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DEMOGRAPHIC CHANGE HEALTH INEQUALITY AND HUMAN DEVELOPMENT IN INDIA

Editors

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8

Geographical Disparities in Mortality

S. V. Subramanian, Shailen Nandy, Michelle Kelly, Dave Gordon and George Davey Smith

INTRODUCTION

It is well-known that there are geographic variations in mortality across India (Murthi, Guio, Dreze 1995). Typically these variations have been shown at the level of states and rather than at the district and village levels. Crucially, the sources that produce these variations (regardless of the ecological level) are less well understood. Specifically, one plausible line of reasoning could be to attribute the observed place-variations in mortality simply to factors that are associated with individuals and then households. Examples of these, may include age, caste, household income and/or standard of living. If supported empirically, one could then argue that the observed place variation is an artifact of the socioeconomic and demographic composition of places. Consequently, one need not invoke any contextual lines of reasoning to understand the variations in mortality. They may be taken as establishing the key importance of individual/household factors to mortality, but we may still wish to consider why individual/household factors are spatially clustered. An alternative (or complimentary) line of reasoning would be to attribute the place variations in mortality to characteristics associated with places, and not simply individuals. Stated differently, variations in mortality can be broadly seen to be coming from two sources: individual/household-induced source of variation *and* place-induced source of variation. Typically, existing research

has analyzed mortality either solely at the individual level (thus missing out the potential importance of the spatial contexts within which people live and die) or at the ecologic/geographic level (thus missing out the obvious importance of individual factors that influence health) and has ignored the multilevel aspect of inequalities in mortality.

Using a multilevel analytical framework we examine three aspects of place variations in mortality in India. First, we examine the multilevel nature of place variations with places being defined as spatial units that represent local areas, districts and states. Second, we examine the compositional sources of variations in mortality. In particular, the interest is in examining the social caste and economic differentials in mortality and how much of the place variation is an artifact of social caste and economic status. Finally, we evaluate the relative importance of household and local area-level socioeconomic deprivation on individual mortality.

As part of its ongoing health projects and assistance in formulation of government health strategies, DFID commissioned an analysis of socioeconomic and cultural differences in health and health-related practices across the four states of Andhra Pradesh Orissa, Madhya Pradesh and West Bengal. The study used data from the 1998-99 Indian National Family Health Survey. This paper represents part of the work undertaken within this commission.

AIMS

Previous studies have mainly looked at mortality variations and their correlates mainly at the ecological level (Murthi, Guio, Dreze 1995; Ramasubban, Crook 1996). This remains the case even with the death data (whether it is for adults or for children) from the 1993-94 or 1998-99 Indian National Family Health Survey (NFHS) (IIPS 2000). In this paper, we present a novel framework for analyzing mortality at the individual level, while simultaneously considering the other micro and macro contextual levels of importance, such as households, local areas, districts and states. Specifically, using a multilevel conceptual and methodological framework (Subramanian, Jones, Duncan 2003) this study raises and addresses the following questions:

- Having taken account of the differences in mortality between the states and the urban-rural differentials in mortality, are the differences between-households; between-local areas; and between-districts significant?

- How much of the above state and urban-rural differentials and the variations at the local area and district level are an artifact of individual characteristics associated with age and sex, and household characteristics associated with caste and religion?
- Do the caste differentials in mortality in India become attenuated by taking into account the household's economic standard of living?
- Are there significant effects of a local area's socioeconomic deprivation on mortality, over and above individual/household socioeconomic well-being?

METHODS

Sources of data

The analysis was based on the 1998-99 Indian National Family Health Survey (NFHS) for the states of Andhra Pradesh, Madhya Pradesh, Orissa and West Bengal. For details on the characteristics and history of this survey see (IIPS 2000). In brief, this survey is the second systematic attempt (after the initial 1992-93 Indian NFHS) to collect information on health of the population, with a special focus on women and children. For this study, we utilized the household data file that includes details on deaths in the household in the 2 years prior to the date of the survey (www.measuredhs.com). Using this information we restructured the data file in order to have individuals represented separately, rather than only by household. Data on household members who had died in the last two years were also included, along with their household, local area, district and state identifiers. In addition, the individual characteristics age and sex–ascertained for each of the deceased–was included along with current household-level information on caste, religion and standard of living.

Outcome measure

The outcome was a dichotomous variable: dead or not, with 0 for individuals who were alive and 1 for dead. Stated simply, we modeled the probability of dying.

Exposure variables

Exposure variables at different levels were considered simultaneously. At the *individual level*, we considered two key demographic variables, age and sex. At the *household level* we considered caste, religion and a standard of living index based on material possessions. Caste status was based on the following classification: Scheduled Caste (SC), Scheduled Tribe (ST), Other Backward Caste (OBC); Other Caste (OC); and No Caste (NOC). The category OC is largely a residual category, that is, those who are *not* SC, ST or OBC; while NOC represents a grouping that is comprised of population groups for whom caste is not applicable and/or those who did not report any caste affiliation in the survey. Religious affiliation was considered as a four categorical variable: Hindu, Muslim, Christian and Others. We also considered a household standard of living index (HSLI), measured on a continuous scale. The HSLI was constructed from data on material goods owned, with a proportionate possessions weight applied reflecting the differences in ownership specific to the population in question (for details see (Subramanian et. al. 2003). At the *local area level*, we considered an area-based standard of living index (ASLI) that was derived by aggregating and averaging the HSLI for each local area.

The term 'local areas' essentially relates to the Primary Sampling Units (PSUs) that were considered in the Indian NFHS 1998-99. PSUs, in the 1998-99 NFHS, were identified as villages or groups of villages (in rural areas) and wards or municipal localities (in urban areas). Consequently, besides ASLI, local areas were also characterized by their urban/rural status using the following Demographic and Health Survey (DHS) classification of PSUs: Large Cities (a population of 1 million or more), Small Cities (population of more than 100,000 but less than 1 million), Towns (population of less than 100,000) and rural areas. While the first three represent grades of urban setting, villages represent rural areas.

Analytical framework

As one of the key aims of this paper is to investigate the degree to which individual mortality is influenced by the contexts within which people live, the use of conventional regression framework is not appropriate. Conventional regression frameworks, in the context of the present analysis, have two critical limitations. First, the analytical framework assumes that the individual observations are independent of one another. This assumption is conceptually and technically problematic. From a conceptual standpoint, it negates the real dependency that is often created by spatial contexts on individual health outcomes. The multi-stage cluster sampling used in many surveys may accentuate this dependency in a particular data set. Conventional regression frameworks require that observations are independent of one another, and violating this assumption may lead to standard errors for the regression coefficients to be under-estimated, thereby increasing the risk of false positive findings. Second, standard regression modeling assumes a single of *source* of variation, that it either individual *or* contextual. Since in our analysis we anticipate the causal pathways to lie at both the levels *simultaneously*, it is essential to ascertain the contribution of the different sources or levels to the variation in the outcomes. Not differentiating the level-contingent nature of different exposure measures can also lead to under- or over-estimation of the regression coefficients as well as their standard errors. Consequently, the statistical modeling framework in this paper anticipates that individual mortality is dependent upon the households and spatial contexts (e.g. local areas; districts). This dependency in the outcome was modeled by partitioning the individual, household, local area and district sources of variation.

Multilevel statistical techniques provide one technically robust framework to analyze the dependent nature of the outcome variable (Goldstein 1995; Raudenbush, Bryk 2002). Specifically, multilevel models are pertinent

a) when data are clustered;

b) when the causal process that affect the outcome is seen to be operating at more than one level simultaneously; and

c) when there is an intrinsic interest in the variation and heterogeneity that underlies average relationships.

All three of these are central to this paper. The principles underlying multilevel modeling procedures, have been extensively discussed (Subramanian, Jones, Duncan 2003).

Briefly, all statistical models, including conventional regression models, can be seen to have two parts: the *fixed part* and the *random part*. The fixed part estimates, also known as regression or "slope" coefficients in conventional models, provide how each exposure, conditional on others included in the model, is related to the outcome variable, *on average*. The "unexplained" part of the statistical model is what constitutes the random component, also typically referred to as "errors" in conventional regression models. In contrast, in multilevel models, while the fixed part is comparable to the regression slope coefficients from a single level regression model, it is the expansion of the random part that provides key methodological and substantive advantages. Firstly, since the source of the variation in the outcome is seen to be coming from different sources, these different sources are specified as levels and the variance attributable to each level is ascertained. Consequently, instead of one variance term, a multilevel model estimates random variance parameters for each of the defined levels. Second, by explicitly recognizing the distinct levels appropriate for each of the exposures the regression coefficients and the standard errors are robust.

In the context of the analysis presented here, the multilevel techniques allow estimation of:

a) the average differences between individual/household factors and mortality across all local areas and districts ('fixed parameters');

b) variation between local areas and districts in mortality that cannot be accounted for by these factors ("random-parameters"); and

c) the effect of local area level exposures on individual mortality ("fixed parameters") and the extent to which they explain local area variations in mortality ("random parameters").

A key motivation of this study is to ascertain and estimate the extent to which there is a ecology of mortality, over and above the individual/household gradients. Stated differently, there is an intrinsic interest in describing the contextuality underlying mortality in India. Meanwhile, in order to ascertain contextual variation between places, two potential modeling strategies can be employed. In the first, spatial contexts (such as local areas) are treated as a level in the analytical framework, with the local areas being seen as a random sample from an overall population of local areas with a mean and variation for the population of local areas. In the second, spatial contexts, such as local areas, can be treated as fixed exposures, rather than as a level. The latter would be appropriate when the interest is in making inferences about specific places and/or if we do not have a large number of places to estimate the mean and variance of the overall population of local areas. The former strategy is appropriate when there is sufficient number of local areas and the interest is in making inferences about the population of local areas, rather than about specific local areas.

In the analysis presented in this paper, we combine the two modeling strategies to ascertain the geographic variations in mortality at multiple spatial levels. While we consider local areas and districts as distinct levels in our multilevel analysis, and thus provide estimate about how local areas and districts vary in the population, we model state-effects as an exposure with a fixed regression coefficient. The reason for not considering state as a distinct level is because our interest is in making specific inferences about the four states (conditional on individual exposures, as well as after taking account of the within state variations due to districts and local areas). Furthermore, since in our study we consider only four states, it may not be appropriate to model them as a random sample of an overall population of states.

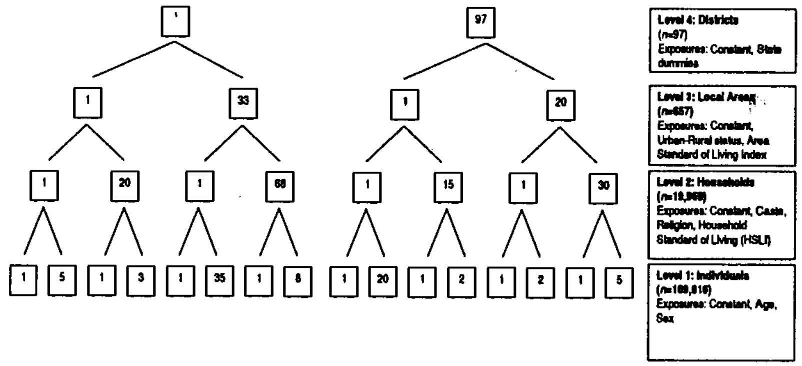
MODEL SPECIFICATION AND STRATEGY

Since the outcome was dichotomous, a binary multilevel logistic model based on a logit-link function was used. Models were fitted using the *MLwiN* program Version 1.10.0006 using a Marginal Quasi Likelihood (MQL) approximation and a first order Taylor linearization procedure (Rasbash et. al. 2000). We also attempted to fit the models using a Predictive/Penalized Quasi Likelihood (PQL) approximation with a second order Taylor linearization procedure, since MQL have been shown to produce downwardly biased estimates of the random part at higher levels (Goldstein, Rasbash 1996). However, the models did not converge even after allowing for a considerable number of iterations. Consequently, the results presented in this paper are based upon MQL first order specification. All models were estimated using the logit (logarithm of the odds) function. For presentation and interpretation we have used proportion and/or Odds Ratio (OR) (see (Subramanian et. al. 2003).

Figure 1 presents the multilevel structure that was developed to calibrate different model specification with 109,616 individuals at level-1 nested within 19,969 households (level-2) nested within 657 local areas

(level-3) within 97 districts (level-4). Thus in the hierarchic structure in Figure 1, 5 individuals are shown to belong to household 1 in local area 1 in district, and so on. Similarly, district 97 is shown as having a total of 20 local areas with local area 20 having 30 households and household number 30 having 5 individuals. The different exposures that were related to the three behaviors at different levels are listed.

Figure 1: Structure and specification for multilevel modeling



Using the above structure, five multilevel models were sequentially developed to analyze the individual probability of dying:

Model 1: A four-level null (empty) model of individuals at level-1 nested within households at level-2 nested within local areas at level-3 nested within districts at level-4 with no exposure variables in the fixed and the random part of the model. This model provides a baseline for comparing the size of contextual variations at the different levels in mortality in subsequent models and is useful for discussing the "compositional" and "contextual" aspects of place variations in mortality.

Model 2: As Model 1, but includes state-specific and urban/rural indicator variables in the fixed part of the model. This model estimates the amount of mortality variations that can be attributed to households, local areas and districts, conditional on effects that states and urban/rural affiliation have on mortality.

Model 3: As Model 2, but includes individual age, sex and household caste and religion. The contextual variation in mortality at the household, local area and district level is evaluated after taking into account the compositional effect of the above mentioned individual/household sociodemographic variables. In addition, the model also assesses whether the state and urban-rural differences are attenuated or exaggerated once we take into account the individual and household sociodemographic effects.

Model 4: As Model 3, but considers the fixed average effect of HSLI on individual mortality and the extent to which household socioeconomic position (SEP) accounts for household, local area and district differences and attenuates the average state and urban-rural differences.

Model 5: As Model 4, but considers the effect of the local area exposure, ASLI (a contextual deprivation measure). This model allowed us to evaluate the relative importance of household versus local area level socioeconomic deprivation. In addition, it also measures the extent to which mortality differences at the local area level can be explained by place-based deprivation measure.

Table 1 provides a summary of the final data considered for the analysis. Except for age (an individual-level attribute) and standard of living (as an household-level attribute and a local area-level attribute) that are specified as a continuous measure, the remaining independent variables were specified as categorical variables, with a baseline and a set of contrast indicator dummies, as shown in Table 1. The total number of individual observations for the four states was 109,879 and after excluding the missing data on the outcome and exposure variables, we conducted a multilevel regression analysis on 109,616 individuals (at level-1) nested within 19,969 households (at level-2) nested within 657 local areas (at level-3) nested within 97 districts (at level-4). Of the total 109,616 individuals, 2793 were dead. Madhya Pradesh accounted for about 37 percent of the total sample, followed by Orissa (23 percent), West Bengal (22 percent) and Andhra Pradesh (18 percent).

RESULTS

Table 2 provides mortality data by the different individual and contextual exposures used in the study. The prevalence rates presented

Table 1: Data description for the final sample

Outcome		
Dead/Alive	Dead (*n*=2793, 2.5%)	Alive (*n*=106823, 97.5%)
Level-1: Individuals, *n*=109616		
Age (in years)	Mean = 26 years	Range = 0 - 99 years
Sex	Base: Male (*n*=55950, 51.0%)	Contrast: Female (*n*=53666, 49.0%)
Level-2: Households, *n*=19969		
Social Caste	Base: Other Caste (*n*=36196, 33.0%)	Contrast: Scheduled Caste (*n*=20050, 18.3%) Scheduled Tribe (*n*=15133, 13.8%) Other Backward Caste (*n*=34324, 31.3%) No Caste (*n*=3913, 3.6%)
Religion	Base: Hindu (*n*=96801, 88.3%)	Contrast: Muslim (*n*=9883, 9.0%) Christian (*n*=1949, 1.8%) Other (*n*=983, 0.9%)
Household Standard of Living Score (HSLI)	Mean: 4.55	Range = 0.046 - 16.364
Level-3: Local areas, *n* =657		
Area Standard of Living Score (ASLI)	Mean: 4.55	Range = 1.43 - 11.2
Place of residence	Base: Village (*n*=77475, 70.7%)	Contrast: Large City (*n*=8965, 8.2%) Small City (*n*=8151, 7.4%) Town (*n*=15025, 13.7)
Level-4: Districts, *n*=97		
State	Base: Andhra Pradesh (*n*=19802, 18.1%)	Contrast: Madhya Pradesh (*n*=40748, 37.2%) Orissa (*n*=25218, 23%) West Bengal (*n*=23848, 21.8%)

in this table are considered for each exposure separately. The general pattern observed for mortality is as follows. First, while there seems to be an urban-rural differential in mortality, no marked differentials are observed between the four states. Second, there seems to be a caste differential in mortality. We must note that the mortality data presented in Table 2 are not age-adjusted and therefore cannot be interpreted. Furthermore, such average prevalence rates have their limits, regardless of whether they are age-adjusted or not. First, it is not clear whether some of the observed differentials for social caste are because we have not taken into account the household economic status. Second, even though we obtain average prevalence there is no description about how these rates varies across households, villages and districts. While a multiple regression would address the first concern, using a multilevel regression model allows us to address both the concerns simultaneously, besides providing robust regression coefficients for the different exposures along with their appropriate standard errors.

Table 3 presents the results of the multilevel models described in the previous section. We present and interpret these results in the order in which the models were developed. The null model (Table 3, Model 1) simply estimates the overall mortality across all the four states, and partitions the variation that can be attributed to the level of households, local areas and districts. Converting the logit estimates from Model 1 (the null model), we found that mortality rate across the sample populations was approximately 26/1000. The null model also showed significant variation between districts and between local areas suggesting some moderate evidence of spatial clustering of mortality. However, no clustering was observed at the household-level.

The results presented in Model 2 (Table 3) are effectively the baseline model since we estimate the average mortality differentials between states along with the urban-rural differentials, commonly observed in mortality, besides evaluating the differences between districts, local areas and households. In Model 2 (Table 3) the constant represents the logarithm of the mortality rate for individuals living in rural Andhra Pradesh, which when exponentiated yields a mortality rate of 30 per 1000. The differentials observed for Madhya Pradesh, Orissa were negative, suggesting lower mortality rates but the coefficients were not statistically significant. Mortality rates in West Bengal were significantly lower at 25 per 1000.

Table 2: Mortality data by individual and area exposures

Exposures	Total	Counts of death
Andhra Pradesh	19802 (18.1%)	548 (2.8%)
Madhya Pradesh	40748 (37.2%)	1069 (2.6%)
Orissa	25218 (23.0%)	651 (2.6%)
West Bengal	23848 (21.8%)	519 (2.2%)
Village	77475 (70.7%)	2130 (2.7%)
Town	15025 (13.7%)	323 (2.1%)
Small City	8151 (7.4%)	171 (2.1%)
Large City	8965 (8.2%)	169 (1.9%)
Male	55950 (51.0%)	1461 (2.6%)
Female	53666 (49.0%)	1332 (2.5%)
No Caste	3913 (3.6%)	80 (2.0%)
Scheduled Tribe	15133 (13.8%)	448 (3.0%)
Scheduled Caste	20050 (18.3%)	526 (2.6%)
Other Backward Caste	34324 (31.3%)	950 (2.8%)
Other Caste	36196 (33.0%)	789 (2.2%)
Other Religion	983 (0.9%)	19 (1.9%)
Christian	1949 (1.8%)	49 (2.5%)
Muslim	9883 (9.0%)	220 (2.2%)
Hindu	96801 (88.3%)	2505 (2.6%)
Age	26.4 (19.7)	47.9 (30.2)
Household Standard of Living Score (HSLI)	4.5 (2.8)	4.0 (2.6)
Area Standard of Living Score (ASLI)	4.5 (1.6)	4.3 (1.5)

Note: Column 'Total' presents the number of observations across each exposure, along with the percent proportion in each category. For Age, Education, HSLI and ASLI, the table provides the mean and their standard deviation in brackets. The tabulations presented for the different exposures are not age-adjusted.

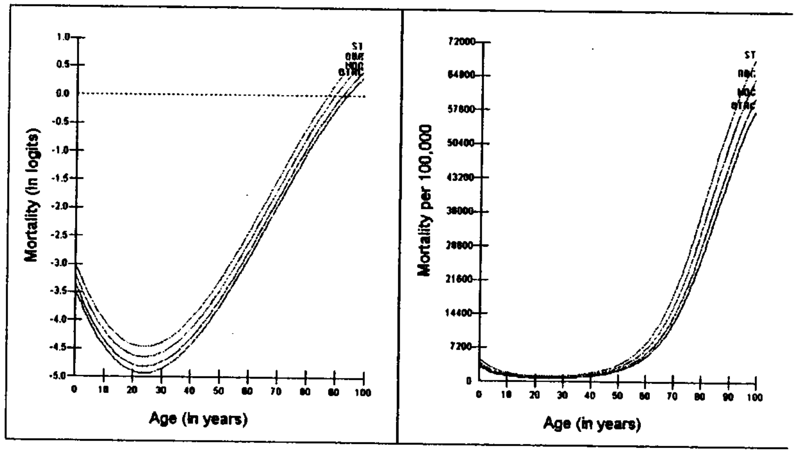
Interestingly, mortality differentials are not simply along urban/rural lines, which is well-known, but there seems to be gradient such that mortality rates are lowest in large cities (21 per 1000) followed by small city (22 per 1000) followed by towns (23 per 1000) and greatest for villages (30 per 1000). While between-district variation continued to be significant, the between-local area differences were only significant at 0.06 probability level. We must note that mortality rates provided here cannot be compared across models as the meaning of the "constant" changes across the models.

Model 3 (Table 3) evaluates the sociodemographic differentials in mortality. While mortality differentials can be observed for age and caste, no significant differences were observed between gender and between religions. Figure 2 shows the predicted mortality as a curvilinear function of age and plots the age/mortality relationship for the five caste groups as main effects. No interaction effects between age and caste were observed. The probability of dying was highest for ST (OR = 1.59) compared to OC, the base category and socially the most advantaged group. For SC, the odds of dying was 1.33 and for the OBC populations group it was 1.32, as compared to OC. The residual category of NOC was not significantly different from the base category, OC, but was significantly different from the other three social caste groups.

In addition to mapping out the individual, household based sociodemographic differentials in mortality, Model 3 (Table 3) also evaluates the extent to which the observed average state and urban-rural differentials and variations between-local areas and between-districts are an artifact of the characteristics associated with individual age, sex and household caste and religion. Adjusting for individual age, sex and household caste and religion, the mortality differential for Orissa (OR = 0.82) became significant; and the differential for West Bengal changed too (OR = 0.85), although was no longer significant. The urban-rural gradient that was observed earlier also seems to be attenuated by socio-demographic factors associated with age and social caste. The odds ratios for the large city (OR = 0.79), small city (OR = 0.84) and town (0.83) also approached unity and only the differential for towns remained statistically significant at 0.05 probability level.

Between-districts variation was no longer statistically significant (p = 0.08) once we adjust the model for individual and household sociodemographic factors. However, between-local area and between-

Figure 2: Predicted relationship between mortality and age for social caste groupings, based on Model 3



Note: The curve for OBC and SC are almost identical and hence the four lines and labels rather than five.

household variation was highly significant (p = 0.02 and 0.01, respectively) suggesting that not controlling for sociodemographic composition actually masked the "true" differences between households and between local areas.

The household standard of living index was linearly and negatively associated with individual mortality, that is, the higher the household standard of living lower is the probability of dying (Model 4, Table 3). While caste inequalities in mortality do become partially attenuated by economic well-being, significant differences between caste groups remain.

However HSLI renders the state-differences to be marginal and the observed urban-rural gradient is also no longer significant. As expected, HSLI partially accounts for the between-household variation (comparing the between-household variance from Model 3 and Model 4), but it also reduces the observed variation between-local areas from 0.41 in Model 3 to 0.031 in Model 4, suggesting some local area clustering of populations according to standard of living.

Table 3: Fixed and random part results for the multilevel analytical models

Parameters	Model 1	Model 2	Model 3	Model 4	Model 5
Fixed					
Constant (in logits)	-3.637	-3.489	-4.439	-4.116	-3.984
Madhya Pradesh		*0.94 (0.82-1.07)	*0.89 (0.78-1.03)	*0.95 (0.82-1.09)	*0.97 (0.84-1.12)
Orissa		*0.89 (0.75-1.04)	0.82 (0.69-0.96)	0.84 (0.71-0.99)	*0.85 (0.72-1.01)
West Bengal		0.83 (0.71-0.97)	*0.85 (0.71-1.01)	0.84 (0.71-1.00)	0.83 (0.70-1.00)
Large City		0.70 (0.56-0.89)	0.79 (0.62-1.00)	*0.93 (0.73-1.19)	*0.96 (0.74-1.26)
Small City		0.74 (0.63-0.87)	*0.84 (0.70-1.02)	*0.96 (0.80-1.16)	*0.95 (0.77-1.17)
Town		0.77 (0.68-0.88)	0.83 (0.72-0.96)	*0.93 (0.81-1.07)	*0.99 (0.85-1.15)
Female			*0.99 (0.92-1.07)	*0.99 (0.91-1.07)	*0.99 (0.91-1.07)
Scheduled Caste			1.32 (1.16-1.50)	1.14 (1.00-1.31)	*1.14 (0.99-1.29)
Scheduled Tribe			1.59 (1.37-1.84)	1.35 (1.16-1.56)	1.32 (1.13-1.53)
Other Backward Caste			1.32 (1.18-1.48)	1.23 (1.09-1.38)	1.22 (1.08-1.37)
No Caste			*1.12 (0.85-1.47)	*1.08 (0.82-1.41)	*1.07 (0.82-1.40)
Muslim			*1.14 (0.96-1.36)	*1.07 (0.90-1.28)	*1.06 (0.89-1.27)
Christian			*0.92 (0.67-1.27)	*0.94 (0.68-1.28)	*0.94 (0.68-1.28)
Other Religion			*0.79 (0.48-1.30)	*0.88 (0.54-1.43)	*0.89 (0.54-1.46)
Household Standard of Living Score				0.93 (0.91-0.94)	0.93 (0.92-0.95)
Area Standard of Living Score					0.95 (0.92-0.99)
Random					
Between-district variation	*0.027 (0.010)	0.020 (0.009)	*0.016 (0.009)	*0.016 (0.009)	*0.018 (0.009)
Between-PSU variation	0.037 (0.016)	*0.029 (0.016)	0.041 (0.018)	0.031 (0.017)	*0.029 (0.017)
Between-household variation	*0.000 (0.000)	*0.039 (0.067)	0.171 (0.067)	0.162 (0.068)	0.160 (0.068)

Notes: The values for the constant are in logits. Fixed part results are presented as Odds Ratios with their 95% Confidence Interval shown in the brackets. Random part results are variance parameters with their standard errors shown in brackets. Those marked with * in the fixed and random part are not significant at 0.05 probability level.

A moderately significant effect of ASLI is observed ($p = 0.05$) such that local areas with higher average levels of standard of living tend to have lower individual mortality, even after controlling for HSLI (Table 3, Model 5). As expected, the local area-level variation also gets partially explained as can be observed in the change in the variance estimate from 0.03 in Model 4 to 0.02 to Model 5.

DISCUSSION

The key findings of the study are as follows.

a) No robust and substantial differences in mortality can be found for the four states, with and without adjusting for individual, household and local area exposures.

b) There are strong caste based inequalities observed in mortality, independent of the socioeconomic position of household and places.

c) Household socioeconomic position is a strong determinant, suggesting the crucial role that material deprivation plays is shaping health patterns in developing societies such as India (Raman Kutty et. al. 1993).

d) Individual and household socioeconomic and demographic factors do not explain the local area variations in mortality. Indeed, not accounting for these factors actually runs the risk of masking the true contextual differences in mortality.

e) Over and above the role that individual and household economic well-being has on mortality, there is evidence of the independent role of local area deprivation in influencing life and deaths of populations.

There are several limitations to this analysis. First, attributing independent area-based influences and linking area-based measures to mortality may be somewhat problematic, as people move over the entire life course and the observed association could be more coincidental than causal. Second, our measures of local area standard of living are crude and might risk the problem of "endogeneity" since it is mainly composed of attributes that are associated with individual/household level rather than "pure" local area measures. Whether emergent contexts can be measured, independent of the populations who inhibit them, is a general methodological challenge in estimating area and place effects. Third, since death history of all individuals within that household is reported by one member of the household (the respondent), it may suffer from recall bias. Finally, we had to assume that the household's socioeconomic status and their residence did not change over the last 5 years.

CONCLUSION

The novelty of this study is considering individual mortality within the contexts of households, local areas and districts simultaneously across the four Indian states. The study also developed and presented a novel multilevel methodological framework for analyzing mortality information from the INFHS. We conclude that while household factors such as standard of living and caste status influence mortality, our study provides some evidence for an ecology of mortality in India, one that is local area based.

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