The Health Implications of Urbanization: Measurement and policy relevance of slums in urban India

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ABSTRACT

Background: In developing countries, the area in which people live determines their access to health facilities, exposure to the hygiene and sanitation practices of their neighbors, and levels of social capital, among many other impacts on wellbeing. But do neighborhoods affect health over and above individual characteristics such as income and education? Literature from cities in developed countries suggests it might, but "neighborhood effects" have been insufficiently studied in developing countries. Since most future population growth will take place in developing country cities it is important to understand the association between concentrated disadvantage and poor health in these areas.

Objective: This paper investigates whether slum dwelling, as one way of characterizing neighborhood-level deprivation, is associated with child health in India, which has the largest number of urban poor of any country, and some of the highest rates of under-nutrition in the world.

Methods: Using the Indian National Family and Health Survey from 2005-2006, we empirically describe four definitions of what constitutes slum dwelling in eight cities, and, using multivariate regression, their association with height for age of children under five.

Findings: Slum characterizations are often in disagreement as to whether a household is in fact located in a slum, and only one, a UN-HABITAT characterization, is marginally associated with lower height for age, with poor quality housing driving this relationship.

Conclusions: These findings indicate the possibility of "neighborhood effects" on health in the developing country context, but highlight the difficulties associated with conceptualizing and measuring concentrated disadvantage in these settings.

Keywords: Slums; urban health; neighborhood effects; India; urban poor

INTRODUCTION

Place matters (1). Where people live defines the health facilities to which they have access, their levels of self efficacy and social capital, and the amount of crime to which they are exposed, among other contextual factors (2). Epidemiological and sociological studies – including a randomized controlled trial (3) – have established a robust link between area-level characteristics and a variety of health outcomes (4). Indeed, although the mechanisms – social interactive, environmental, geographic, and institutional, to name a few (5) – by which neighborhood poverty and other community social processes cause or are even associated with health outcomes are still under investigation, the association between neighborhood characteristics and health is empirically robust.

While "neighborhood effects" on health have been studied extensively in developed countries and urban America in particular, contextual effects on urban health are under-appreciated in developing country cities (6). Although community characteristics in resource-poor settings have been found to significantly impact individual health – neighbors' open defecation is associated with child height (7), distance from a health facility matters for access to maternal healthcare (8), and community characteristics such as presence of a sewer system, which provides a "measure of community infrastructure beyond availability of a clinic", are associated with use of formal health services (9) – most of these studies have taken place either in predominantly rural areas, special settings like tea estates (10) or large capital cities (11). Finally, a few studies of the association between neighborhood amenities and individual-level health outcomes have been undertaken nationally, but they simply control for urban/rural residence, thus precluding a thorough investigation of the importance of either context (12). Indeed, very little research has considered neighborhood effects in the urban context of developing countries specifically (13).

Research on contextual, or "neighborhood", effects on urban health in developing countries is important, timely and policy relevant for a number of reasons. First, urban populations are growing ever larger (14). Neighborhood-level characteristics such as close living quarters, poor sanitation and lack of access to potable water are likely to contribute to the burden of poor health outcomes (15) over and above the effects of simply living in a poor household and other individual-level characteristics. For example, crowding tends to promote the transmission of infectious diseases like pneumonia, diarrhea, and tuberculosis (16), which alongside insufficient health and general public services provision, produces the possibility of an "urban mortality penalty" (17). Second, policy and media rhetoric on urban issues often focuses on slums, which are a relatively natural operationalization of what constitutes a poor neighborhood in developing countries. Indeed, slums can serve as a policy-relevant proxy for the community in which individuals and households are situated. But slums are more heterogeneous than is often assumed (18), and their definition, like that which constitutes an urban area more generally (19), often differs by country (20) and even city (21) or state. Both poor communities' heterogeneity and the challenges associated with their characterization complicates the study of health in slums (22). Further investigation into the ways in which slums are defined and whether living in a resource-poor environment, net of personal characteristics, is indeed associated with individual-level health outcomes prompts the need for further research in this area.

Finally, studying “neighborhood effects” in urban areas in developing countries is essential for developing and improving public policy oriented towards mitigating both rural-urban and intra-urban health inequalities (23). As rural residents move to urban areas in search of jobs, and villages are overtaken by expanding cities, many low- and middle-income countries are increasingly concerned with the urbanization of poverty (24). Indeed, nowhere is the study of slum dwellers’ health more relevant or timely than in the Indian context. After economic liberalization in the early 1990s, the country’s urban population grew by almost 32% in a decade, with the UN projecting that India will be majority urban by 2030 (25).The Government of India is increasingly concerned with growing inequality, poverty and poor health among its 400 million urban residents, and has developed public policy initiatives such as the *Rajiv Awas Yojana*, which envisages a “slum free India”, to address some of these issues (26). Rights to service provision such as potable water and sanitation come with administrative designation as a slum, however, and many communities exhibiting distinctly slum-like characteristics are never “notified”, or listed as legal (27). Delhi, for example, has notified no new slums since 1994 (28).

This paper investigates some of the ways in which slums can be and are characterized in urban India as well as slum dwelling’s impact on individual health, focusing in particular on the relationship between four different definitions of slum dwelling and poor child health in India. The four definitions emphasize different slum-related community characteristics and prove useful in investigating the possible mechanisms by which living in a slum may be bad for health.

The outcome of interest is child height for age, which is a marker of past, and to a lesser extent, present epidemiological and nutritional environment (29). About half of India's children are undernourished, and lower height for age is associated with reduced cognitive, educational (30) and labor market achievement over the life course (31). Evidence from India indicates that economic growth has not brought about improved child nutrition (32); almost half of children under five are stunted (33). While one paper by Montgomery and Hewett investigated neighborhood socio-economic status' effect on height for age (13), and the difference between rural and urban children's height and nutritional status (34, 35) has also been studied, the association between slum dwelling and child height has, to the author's knowledge, not yet been investigated. This is the focus of this paper.

METHODS

This study uses data from the third wave of India's National Family and Health Survey (NFHS), collected in 2005-2006, which is the first and only demographic and health survey to include multiple measures of slum designation at the primary sampling unit level. Slum designation, however, is only available in eight cities: Chennai, Delhi, Hyderabad, Indore, Kolkata, Meerut, Mumbai, and Nagpur (36). While the NFHS is a nationally representative repeated cross sectional survey of demographic and health indicators, the analyses presented here use only data from the eight cities in order to take advantage of their inclusion of slum designation. This allows for comparison across four different slum definitions; two embedded in the individual-level data as dummy 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 oriented towards universally recognized components of a healthy environment (37) 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 (38).

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 must suffice 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. While not an ideal proxy of neighborhood, using the PSU is the only manner in which to locate households proximally in the NFHS (36). Since NFHS data are not geo-referenced and there is no other manner in which to operationalize spatial proximity, the PSU will have to suffice, as Census tract and block have sufficed in many studies of neighborhood effects in developed countries (39). There are 597 PSUs in the eight cities that have non-missing values for the four slum designations included in these analyses.

In order to make a fair unit-wise comparison across all four definitions, the two definitions constructed from the household survey – the UN and Committee definitions – are aggregated to the PSU level as the proportion of surveyed households in that PSU characterized as “slum-like” by each definition, respectively. We define PSUs as slums by the UN definition if over 75 percent of the households interviewed exhibit “slum-like” characteristics. However, given the stringency of the Committee on Slum Statistics/Census’ definition recommended for adoption, the cutoff for PSUs for the Committee definition was at 25 percent. While the use of cutoffs to create dummy variables for slum designation is not ideal, the methodology has been used previously (40) and is required to ensure a fair comparison (at the PSU level) across the four definitions in regression models.

The dependent variable is height-for-age z-score 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 (defined as 2 or more standard deviations below the median height for age of the reference population) to preserve power, as has been recommended in the literature (41). Ordinary least squares models of height for age control for covariates known to be associated with the outcome of interest[i] as well as an asset-based measure of household wealth, computed using principle component analysis with items relevant in the urban Indian context.[ii] The ordinary least squares model is as follows:

$$\text{height}_i = \beta_0 + \beta_i \text{ individual}_a + \beta_p \text{ primary sampling unit}_b + \varepsilon_i$$

Where *i* stands for variables assessed at the individual level, *a* for the different individual-level covariates of interest, *p* for variables assessed the primary sampling unit level, and *b* for the different slum designation or its components. Models cluster the standard errors at the household level to account for the possibility of there being more than one woman or child in a household.

The results from the ordinary least squares models precipitate further investigation into the components of the one definition of slum dwelling found to be statistically significant in the

[i] Child sex, multiple birth, size at birth (small, medium, large), mother's education (none, primary, secondary, higher), religion (Hindu, Muslim, Other-Christian, Sikh, Buddhist, Jain, none), age, number of children born in the last five years, mother's height, mother working, scheduled caste or tribe, migrant (not, from rural, from urban), partner's education
[ii] Television, refrigerator, bicycle, motorcycle/scooter, car, modern cooking fuel (electricity, gas), mobile phone, mattress, pressure cooker, chair, cot/bed, table, electric fan, sewing machine, computer

regression model – the UN measure – in order to investigate which aspect of community-level deprivation might be driving this relationship. A final ordinary least squares model is presented with the four components of the UN definition entered separately. All analyses employed STATA Statistical Software version 12 (42). The final study sample of 4,609 children excludes respondents with missing data on either the dependent or on any of the independent variables.

RESULTS

Characteristics of the study sample are shown in Table 3. Table 4 lists the proportion of households in the study sample that are living in slums in each city. Even within the same city, estimates vary widely by definition. In the capital city of New Delhi, the UN definition characterizes 56 percent of PSUs as slums, whereas the Committee definition finds only 28 percent of PSUs *in the same study sample* to be slums. The variation is widest in Indore, where the UN definition finds 52 percent of PSUs can be characterized as slums, and the NFHS definition finds only 8.5 percent. While this is likely a mistake on the part of the survey enumerator(s) in Indore, dropping these observations does not change regression results significantly. Proportions of PSUs designated as slum dwelling by each possible combination of two definitions (Table 5) indicates that overall there is surprisingly minimal overlap between the four definitions. More specifically, while 85 percent of PSUs designated as slums by the UN definition are designated as such by the Committee definition, only 53 percent of PSUs designated as slums by the UN definition are designated as such by the NFHS definition. 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 four ordinary least squares regression models; the same model is run for each of the four slum definitions. While all slum indicators are statistically significant at least at the 10 percent level in models not controlling for wealth index (results not shown), when including all covariates, the only slum indicator that is significantly associated with child height for age (albeit at the 10 percent level), 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 0.0940 (about 6 percent of a standard deviation) lower than their non-slum dwelling counterparts. In order to investigate which of the four components of the UN definition might be driving this relationship, a final ordinary least squares regression model is estimated with all four PSU-level components – density, housing, water, and sanitation – entered separately. Table 7 shows that only housing is statistically significantly (at the 5 percent level) associated with children's height for age. Specifically, a 1 unit increase in the proportion of homes in the PSU that are *kaccha* or semi-*pucca* as compared to *pucca* (i.e. poor as compared to good quality) is associated with, on average, a 0.431 lower height for age z-score (or about 26 percent of a standard deviation). As before, this model also controls for a wide variety of covariates, including a measure of income.

DISCUSSION

Study results indicate that while the effect of neighborhood deprivation (as measured by slum dwelling) on child health in selected settings in urban India may be minimal when controlling for individual characteristics, results depend on the definition of slum dwelling utilized. Indeed, there is significant discrepancy between definitions as to which primary sampling unit, and thus which households, to designate as "slum-like". Further, only one of the four slum indicators – the definition developed by the UN – is found to be marginally associated with child height for age. Of the four components constituting the UN definition, the findings appear to be driven by housing quality. While these results show that neighborhood effects on health can and should be empirically investigated in the developing country context, they strongly suggest that the conceptualization and measurement of slums requires more theoretical and empirical work given its policy relevance.

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, an issue that has not been addressed by studies using these data (43). A second reason for this 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. Distinctions such as these are particularly important in the Indian context where legal status confers rights to public service provision, making non-notified slums significantly worse off than those that are notified (27). Any slum designation that fails to take this into account will poorly measure neighborhood-level deprivation. A third explanation may be that while every effort was made to ensure comparability between the four definitions in these data, two of them required construction from household questionnaires while the other two were supplied in the dataset at the PSU level. However, the difference in proportions designated as slums even within these two category groupings is notable, suggesting that this may be less of an issue. While it is not possible to adjudicate between the proposed explanations of slum designation discrepancy, and it is likely that more than one is operating, this descriptive finding necessarily complicates the measurement and policy implications of area deprivation in developing countries.

Measurement challenges notwithstanding, the regression results, namely that child height for age is not strongly associated with slum dwelling net of individual and household characteristics, point to a relatively weak and inconsistent association between slum dwelling and a widely used indicator of child wellbeing. Given the literature detailing the many probable adverse health effects of living in a slum (44) and the mechanisms by which disease and poverty are thought to be perpetuated in urban areas (45), it is surprising that more robust neighborhood effects were not uncovered in these analyses. It may be that neighborhood effects impact adult health more significantly than child health in this context (40), or that individual and household characteristics are much more proximal and relevant for child height for age. A relatively "small" effect (as compared to individual-level characteristics) of neighborhoods on a variety of indicators of wellbeing has also been found in developed country cities (1). In terms of the final regression model, however, while PSU-level housing type is associated with child height for age, it is unclear why. 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 PSU-level housing type is a proxy for some other, unmeasured, neighborhood advantage.

There are a number of limitations to this study. First, employing PSUs as a proxy for neighborhoods is not ideal as they are administratively set and not arrived at through community or contextual knowledge; the analyses presented here are constrained by the fact that PSUs are the only indicator of spatial proximity available in these data. Second, since the data used in this study are from only eight cities, the findings cannot be generalized to all of urban India. Third, in operationalizing the Committee definition from the household questionnaire, information about the fourth component, closed drainage, was not available in the NFHS. The third component of the definition, that the household does not have a latrine facility within the premises, provided the only information regarding household sanitation and drainage. Fourth, we observe only height for age of surviving children and the responses of adult women surviving childbirth (46). The strength of using child height for age (and not child mortality, for example) as a dependent variable, however, is that it is measured and not self-reported, which may reduce measurement bias. Finally, like all cross-sectional survey-based study designs, we are unable to account for any unobserved heterogeneity (47), or unmeasured characteristics that are simultaneously associated both with at least one independent variable and child height for age.

In sum, this study describes a number of ways in which it is possible to characterize what constitutes a slum area, and that these definitions often do not identify the same households as slum-dwelling. Further, their association with an indicator of child health is inconsistent and, even when of moderate statistical significance, small in magnitude. This has implications both for current policy and media rhetoric focusing on slums (48), as well as the empirical measurement and study of the implications of area-level deprivation in this context. Continued investigation of intra-urban differentials in health (49) is therefore recommended, as is a more widespread acknowledgement that slums are not homogenous entities (50), but complex and dynamic areas characterized both by risk as well as resilience. Serious research interest on slums will be necessary to inform policy debates on this issue (51).

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[iii]	Committee
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[iv]	NA	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[v]	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;[vi] 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[vii] that is	Available drinking water source not be

[iii] The UN definition technically includes security of tenure and protection against forced eviction. But this is information is not captured in demographic and health surveys and it is therefore standard procedure to omit it from empirical analyses on this topic
[iv] Not applicable (NA) – information on this slum characteristic is not included in this definition
[v] More than three people sharing a room
[vi] *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
[vii] All water sources but piped into dwelling, plot or yard; public tap/standpipe

			sufficient, affordable, and attained without extreme effort	available within the premises
Sanitation	Lacking in proper sanitary facilities	Lacking in proper sanitary facilities	Lack of access to improved sanitation facilities, including a private toilet, or a public one shared with a reasonable number of people[viii]	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[ix]

[viii] All sanitation but flush or pour-flush and ventilated improved pit latrine; if respondent reported sharing a toilet with another family, their facility was considered unimproved

[ix] Information on drainage was not included in the National Family and Health Survey; only latrine information was used for this indicator

TABLE 3: Characteristics of the study population (N=4,609)

Characteristic			Proportion, or mean (sd)
Child	Height for age		-1.49(1.65)
	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 an urban 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 (N=4,609)

City	Census	NFHS	UN	Committee
Delhi (n=612)	44.0	38.6	55.6	28.0
Meerut (n=866)	51.7	34.1	61.7	3.0
Kolkata (n=389)	60.4	57.3	61.9	64.3
Indore (n=644)	52.8	8.5	52.0	26.1
Mumbai (n=368)	61.4	63.3	77.4	48.6
Nagpur (n=576)	50.0	48.8	47.7	24.6
Hyderabad (n=719)	49.4	44.6	43.1	18.4
Chennai (n=435)	53.3	52.0	72.2	41.8
Total	51.7	42.0	58.5	28.1

TABLE 5: Proportion of PSUs in the study sample identified as slums by two definitions (N=4,600)

	Census	NFHS	UN	Committee
Census	100			
NFHS	79.2	100		
UN	63.1	53.4	100	
Committee	69.4	60.2	85.4	100

TABLE 6: Ordinary least squares regression of height for age with each slum definition (N=4,609)

Independent variables	Model			
	(1) Census	(2) NFHS	(3) UN	(4) Committee
Slum indicator variable	-0.0505 (0.0481)	-0.0800 (0.0518)	-0.0940* (0.0530)	-0.0433 (0.0568)
Child characteristics	Yes	Yes	Yes	Yes
Mother characteristics	Yes	Yes	Yes	Yes
Mothers' partners' characteristics	Yes	Yes	Yes	Yes
City fixed effects	Yes	Yes	Yes	Yes
Deprivation index	Yes	Yes	Yes	Yes
R^2	0.1477	0.1475	0.1481	0.1476

* - statistically significant at p<0.1
** - statistically significant at p<0.05
*** - statistically significant at p<0.01

TABLE 7: Ordinary least squares regression of height for age with UN-HABITAT definition components entered separately (N=4,609)

Independent variables		Coefficient (standard error)
Community-level slum components	House type	-0.4306*** (0.1673)
	Crowding	-0.2390 (0.1673)
	Water	-0.1028 (0.0941)
	Sanitation	-0.0259 (0.1157)
Child characteristics	Yes	
Mother characteristics	Yes	
Mothers' partners' characteristics	Yes	
City fixed effects	Yes	
Deprivation index	Yes	
R^2	0.1508	

* - statistically significant at p <0.1
** - statistically significant at p<0.05
*** - statistically significant at p<0.01

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