indicators (non-concrete roofing material, no drinking water facility on the premises, and use of public or no latrine) were coded as 0/1 and summed. Households with a score of 3 were designated as slum-like; the definition required the household to display all three characteristics:

$$\text{Committee Slum} = \sum_{i=1}^{i=3} d_{i\ committee} = 3$$

Where $d_{i\ committee}$ indicates deprivations i = 1 through 3 from the Committee definition.

Finally, in order to make a fair unit-wise comparison across all four definitions and for consistency in the conceptualization of slum dwelling as a community-level phenomenon, the two definitions constructed from the household survey – the UN and Committee definitions – were aggregated to the PSU level as the proportion of surveyed households in that PSU characterized as "slum-like" by each definition, respectively. PSUs are defined as slums by the UN and Committee definitions if over 50 percent of the households interviewed exhibited "slum-like" characteristics. This cutoff has been used previously for the UN definition (Günther and Harttgen, 2012), although Fink and colleagues again used a more stringent approach given their focus on cross-country assessment of the urban advantage in child health, rather than an accurate operationalization of slum dwelling in any particular context.

The dependent variables are height-for-age and weight-for-age z-scores of children under 5 years old, scaled to the World Health Organization's reference chart and excluding children with questionable scores of under −6 and over 6 as is standard practice. We do not investigate stunting or wasting – dichotomous variables defined as two or more standard deviations below the median of the reference population – to preserve power, as has been recommended in the literature (Spears, 2013). We also neither investigate mortality given the relatively small sample size, nor child morbidity given concerns about the accuracy of self-reported health diagnoses.

Independent variables included in the regressions are all well known to be associated with both poor child health and poverty in the Indian context. Child characteristics include child's sex, multiple births, and child's size at birth. It is well known that son preference remains prevalent in India (Deaton, 2008), and has been shown to manifest itself in discrimination

against women and girls (Ramalingaswami et al., 1996); poorer nutrition and neglect can lead to lower height for age. Being one of multiple births is also controlled for in the multivariate models; birth weight is related to later height, health and development outcomes (Currie and Vogl, 2013).

Mothers' characteristics include her education, religion, number of children ever born, whether she works outside the home, her height, her caste and her migration status. The effect of mothers' education on the health and wellbeing of her children is one of the most robust, consistent and generalizeable findings in the development literature (Lutz and KC, 2011). Education is related to maternal health and height attainment as well as increased human capital and productivity (Strauss and Thomas, 1998). High levels of childbearing take a toll on women's health and is associated with poorer health and greater stress, leading to lower birth weight babies (Cleland et al., 2006). Recent work in an urban demographic surveillance site in Nairobi City, Kenya found that working outside the home was associated with child morbidity (Taffa et al., 2005). Being a member of a "backward" or scheduled caste or tribe in India is a marker of historic experiences of marginalization and deprivation, which may significantly influence current health and development outcomes and future trajectories (Gragnolati et al., 2005). Being a Muslim versus a Hindu may also indicate underprivileged. Finally, a large literature on migration status and health in indicates that the children of recent migrants have worse health outcomes and higher odds of dying than non-migrants (Brockerhoff, 1995), findings that have been replicated in India (Stephenson et al., 2003).

Other control variables include husband/father's education, a fixed effect for the eight cities in which the data were collected, and a household wealth score. Fathers' education is associated with higher standards of living and presumably a healthier nutritional and epidemiological environment, although the effect found in the literature is nowhere near the size of that for maternal education. Indeed, women are thought to invest additional available resources more heavily in their household's wellbeing than their male counterparts (Duflo, 2012). City fixed effects are included to control for characteristics of each city to which all respondents living in that city were exposed, and to account for the uneven distribution of health status across urban areas in the sample under study. Table 3 presents summary statistics for all control variables included in the models.

Finally, a wealth score was constructed using the first principle component (Filmer and Pritchett, 2001) of a factor analysis of 19 household assets indicative of socioeconomic status in an urban area in India. These include: radio, television, refrigerator, bicycle, motorcycle/scooter, car, modern cooking fuel, mobile phone, watch, mattress, pressure cooker, chair, cot/bed, table, electric fan, sewing machine, computer, water pump. About 96 percent of the analytical sample reported having electricity, so these items are both relevant and usable in the urban Indian context. Items like tractor, livestock and irrigated land were excluded because they were unlikely to indicate socioeconomic status in an urban setting. Modern cooking fuel was designated as 1 for electricity, lpg/natural gas and biofuel, and 0 for kerosene, coal, lignate, charcoal, wood, straw/shrubs/grass, agricultural crop, animal dung. The score produced from the principle components analysis was not broken into

quintiles because its cumulative distribution is not linear, but is used as a continuous variable in all regressions.

Methods

The final analytical sample of children with no missing data on the dependent or any of the independent variables consisted of 4,609 children under the age of 5 years. The four definitions are first compared descriptively and then their association with child health is assessed beginning with bivariate regressions of each slum definition on each health outcome. These were followed by a second step of ordinary least squares models containing all independent variables (Fink et al., 2012):

$$Y_{ih}=\alpha+\beta slum_c+X_h\gamma+X_i\delta+\varepsilon_{chi}$$

Where Y_{ih} is the height or weight for age z-score of child i in household h, β is one of four indicators of slum dwelling for community (i.e. PSU) c in which child i lives and is the coefficient of interest. X_h is a vector of household-level control variables, and X_i is a vector of individual-level control variables. All models cluster the standard errors at the household level to account for the possibility of there being more than one child in a household. The error term, ε_{chi}, is assumed to be normally distributed.

The results from the ordinary least squares models precipitate further investigation into the components of the UN definition of slum dwelling that are predictive of poor child health. In this third step, the four components of the UN definition are entered separately into an ordinary least squares regression model as follows:

$$Y_{ih}=\alpha+X_c\eta+X_h\gamma+X_i\delta+\varepsilon_{cih}$$

Where Y_{ih} again is the height or weight for age z-score of child i in household h, X_c now stands for a vector of the four characteristics constituting the UN definition of slum dwelling. X_h and X_i are the same vectors of household- and individual-level control variables as in the model with slum designation as a dichotomous indicator variable. This model is run for both health outcomes.

All analyses employed STATA Statistical Software version 13 (StataCorp, 2013) and R version 3.1.0 (R Core Team, 2014).

RESULTS

Characteristics of the study sample are shown in Table 3. Table 4 lists the proportion of children in the study sample that are living in slums in each city. Estimates of the proportion slum dwelling vary widely by definition in every city. In the capital city of New Delhi, the UN definition (comprised of community-wide lack of access to improved water, sanitation, and durable housing, and crowding) indicates that 65 percent of children are living in PSUs characterized as slums, whereas the Committee definition (comprised of community-wide unimproved roof material, lack of access to potable water, and poor sanitation facilities)

finds only 32 percent of children to be living in slums. The variation is widest in Meerut and Hyderabad, where the UN definition finds over 60 percent of children can be characterized as slum dwelling, while the Committee definition finds the proportion to be close to zero. While the Census definition (which emphasizes legality) systematically produces lower estimates than that of the NFHS definition (which relies on enumerator observations of local surroundings), the UN definition consistently produces higher estimates of the proportion slum-dwelling than both the Census and the NFHS definitions. The Committee definition produces the lowest estimates of all four.

Proportions designated as slum dwelling by each possible combination of two definitions (Table 5) indicates significant variation in overlap between the four definitions. More specifically, while 90 percent of children designated as living in slums by the UN definition are designated as such by the Committee definition, only 54 percent of children designated as living in slums by the UN definition are designated as such by the NFHS definition. Figure 2 presents a Venn Diagram of the overlap between different slum designations. While it does not display these results proportionally, the Venn Diagram provides additional support for the variability in overlap between the definitions. These descriptive results should give pause to researchers, policymakers and public health practitioners who might consider slum dwelling conceptually and/or empirically straightforward.

Table 6 presents the results of bivariate regressions of each of the four slum designations on the two health outcomes. Four regression models are presented, one for each of the four slum definitions. All slum designations are associated with statistically significantly lower height and weight for age of children under 5 years old, although the indicator explains a very small proportion of the variation in the outcome in each case. The negative association between living in a slum and height for ages ranges from 20 percent to one third of a standard deviation in magnitude for height for age for the Census and NFHS definitions, respectively. The negative association ranges from 15 to 30 percent of a standard deviation in magnitude for weight for age for the NFHS and UN definitions, respectively.

Table 7 presents multivariate models of the relationship between the slum dwelling and the two health outcomes, but includes a wide variety of control variables. Four regression models are again presented, one for each of the four slum definitions. When including all covariates, the only slum indicator that is statistically significantly associated (at the 5 percent level) with child height for age is that of the UN. Specifically, children living in slums as characterized by the UN definition have, on average, a height for age z-score that is 0.177 (about 11 percent of a standard deviation) lower than their non-slum dwelling counterparts. The results are similar for weight for age. When including all covariates in the model, the UN definition is the only slum indicator that is statistically significantly associated with child height and weight.

A number of covariates appear to “explain away” the bivariate relationship between the Census, NFHS and Committee definitions of slum dwelling and poor heath, including children’s size at birth, maternal education, being of Muslim as compared to Hindi faith, mother’s height, whether the mother works outside the home, and the household’s wealth. A high level of education on the part of the father is also associated with higher weight for age

but not height for age. In order to investigate which of the four components of the UN definition might be driving its relationship with poor health, in spite of the inclusion of these additional covariates, a final ordinary least squares regression model is estimated with all four components – density, housing, water, and sanitation – entered separately.

Rather than dichotomize the four components, they are left as continuous variables representing the proportion of households in the PSU lacking each of the four amenities. The models are run separately for height and weight for age z-scores and indicate that for height for age, it is housing quality that is driving the UN definition's negative association. More specifically, living in a neighborhood filled with poor as compared to good quality homes (referred to in India as *kaccha* or semi-*pucca*, as compared to *pucca*) is associated with, on average, a 0.483 lower height for age z-score (or about 30 percent of a standard deviation). For weight for age, both housing quality and crowding are statistically significantly associated with lower z-score, with a particularly large effect of density; living in a neighborhood filled with very crowded homes is associated with almost a third of a standard deviation lower weight for age.

DISCUSSION

The results indicate that the way in which slum designation is defined matters for both the descriptive characterization of urban populations as well as both the magnitude and significance of the empirical association between community disadvantage and child health. Indeed, there is significant discrepancy between slum definitions as to which households to designate as being located in a slum. These results strongly suggest that the conceptualization and measurement of slum dwelling requires further theoretical and empirical work given the term's policy relevance. The mismatch between the UN definition, which is used to compare slum dwelling across countries, and definitions used to monitor individual country's (like India's) levels of concentrated urban disadvantage for policy and planning purposes can lead to divergent and even conflicting conclusions and development priorities.

There are a number of potential explanations for the relatively minimal overlap between the four slum designations. First, the Census was conducted in 2001, but the NFHS was undertaken in 2005–2006, making it possible that slum areas changed significantly between Census enumeration and NFHS survey observation and respondent reports (Montana et al., forthcoming), an issue that has not been addressed in studies using these data (Swaminathan and Mukherji, 2012). A second reason for the definition discrepancy may be the significant variation in components that make up the four definitions. While the Census definition relies mainly on notification (i.e. recognition as a legal settlement by a governing body), the other definitions are made up of a variety of characteristics associated with slum dwelling, with one definition based on enumerator observation alone and the two others differing significantly in their stringency in terms of the number of slum-related indicators the households – and by extension the communities in which they are located – must exhibit.

Distinctions such as these are particularly important in the Indian context where legal status confers rights to public service provision; any slum designation that emphasizes legality will

underestimate the prevalence of communities with slum characteristics (Agarwal, 2011) and will likely miss the communities experiencing the highest levels of exclusion and disadvantage (Subbaraman et al., 2012). While it is not possible to adjudicate between the proposed explanations for slum designation discrepancy, and it is likely that more than one is operating, this descriptive finding complicates the measurement and policy implications of area deprivation in developing countries.

The regression results, namely that child height and weight for age is negatively associated with only one slum definition net of individual characteristics, points to the need for a more nuanced approach to studying the relationship between area-level deprivation and child health. Given the literature detailing the many probable adverse health effects of living in a slum (Rice and Rice, 2009) and the mechanisms by which disease and poverty are thought to be perpetuated in urban areas (Wratten, 1995), it is surprising that more robust “slum effects” were not uncovered in these analyses. It may be that neighborhood effects impact adult health more significantly than child health, as has been found in Sub-Saharan Africa (Günther and Harttgen, 2012), or that individual and household characteristics are much more proximal and relevant for child height for age (Fink et al., 2014). A relatively “small” effect (as compared to that of individual-level characteristics) of neighborhoods has also been found in developed country cities (Fitzpatrick and LaGory, 2003).

Why might the UN definition in particular be the only slum indicator that is associated with poor child health? One possibility is that it is based on household reporting of current living conditions, which may better capture disadvantage than the Census information, which was based on administrative data collected almost five years before the survey even took place. Slum areas are dynamic in nature and frequent updates are needed to maintain the accuracy of their identification (Montana et al., forthcoming); indeed, information collected at the same time as child health measurement may be particularly informative of health hazards in the immediate vicinity.

It might also be that the way in which slums are characterized by the UN definition is particularly well suited to identifying the characteristics of urban disadvantage that may be most predictive of poor health. The results presented here indicate that a number of individual components comprising the UN definition are associated with poor child health, namely housing quality and crowding. While one can imagine the use of modern floor or roof material may be protective against flooding and the spread of disease as well as being easier to clean, it is also possible that housing type is acting as a proxy for some other, unmeasured, neighborhood advantage. Similarly, high density of living arrangements may promote the spread of infectious disease and may proxy for other characteristics of the area such as large amounts of garbage or open defecation. Since there is no gold standard with which to compare these definitions, it is not possible to discern which of these explanations is most indicative of the underlying process at work. The results highlight, however, the importance of investigating the individual components that comprise slum designation in order to fully understand the underlying mechanisms driving the relationship between area-level poverty and health.

In sum, this is the first study to compare slum definitions as well as to investigate their implications for children's health in the Indian context in particular. We describe four different ways to characterize what constitutes a slum area, even within just one country, and demonstrate that these definitions frequently do not identify the same households as slum dwelling. The manner in which a slum is defined appears to determine whether or not there is a relationship between slum dwelling and health; only one of the definitions of slum dwelling presented is actually associated with child health when controlling for individual- and household-level characteristics, and this relationship seems to be driven by only 2 of its four components. These findings have implications for the empirical measurement and study of area-level deprivation and intra-urban health inequality, and, by extension, for current policy and media rhetoric focusing on slums (Bhaumik, 2012).

Continued investigation of intra-urban differentials in health (Montgomery, 2009) is therefore recommended, as is more widespread acknowledgement that slums are not homogenous entities (Gaur et al., 2013), but complex and dynamic. One important area of future research is to investigate the use of a slum scale, which may provide more information than a dichotomous slum measure. The use of a slum scale will allow insight into whether there is a cumulative nature to the negative effects of slum dwelling and/or a non-linear relationship between slum adversity and health outcomes, which has been found for common mental disorders in a particularly deprived slum community in Mumbai (Subbaraman et al., under review). Indices have previously been explored in the study of the urban environment more generally; Dahly and Adair find that, using longitudinal data, a scale measure of urbanicity "outperforms the urban-rural dichotomy" (Dahly and Adair, 2008). While a slum index was proposed at an Expert Group Meeting on Urban Indicators at the United Nations in 2002 (UN-HABITAT Urban Secretariat & Shelter Branch, 2002), further action has not been taken.

Further serious research interest on slums will be necessary to inform policy debates on this issue (Marx et al., 2013) and should include the collection of both longitudinal data (Entwisle, 2007) to monitor the evolution of slums, as well as satellite and other spatial data along with ground-based validation (Montana et al., forthcoming). Slum growth is not inevitable (Ooi and Phua, 2007); city governments can and should take responsibility for strategic planning and intervention on behalf of deprived urban populations by linking their area's economic development trajectories with urban growth, housing, and the infrastructural needs of the individuals and families who come to cities looking for a better life.

Acknowledgments

Support for this research was provided by grants from the Eunice Kennedy Shriver National Institute of Child Health and Human Development of the National Institutes of Health (P32CHD047879 and T32HD007163).

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FIGURE 1.
Map of eight cities in India where data include slum designation

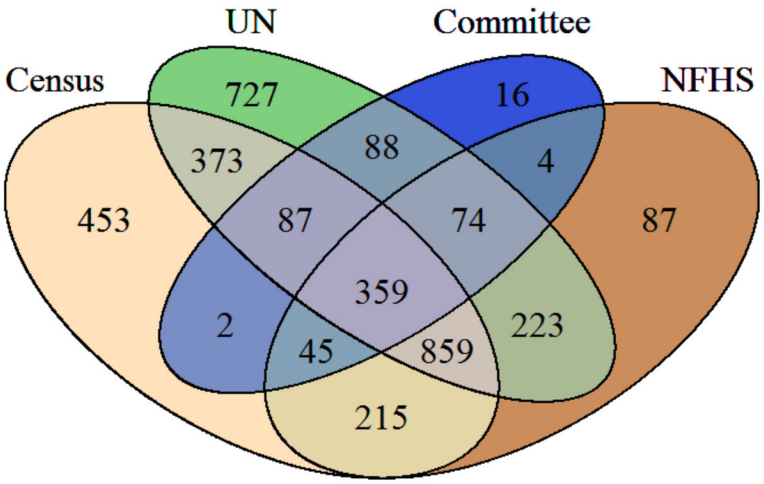

FIGURE 2.
Venn Diagram of slum categorization

TABLE 1

Origin and emphases of slum definitions

Name	Origin	Empirical generation	Legality	Density	Housing	Water	Sanitation
Census	2001 Census of India	Variable included in the NFHS-3	X	X	X	X	X
NFHS	Survey enumerator observation	Variable included in the NFHS-3		X	X	X	X
UN	Household questionnaire	Aggregated to the primary sampling unit level		X	X	X	X
Committee	Household questionnaire	Aggregated to the primary sampling unit level			X	X	X

TABLE 2

Slum definitions in detail

Characteristic	Census	NFHS	UN – at least one or more	Committee – all four
Legality	**1** All specified areas in a town or city notified as "Slum by State/Local Government and UT Administration under any Act including a "Slum Act"; and/or **2** All areas recognized as "Slum by State/Local Government and UT Administration, Housing and Slum Boards, which may have not been formally notified as slum under any act	NA[i]	NA[ii]	NA
Density	A compact area of at least 300 population or about 60–70 households	A compact area of at least 300 population or about 60–70 households	Insufficient living area[iii]	NA
House	Poorly built congested tenements in unhygienic environment usually with inadequate infrastructure	Poorly built congested tenements in unhygienic environment usually with inadequate infrastructure	Non-durable housing;[iv] lack of a permanent structure providing protection from extreme climate conditions	Predominant material of roof is anything other than concrete
Water	Lacking proper drinking water facilities	Lacking proper drinking water facilities	Lack of access to improved water[v] that is sufficient, affordable, and attained without extreme effort	Available drinking water source not be available within the premises[vi]
Sanitation	Lacking in proper sanitary facilities	Lacking in proper sanitary facilities	Lack of access to improved sanitation facilities[vii]	Household does not have an latrine facility within the premises (e.g. members use either a public latrine or no latrine) and does not have closed drainage[viii]

[i]Not applicable (NA) – information on this slum characteristic is not included in this definition

[ii]The UN definition technically includes security of tenure and protection against forced eviction. But this is information is not captured in demographic and health

[iii]More than three people sharing a room

[iv]*Kachha*– houses made out of low-quality materials like mud, thatch or tarpaulin and semi-*pucca* – houses using a mix of low- and high-quality materials

[v]Unimproved water sources include unimproved dug well, unprotected spring, cart with small tank/drum, bottled water, tanker-truck, surface water (river, dam, lake, pond, stream, canal, irrigation channels)

[vi]Coded as not piped into dwelling

[vii]Unimproved sanitation facilities include flush or pour-flush to elsewhere, pit latrine without slab or open pit, bucket, hanging toilet or hanging latrine, no facilities, or bush or field

[viii]Information on drainage was not included in the National Family and Health Survey; this indicator was coded as the household either sharing a toilet facility or having none at all, i.e. bush or field

TABLE 3

Characteristics of the study population

Characteristic			Proportion, or mean (sd)
Child	Height for age		−1.49(1.65)
	Weight for age		−1.38(1.21)
	Sex	Male	52.8
		Female	47.2
	Multiple birth	Yes	1.2
		No	98.8
	Size at birth	Small	14.2
		Medium	63.4
		Large	22.4
Mother	Education	None	22.7
		Primary	10.8
		Secondary	48.4
		Higher	18.1
	Religion	Hindu	72.1
		Muslim	24.5
		Other	3.4
	Children born in the last 5 years		1.5(0.64)
	Age		26.8(4.59)
	Height		152.5(5.86)
	Working	Yes	82.7
		No	17.3
	Scheduled caste or tribe	Yes	20.8
		No	79.2
	Migrant	Yes – from a rural area	29.5
		Yes – from anurban area	43.7
		No	26.8
Mothers' partner	Education	None	13.4
		Primary	11.3
		Secondary	54.1
		Higher	21.2

TABLE 4

Proportion of PSUs in the study sample identified as slums in each city

City	Census	NFHS	UN	Committee
Delhi (n=612)	44.0	38.6	65.4	32.2
Meerut (n=866)	51.7	34.1	61.9	1.0
Kolkata (n=389)	60.4	57.3	41.9	44.0
Indore (n=644)	52.8	8.5	34.8	11.8
Mumbai (n=368)	61.4	63.3	74.5	48.6
Nagpur (n=576)	50.0	48.8	67.5	23.6
Hyderabad (n=719)	49.4	44.6	61.2	3.1
Chennai (n=435)	53.3	52.0	83.7	15.4
Total	51.9	40.6	60.5	14.7

TABLE 5

Proportion of children in the study sample identified as living in slums by two definitions

	Census	NFHS	UN	Committee
Census	100			
NFHS	79.2	100		
UN	60.1	54.3	100	
Committee	73.0	71.4	90.1	100

TABLE 6

Bivariate regressions of slum dwelling indicator variable on child health

Independent variables	Model			
	(1) Census	(2) NFHS	(3) UN	(4) Committee
Height for age				
Coefficient (sd)	−0.319* (0.051)	−0.331* (0.052)	−0.568* (0.052)	−0.443* (0.072)
R^2	0.010	0.010	0.028	0.009
Weight for age				
Coefficient (sd)	−0.224* (0.0039)	−0.182* (0.039)	−0.362* (0.039)	−0.333* (0.054)
R^2	0.009	0.005	0.021	0.010

Standard errors clustered at the household level.

*statistically significant at $p<0.05$

TABLE 7

Ordinary least squares regression of height for age with each slum definition, coefficient(se)

Independent variables	Model			
	(1) Census	(2) NFHS	(3) UN	(4) Committee
Slum indicator variable	−0.050 (0.048)	−0.080 (0.052)	−0.177* (0.055)	−0.115 (0.128)
Child characteristics	Yes	Yes	Yes	Yes
Sex				
Male	-	-	-	-
Female	0.078 (0.0454)	0.077 (0.046)	−0.177* (0.055)	−0.080 (0.045)
Multiple				
No	-	-	-	-
Yes	−0.118 (0.256)	−0.115 (0.255)	−0.136 (0.260)	−0.118 (0.257)
Size				
Small	-	-	-	-
Medium	0.299* (0.068)	0.303* (0.068)	0.303* (0.068)	0.298* (0.068)
Large	0.451* (0.079)	0.447* (0.079)	0.452* (0.079)	0.452* (0.079)
Mother characteristics				
Education				
None	-	-	-	-
Primary	0.254* (0.093)	0.250* (0.093)	0.246* (0.093)	0.251* (0.068)
Secondary	0.183* (0.074)	0.183* (0.074)	0.165* (0.075)	0.176* (0.074)
Higher	0.478* (0.107)	0.150* (0.107)	0.442* (0.109)	0.478* (0.107)
Religion				
Hindu	-	-	-	-
Muslim	−0.202* (0.063)	−0.193* (0.063)	−0.162* (0.064)	−0.209* (0.063)
Other	0.151 (0.147)	0.150 (0.149)	0.132 (0.147)	0.148 (0.148)
Children born in last 5				
0	-	-	-	-
1	−0.106* (0.052)	−0.106* (0.052)	−0.100 (0.051)	−0.106* (0.052)
2	−0.159* (0.089)	−0.159 (0.089)	−0.141 (0.089)	−0.158 (0.089)
Age	0.005 (0.006)	0.005 (0.006)	0.005 (0.006)	0.004 (0.004)
Height	0.050* (0.004)	0.050* (0.004)	0.050* (0.061)	0.050* (0.004)
Work				
Not working	-	-	-	-
Working	−0.236* (0.061)	−0.236* (0.0.061)	−0.241* (0.061)	−0.238* (0.061)
Caste				
Sched. caste/tribe	-	-	-	-
Not scheduled	−0.081 (0.063)	−0.076 (0.064)	−0.062 (0.063)	−0.083 (0.063)

Independent variables	Model			
	(1) Census	(2) NFHS	(3) UN	(4) Committee
Migrant				
Not a migrant	-	-	-	-
Migrant – city/town	−0.045 (0.055)	−0.048 (0.055)	−0.045 (0.055)	−0.048 (0.055)
Migrant – rural area	−0.026 (0.065)	(0.065)	−0.024 (0.065)	−0.031 (0.063)
Partner's education				
None	-	-	-	-
Primary	−0.026 (0.098)	−0.026 (0.098)	−0.030 (0.098)	−0.032 (0.098)
Secondary	0.088 (0.085)	0.085 (0.085)	0.083 (0.085)	0.080 (0.085)
Higher	0.204 (0.111)	0.201 (0.111)	0.186 (0.111)	0.196 (0.111)
Deprivation index	0.083* (0.015)	0.082* (0.015)	0.079* (0.015)	0.080* (0.016)
City fixed effects	Yes	Yes	Yes	Yes
R^2	0.1477	0.1475	0.1494	0.1479

Standard errors clustered at the household level.

* statistically significant at $p<0.05$

TABLE 8

Ordinary least squares regression of weight for age with each slum definition

Independent variables	Model			
	(1) Census	(2) NFHS	(3) UN	(4) Committee
Slum indicator variable(sd)	−0.023 (0.037)	−0.073 (0.039)	−0.152* (0.041)	−0.107 (0.058)
Child characteristics				
Sex				
Male	-	-	-	-
Female	0.052 (0.033)	0.052 (0.033)	0.055 (0.033)	0.053 (0.033)
Multiple				
No	-	-	-	-
Yes	−0.317 (0.198)	−0.374 (0.198)	−0.392 (0.202)	−0.377 (0.198)
Size				
Small	-	-	-	-
Medium	0.269)* (0.051)	0.271* (0.051)	0.271* (0.051)	0.267* (0.051)
Large	0.422* (0.059)	0.423* (0.059)	0.423* (0.059)	0.423* (0.423)
Mother characteristics				
Education				
None	-	-	-	-
Primary	0.232* (0.069)	0.232* (0.069)	0.224* (0.069)	0.228* (0.069)
Secondary	0.149* (0.055)	0.147* (0.055)	0.133* (0.055)	0.141* (0.055)
Higher	0.402* (0.079)	0.397* (0.079)	0.366* (0.080)	0.397* (0.079)
Religion				
Hindu	-	-	-	-
Muslim	−0.139* (0.048)	−0.134* (0.048)	−0.104* (0.049)	−0.145* (0.048)
Other	0.015 (0.015)	0.123 (0.096)	−0.003 (0.095)	0.010 (0.096)
Children born in last 5				
0	-	-	-	-
1	−0.021 (0.038)	−0.022 (0.038)	−0.015 (0.038)	−0.020 (0.038)
2	0.023 (0.074)	0.022 (0.074)	0.040 (0.074)	0.026 (0.074)
Age	0.005 (0.004)	0.005 (0.004)	0.005 (0.004)	0.005 (0.004)
Height	0.041* (0.003)	0.042* (0.003)	0.041* (0.003)	0.042* (0.003)
Work				
Not working	-	-	-	-
Working	−0.104* (0.047)	−0.104* (0.047)	−0.107* (0.046)	−0.105* (0.047)
Caste				
Sched. caste/tribe	-	-	-	-
Not scheduled	−0.019 (0.046)	−0.014 (0.046)	−0.001 (0.046)	−0.019 (0.046)

Independent variables	Model			
	(1) Census	(2) NFHS	(3) UN	(4) Committee
Migrant				
Not a migrant	-	-	-	-
Migrant – city/town	0.017 (0.042)	0.017 (0.042)	0.018 (0.042)	0.015 (0.042)
Migrant – rural area	−0.041 (0.049)	−0.045 (0.049)	−0.039 (0.049)	−0.044 (0.049)
Partner's education				
None	-	-	-	-
Primary	0.132 (0.074)	0.133 (0.074)	0.129 (0.073)	0.127 (0.074)
Secondary	0.101 (0.064)	0.101 (0.064)	0.097 0.064	0.094 (0.064)
Higher	0.178* (0.083)	0.174* (0.083)	0.163* (0.083)	0.171* (0.083)
Deprivation index	0.059* (0.011)	0.057* (0.011)	0.055* (0.011)	0.056* (0.011)
City fixed effects	Yes	Yes	Yes	Yes
R^2	0.1625	0.1629	0.1651	0.1632

Standard errors clustered at the household level.

* statistically significant at $p<0.05$

TABLE 9

Ordinary least squares regression of height for age with UN-HABITAT definition components entered separately[ix]

Independent variables		Coefficient (standard error) Height for age	Coefficient (standard error) Weight for age
Community-level slum components	Housing quality	−0.483* (0.174)	−0.271* (0.136)
	Crowding	−0.273 (0.094)	−0.393* (0.125)
	Water	−0.262 (0.173)	−0.058 (0.139)
	Sanitation	0.037 (0.182)	0.173 (0.130)
R^2		0.1510	0.1631

Standard errors clustered at the household level.

*statistically significant at $p<0.05$

[ix]Controlling for all the same covariates as in the multivariate models with slum indicators