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Socioeconomic Inequalities in Childhood Undernutrition in India An Application of the Corrected Concentration Index

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Abstract

Measuring inequalities in child undernourishment with the help of the most popular concentration index (CI) has its own limitation in valuation and comparison. This is an attempt at contrasting a set of improved inequality measures against the conventional CI to comment on their robustness. In the process, it raises a need for revisiting the attainment-inequality relationship in health outcomes

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1. Introduction

There are subtle differences in the way we approach measurement of health inequalities. If the objective of the measurement exercise is to obtain a value-free description of the magnitude of health inequality then our exercise is analogous to the measurement of income inequality and the applicability of income inequality measures is immediate. This approach to measure health inequality ranks individual by health status and reflects the experience of each individual irrespective of the socioeconomic status. This approach steers clear of normative positions and, therefore, is less effective in recognising health inequalities as health inequities. Clearly, it makes a fundamental difference, if socioeconomic identities are ignored because it can prevent us from understanding health inequalities and to develop consensus on political and social interventions. Such inherent concerns have motivated researchers to examine inequalities in health that are systematically related with socioeconomic status (SES). In this regard, selection of an appropriate SES related health inequality measure is a key requirement to pursue any examination of health inequities. Most of the empirical studies on this issue employ the (ill) health concentration index (CI) as an indicator of the inequality of health in relation to the socioeconomic position of individuals (Wagstaff et al 1991, Kakwani et al 1997). As Erreygers (2009) notes, CI's popularity as a measure of the socioeconomic inequality of health is primarily due to its similarity with the well-known Gini coefficient, its effective graphical representation by means of the concentration curve (generalised Lorenz curve), and relative ease of decomposability by following a regression-based technique (see Wagstaff et al 2003). However, recent studies, including Erreygers (2009), have noticed that CI is not devoid of problems. Some of the key problems arise from the fact that the bounds of the CI may depend upon the mean of the health variable and, therefore, makes comparison of populations with different mean health levels problematic (Wagstaff 2005). It can also be discerned that different rankings are obtained if inequalities in health rather than inequalities in ill-health are considered (Clarke et al 2002). In fact, it is also noticed that the value of the index is to a large extent arbitrary if the health variable is of a qualitative nature (Zheng 2006). These limitations of the Concentration Index are effectively discussed by Erreygers (2009) who adopts an axiomatic approach to clarify the desirable properties that an ideal socioeconomic health inequality index should possess. After a careful review of the Concentration Index (CI) and its variants, Erreygers (2009) provides a general expression for this family of rank-dependent socioeconomic indicators and advances a corrected version of the concentration Index, which also abides by some necessary axioms of measurement. In this paper, we apply the corrected concentration index to assess the magnitude of socioeconomic status related inequalities in childhood undernutrition in India and its major states. Estimates from the traditional concentration index and its variants are also presented to facilitate a discussion by way of comparison. Based on the new estimates, the paper also revisits the widely acknowledged positive relationship between mean level of health achievement and socioeconomic inequalities (Wagstaff 2002).

2. Methods

Erreygers (2009) outlines some basic properties that should be satisfied by any socioeconomic-rank-related measure of health inequality. To elaborate, the *Transfer* axiom is inspired by the classic Pigou-Dalton principle of transfers commonly used in the literature on measurement of income inequality. It requires that any mean-preserving change of the distribution, which favours the better off, be translated into a pro-rich change in the index value, and one in favour of the worse-off into a pro-poor change. The axiom of *Level Independence* is motivated from the translation invariance assumption used in the literature on poverty measurement (for example see, Zheng 1994). Its implementation requires that the index remains constant if all health levels increase by the same amount despite the fact that both the lower and the upper limit of the health variable do not shift at all. *Cardinality* imposes both scale and translation invariance. Since health and ill-health are mirror of one another, the *Mirror* condition requires that the index should obtain equal estimates of the degree of inequality but with opposite signs. Following the axiomatic approach, Erreygers (2009) provides a general expression for the family of rank-dependent socioeconomic indicators as;

$$I(h) = f(H)\sum_{i=1}^{n} z_i h_i \text{ ; with } z_i = \frac{n+1}{2} - \lambda_i \quad (1)$$

where, set N = {1, 2, . . . , n} represents a given population of n individuals; λ_i is the socioeconomic rank of the person with the best well-off individual ranked first and the least well off ranked last. In the case of ties, each member of the tied group is assigned the average rank of the group. The health variable h_i, is a real number measuring the health status of i^{th} individual and is represented by the vector $h = (h_1, h_2, . . . , h_n)$ and the average health of the population is denoted as μ_h. It must be noted that that the health status variable of each individual lies between certain lower and upper bounds, a_h and b_h respectively and that a higher value of h_i would indicate a better health situation. It is also assumed that for each person i we have $0 \leq a_h \leq h_i \leq b_h < +\infty$. In equation (1), $f(H) > 0$, determines the specific form of the indicator with vector H capturing different aspects related to health and population. The ill-health variable s_i is defined by a simple transformation; $s_i \equiv b_h - h_i$.

Based on the general expression, the CI and its variants could be written as (see, for details, Erreygers 2009);

$$C(h) = \frac{2}{n^2 \mu_h}\sum_{i=1}^{n} z_i h_i \text{ ; and } C(s) = -(\mu_h / \mu_s)C(h) \quad (2)$$

$$W(h) = \frac{2(b_h - a_h)}{n^2 (b_h - \mu_h)(\mu_h - a_h)}\sum_{i=1}^{n} z_i h_i \quad (3)$$

$$V(h) = \frac{2}{n^2}\sum_{i=1}^{n} z_i h_i \quad (4)$$

The health concentration index, C(h), and its analogue ill-health concentration index, C(s), fulfils *Transfer* but fails to satisfy rest of the properties. W(h), represents the Wagstaff-normalized health Concentration Index. This index fulfils *Transfer* and *Mirror* conditions but fails to satisfy the axiom of *Level Independence*. The generalised concentration index V(h) fails to satisfy the *Cardinal Invariance* property. Erreygers (2009) proposes a rank dependent socioeconomic indicator, E(h), that satisfies the properties of *Transfer*, *Level Independence*, *Cardinal Invariance* and *Mirror* as;

$$E(h) = \frac{8}{n^2(b_h - a_h)} \sum_{i=1}^{n} z_i h_i \qquad (5)$$

The Corrected Concentration Index, E(h), satisfies the basic properties discussed above and has the maximum bounds of -1 and +1. In this paper we apply E(h) to assess the magnitude of inequality in the distribution of underweight outcomes among children in India and its states. For each state the number of underweight children are estimated and are defined in terms of a binary ill-health variable s, where (s=1) if the child is underweight and (s=0) otherwise. The corresponding health variable assumes a value of (h=0) if the child is underweight and (h=1) if not.

3. Results

To compute inequalities in childhood undernutrition in India we use the information obtained through the Indian National Family Health Survey (NFHS) 2005-06 (IIPS 2007). Anthropometric data on weight-for-age of children (aged below five years) is used to assess their nutritional status. Underweight or weight-for-age is a composite measure of height-for-age (captures chronic nutritional inadequacies or illness) and weight-for-height (captures current nutritional status) and could be used for monitoring child growth. The NFHS 2005-06 provides information on childhood weight-for-age growth standards (z-scores). The z-scores are calculated as the difference between the child's weight and the median weight of children of the same age and sex in a healthy reference population, divided by the standard deviation of that reference population. The growth standards used in NFHS 2005-06 are formed on the basis of the new international reference population released by World Health Organization (WHO) in April 2006 (WHO Multicenter Growth Reference Study Group, 2006) and accepted by the Government of India (IIPS, 2007). In the analysis, a child is considered underweight if it falls two standard deviations below the median score for children of the same age and gender in the reference population.

The prevalence of underweight outcomes and the estimates of SES related health inequality are presented in Table 1 for all India and states. The table highlights the disquieting and widespread burden of childhood undernutrition in India. At the national level, prevalence of underweight outcome is estimated to be 42.5%, which varies considerably across states (ranging between 22.7% and 59.9% in Kerala and Madhya Pradesh, respectively). Given the large magnitude and wide variations, an examination of its socioeconomic concentration across different states is identified as a first step to comprehend whether policies should be devised as a general strategy or we require policy targeting.

Table 1: Socioeconomic rank related inequalities in prevalence of childhood underweight, India 2005-06

States	*U*	*C(h)*	*C(s)*	*W(h)*	*V(h)*	*E(h)*
(i)	*(ii)*	*(iii)*	*(iv)*	*(v)*	*(vi)*	*(vii)*
Andhra Pradesh	32.7	0.075	-0.154	0.23	0.051	0.202
Assam	36.4	0.078	-0.137	0.215	0.05	0.199
Bihar	56.1	0.13	-0.102	0.232	0.057	0.228
Chhattisgarh	47.7	0.101	-0.111	0.213	0.053	0.212
Gujarat	44.7	0.121	-0.149	0.27	0.067	0.267
Haryana	39.7	0.095	-0.144	0.238	0.057	0.228
Jharkhand	57.1	0.128	-0.096	0.224	0.055	0.22
Karnataka	37.6	0.103	-0.171	0.274	0.064	0.257
Kerala	22.7	0.066	-0.226	0.292	0.051	0.205
Madhya Pradesh	59.9	0.122	-0.082	0.204	0.049	0.196
Maharashtra	36.7	0.112	-0.194	0.306	0.071	0.285
Orissa	40.9	0.13	-0.188	0.319	0.077	0.308
Punjab	24.6	0.091	-0.28	0.371	0.069	0.276
Rajasthan	40.4	0.093	-0.138	0.231	0.056	0.222
Tamil Nadu	30	0.085	-0.198	0.282	0.059	0.237
Uttar Pradesh	42.3	0.091	-0.124	0.215	0.053	0.21
Uttaranchal	38.1	0.132	-0.216	0.348	0.082	0.328
West bengal	38.6	0.105	-0.167	0.273	0.065	0.258
All India	42.5	0.122	-0.165	0.287	0.07	0.281

Note: U – percent of children underweight; C(h) health concentration index, C(s) ill health concentration index, W(h) Wagstaff's normalised health concentration index, V(h) Generalised health concentration index, E(h) Erreygers' corrected health concentration index.

Source: Authors own computations based on NFHS 2005-06

In this exercise, five different measures of health inequality are computed to understand whether burden of undernutrition is associated with socioeconomic status. A quick glance at the estimates reveals that there is significant SES related health inequality in India and its magnitude varies considerably across states. It can also be observed that these inequalities do not have any systematic bearing with the average prevalence of undernourishment. To elaborate, consider inequality estimates obtained by applying the traditional concentration index C(h) and C(s). The positive C(h) values suggest that the concentration of non-underweight outcomes (well nourished children) is greater among the richer sections of the population. For all-India the C(h) is computed to be 0.122 with a smaller variation ranging from 0.066 in Kerala to 0.132 in Uttaranchal. The negative C(s) values presents different estimates regarding the magnitude of inequality across states, nonetheless, confirms the key observation that the burden of undernutrition is borne disproportionately by children belonging to lower socioeconomic status. At the all India level the C(s) is computed to be -0.165 and presents a much wider range across states (from -0.082 in Madhya Pradesh to -0.280 in Punjab). This suggests that choice of indicator and inequality measure considerably influences the computed magnitude of health inequality. For instance, if we chose to measure health inequality in terms of good health indicator (h=0 if the child is underweight and h=1 otherwise), then Kerala emerges to be the most equitable state, however, if we employed C(s) as the measure (s=1 if the child is underweight and s=0 otherwise) then Kerala is found to be among the second most unequal state in India. The comparison of C(h) and C(s) values clearly indicate that the mirror condition is violated. In this regard, the case of Chhattisgarh with similar C(s) and C(h) estimates of inequality is not an exception because the two indices are bound to satisfy mirror condition when (μ_h/ μ_s) is equal to 1. Given such drastic shuffling in rankings and conflicting inferences, it is only reasonable to obtain estimates by employing measures that overcomes such inconsistencies.

The violation of the mirror condition is due to the disqualification of bound condition in case of simple concentration index. Wagstaff (2005) suggests a normalization technique, the index W(h), to overcome the bound issue, which also satisfies the mirror condition as well. The estimates of undernutrition inequality based on W(h) is presented in column (v) of Table 1. In general, the W(h) values obtain a pattern of inequality that is entirely different from what is observed by means of employing simple concentration index. The W(h) estimates have a greater range than the previously discussed estimates and suggests that the magnitude of inequality is much greater than what is obtained through the application of traditional concentration index. For instance, take the case of Madhya Pradesh. It emerges to be least unequal state if we consider the ranking in terms of C(s) or W(h) but importantly the magnitude of inequality differs considerably on account of the two measures. The other alternative inequality measure V(h), being a generalized measure of concentration, only moderates the magnitude of inequality and depicts lower variations across states. For instance, Madhya Pradesh continues to be the least unequal state while there is some reshuffling in rankings at the upper end. Although, V(h) satisfies all other desirable properties, it is noted to be sensitive to the scale or unit of the health variable. In other words, V(h) more readily qualifies as an absolute measure of inequality and not a relative one (see Erreygers 2009). The final inequality measure, the corrected concentration index E(h), that satisfies a whole host of properties to claim itself superior to others, does reveal a pattern of inequality which is entirely different from the estimates presented above. It is interesting to note that E(h) has some agreement with the computed W(h) values but is systematically lower in its magnitude. While the ranking of states in terms of magnitude of inequality obtained through V(h) and E(h) are similar, its rank correlation with other indices is relatively lower. As per E(h), Madhya Pradesh (0.196) is noted to be the least unequal state whereas Uttaranchal (0.328) is found to be the most unequal state. It is surprising to note that the states of Punjab and Kerala which are ranked first and second, respectively, in terms of inequalities computed using the index C(s) move in opposite directions when compared by means of E(h). Kerala emerges to be amongst the more equal states whereas Punjab continues to be among highly unequal ones.

Given the key results, we now investigate the plausible relationship between socioeconomic inequality of health and average health in India. A simple way to arrive at some insights on this matter is to obtain the coefficient of correlation between the four different inequality measures and the average prevalence of underweight outcomes across Indian states. These correlation coefficients are reported in Table 2.

Table 2: Correlation between different inequality indices and average underweight outcomes, India 2005-06

Pearson Correlation	C(h)	-C(s)	W(h)	E(h)
Average Underweight	0.698**	-0.857**	-0.583**	-0.188
Spearman's rho	C(h)	-C(s)	W(h)	E(h)
Average Underweight	0.670**	-0.793**	-0.534*	-0.097

*Note: ** and * implies correlation is significant at the 0.01 and 0.005 percent level (2-tailed).*
C(h) is health concentration index, -C(s) is negative of underweight concentration index, W(h) is Wagstaff normalised health concentration index and E(h) is Erreygers corrected concentration Index.

From the Table, it could be discerned that that simple ill-health concentration index, C(s), as well as Wagstaff's normalized measure, W(h), bear a significant and negative relationship with the level of the phenomenon. Accordingly, we may infer that health inequality increases with betterment of the situation. But this position is not qualified with the simple health concentration index C(h) that suggests of a direct and significant relationship between inequality and average achievements implying that greater the average health failures greater will be health inequalities. However, when we review the relationship by using the refined measure of inequality E(h) it emerges that there exists a negative but insignificant relationship between average health attainments and health inequalities in India. In other words, the use of index E(h) illustrates that there is no systematic association between health attainment and inequalities in childhood undernutrition in the country. It implies that, there are no implicit compulsions that SES related health inequalities would increase with improvements in health or SES related health inequalities are bound to be greater if health failures are higher. For instance, the state of Kerala is among the high-income states in the country but when compared with other high-income states such as Punjab or Maharashtra it presents considerably lower prevalence of childhood undernutrition as well as lower magnitude of health inequality. Much of the explanation for such observation rests in the fact that the health system design of Kerala is highly equitable when compared with other Indian states (see Peters et al 2002). However, it is pertinent to notice that we are working with a small sample and have information for one time point only. Hence, further enquiries on the subject would be warranted to confirm and elaborate upon our simple and preliminary findings.

4. Conclusion

A measure of inequality, such as E(h), which is robust in terms of satisfying some necessary properties to enable valuation and comparison is a definite alternative to measure health inequality. The estimates obtained through the application of corrected concentration index, E(h), invariably motivates us to revisit the attainment-inequality relationship in health outcomes, which, until recently, was acknowledged to be significantly positive. This exercise of applying E(h) in the context of childhood undernutrition in India, revealed that there are huge SES related health inequalities in the distribution of underweight outcomes however; it was also observed that these inequalities aren't significantly associated with the differing levels of undernourishment. This insightful disclosure perhaps delivers the message that health inequalities are possibly the result of the approaches our health system adopts for advancing health attainment. Whether we adopt an inclusive strategy of health progress or tend to focus on means that are not supportive of wider participation is very much a part of actions that have varying impact on inequality.

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