Policy and Practice

Poverty, child undernutrition and morbidity: new evidence from India

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Abstract Undernutrition continues to be a primary cause of ill-health and premature mortality among children in developing countries. This paper examines how the prevalence of undernutrition in children is measured and argues that the standard indices of stunting, wasting and underweight may each be underestimating the scale of the problem. This has important implications for policy-makers, planners and organizations seeking to meet international development targets.

Using anthropometric data on 24 396 children in India, an alternative Composite Index of Anthropometric Failure (CIAF) was constructed and compared with conventional indices. The CIAF examines the relationship between distinct subgroups of anthropometric failure, poverty and morbidity, showing that children with multiple anthropometric failures are at a greater risk of morbidity and are more likely to come from poorer households.

While recognizing that stunting, wasting and underweight reflect distinct biological processes of clear importance, the CIAF is the only measure that provides a single, aggregated figure of the number of undernourished children in a population.

Keywords Malnutrition/epidemiology/complications/economics; Child nutrition disorders/epidemiology; Poverty; Anthropometry; Body weight; Body height; Diarrhea/etiology; Respiratory tract infections/etiology; Socioeconomic factors; Nutrition surveys; India (*source: MeSH, NLM*).

Mots clés Malnutrition/épidémiologie/complications/économie; Troubles nutrition enfant/épidémiologie; Pauvreté; Anthropométrie; Poids corporel; Taille corporelle; Diarrhée/étiologie; Facteur socioéconomique; Voies aériennes supérieures, Infection/étiologie; Enquête nutritionnelle; Inde (*source: MeSH, INSERM*).

Palabras clave Desnutrición/epidemiología/complicaciones/economía; Trastornos de la nutrición del niño/epidemiología; Pobreza; Antropometría; Antropometría; Peso corporal; Diarrea/etiología; Infecciones del tracto respiratorio/etiología; Factores socioeconómicos; Encuestas nutricionales; India (*fuente: DeCS, BIREME*).

الكلمات المتفاحية :سوء التغذية، وبائيات سوء التغذية، مضاعفات سوء التغذية، اقتصاديات سوء التغذية، اضطرابات التغذية لدى الأطفال، وبائيات اضطرابات التغذية لدى الأطفال، الفقر، القياسات البشرية، وزن الجسم، الإسهال، مسببات الإسهال، التهابات الطرق التنفسية، مسببات التهابات الطرق التنفسية، العوامل الاجتماعية الاقتصادية، مسوحات التغذية، الهند (**المصدر: رؤوس الموضوعات الطبية، المكتب الإقليمي لشرق المتوسط**)

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Voir page xxx le résumé en français. En la página xxx figura un resumen en español.

Introduction

Undernutrition in young children is conventionally determined through measurement of height, weight, skin-fold thickness (or subcutaneous fat) and age (*1*). The most commonly used indices derived from these measurements are stunting (low height for age), wasting (low weight for height) and underweight (low weight for age). Stunting is an indicator of chronic undernutrition, the result of prolonged food deprivation and/or disease or illness; wasting is an indicator of acute undernutrition, the result of more recent food deprivation or illness; underweight is used as a composite indicator to reflect both acute and chronic undernutrition, although it cannot distinguish between them (*1*). These indices are compared against an international reference population developed from anthropometric data collected in the United States by the National Center for Health Statistics (NCHS) (*2*). Children whose measurements fall below –2 z-scores from the reference population median are considered undernourished, i.e. to have stunting, wasting or to be underweight. Those children with measurements below –3 z-scores are considered to be severely undernourished.

These indices reflect distinct biological processes, and their use is necessary for determining appropriate interventions (*1*).

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However, because they overlap, none is able to provide a comprehensive estimate of the number of undernourished children in a population; some children who are stunted will also have wasting and/or be underweight; some children who are underweight will also have wasting and/or be stunted; and some children who have wasting will also be stunted and/or underweight.

Estimates of the prevalence of undernutrition depend on the indicator used. For example, in 2002 UNICEF estimated that among children less than 5 years old in India prevalence rates of stunting, underweight and wasting were 45%, 47% and 16%, respectively (*3*). The use of three indices to show the prevalence of undernutrition raises a number of questions: just how many undernourished children are there in a particular population? Do the three indices provide a true picture of the scale of the problem? Is being underweight (currently used as the main measure of undernutrition) the most appropriate population indicator, or can an alternative composite measure that includes all undernourished children be developed?

Development economist Peter Svedberg argues that conventional indices are not sufficient for measuring the overall prevalence of undernutrition among young children (*4*). Since being underweight (having low weight for age) is a product of stunting and wasting and not the sum, it misses some children who are considered undernourished by the other indices, so producing an underestimate. Svedberg suggests that if children with wasting, stunting or who are underweight are all considered undernourished, or to be in a state of "anthropometric failure", a new aggregate indicator is needed, one that incorporates all undernourished children, be they wasted and/or stunted and/or underweight. He proposes constructing a Composite Index of Anthropometric Failure (CIAF).

Svedberg's model identifies six groups of children. These groups include children with height and weight appropriate for their age (i.e. who are not in anthropometric failure) and also children whose height and weight for their age are below the norm and thus are experiencing one or more forms of anthropometric failure. These groups are defined more fully in Box 1. The CIAF excludes those children not in anthropometric failure (i.e. Group A) and counts all children who have wasting, stunting, or are underweight (i.e. Groups B to F). It therefore provides a single measure with which to estimate the overall prevalence of undernutrition.

This paper will apply Svedberg's theory and construct the CIAF; identify the distinct subgroups; compare the CIAF to conventional indicators of undernutrition; and examine the relationships between poverty and morbidity among the different subgroups of anthropometric failure.

Methods

Data

This paper uses data from the 1998–99 National Family Health Survey (NFHS–2) for India. The NFHS–2 is a nationally representative survey, collecting demographic and health data on over 90 000 households in India (*5*); the data are freely available from ORCMacro (http://www.measuredhs.com). As part of the survey, detailed data were collected on 32 393 children less than 3 years old. Anthropometric measurements were not taken for approximately 13% of children. When the data were converted into z-scores, those children with grossly improbable z-scores were flagged and excluded. Thus, the final sample included a total of 24 396 children, all less than 3 years old. Around 25% of the original sample were excluded; those excluded consisted of children who were dead, who were unavailable for measurement, or whose mothers did not want them measured; those whose month and year of birth were not known; and those whose anthropometric data were flagged as improbable. Age and sex were taken into account when calculating the z-scores from the NCHS reference population median. The data were analysed using SPSS software version 12.0.

The NFHS–2 survey collected morbidity data, specifically on recent episodes of diarrhoea and acute respiratory infections (ARI). Mothers were asked if their child had had diarrhoea or a cough in the two weeks preceding the survey. Those whose children had had diarrhoea were asked if there had been any blood in the stools; those whose children had had a cough were asked if the child had also experienced breathing difficulties (i.e. short, rapid breaths). Other studies have used such information to develop indicators of diarrhoeal disease (dysentery) (*6–8*) and ARI (*9–11*), and WHO recommends using such measures as part of its surveillance standards for infectious diseases (*12*, *13*). Three indices of morbidity were constructed: children who were reported as having diarrhoea in the two weeks before the survey were defined as having diarrhoea. Those children

Box 1. **Classification of children with anthropometric failure**[a]

Group name	Description	Wasting	Stunting	Underweight
A	**No failure:** Children whose height and weight are above the age-specific norm (i.e. above –2 z-scores) and do not suffer from any anthropometric failure.	No	No	No
B	**Wasting only:** Children with acceptable weight and height for their age but who have subnormal weight for height.	Yes	No	No
C	**Wasting and underweight:** Children with above-norm heights but whose weight for age and weight for height are too low.	Yes	No	Yes
D	**Wasting, stunting and underweight:** Children who suffer from anthropometric failure on all three measures.	Yes	Yes	Yes
E	**Stunting and underweight:** Children with low weight for age and low height for age but who have acceptable weight for their height.	No	Yes	Yes
F	**Stunting only:** Children with low height for age but who have acceptable weight, both for their age and for their short height.	No	Yes	No
Y	**Underweight only:** Children who are only underweight.	No	No	Yes

[a] Another theoretical combination would be "wasted and stunted", but this is not physically possible since a child cannot simultaneously experience stunting and wasting and not be underweight.

with diarrhoea who had blood in their stools were defined as having severe diarrhoea. Those reported to have had a cough followed by breathing difficulties were defined as having ARI. These indicators were used to examine the relationship between morbidity and undernutrition. Around 20% of children in the sample were reported to have had an episode of diarrhoea or showed symptoms of ARI.

Undernutrition and standard of living

The NFHS–2 dataset contains a standard of living index (SLI) based on household ownership of assets and possessions; the index can be used to measure socioeconomic disadvantage or poverty. The SLI was created by assigning scores to a range of 30 household goods and assets, including the type of house and toilet facilities, fuel used for cooking, and ownership of durable goods (*5*). Indices of standards of living have been used in a number of studies as proxies for household wealth and economic status (*14–17*), and are increasingly used to reveal social, economic and health inequalities that result from relative poverty. Index scores of 0–14 indicate a low standard of living; scores of 15–24 indicate a medium standard; and scores of 25–67 indicate a high standard. The NFHS–2 index was used to examine the relationship between household living standards and undernutrition.

Analytical methods

Age-adjusted logistic regression and analysis of variance were used to examine the relationships between the subgroups of anthropometric failure, morbidity and standard of living. In the logistic regression models, children with no anthropometric failure (i.e. those in Group A) were set as the referent group, with age (in months) entered as a continuous variable.

Results

Rates of stunting, wasting and underweight were calculated from the anthropometric data collected by NFHS–2. The same data were used to construct the CIAF. Svedberg originally suggested six subgroups of anthropometric failure (to be labelled A to F). However, we identified an additional subgroup: one that includes children who are only underweight but not stunted or wasted. This group is labelled group Y.

Prevalence of undernutrition

Table 1 presents rates of stunting, wasting and underweight in Indian children aged less than 3 years. It also shows the rate of undernutrition as measured by the CIAF. According to the data, 45% of children are stunted, 47% are underweight and 16% have wasting. These rates are consistent with those published by UNICEF (*3*). The CIAF shows a higher prevalence of undernutrition, with 60% of children suffering from anthropometric failure.

Identification of subgroups

Table 2 shows the proportions of children in each of the subgroups. Of the six subgroups with undernourished children, group E (containing children who are stunted and underweight) is the largest, accounting for over one-quarter of children in the sample. Children who simultaneously have wasting, stunting and are underweight (i.e. those in group D) account for 7% of the children in the sample.

Table 1. **Prevalence of undernutrition among Indian children aged 0–3 years (n = 24 396)[a]**

	Number of children[b]
Stunted	11 024 (45.2)
Wasted	3 904 (15.9)
Underweight	11 493 (47.1)
CIAF	14 590 (59.8)

[a] Calculated from NFHS–2 data.
[b] Figures in parentheses are percentages.

Table 2. **Subgroups of anthropometric failure among Indian children aged 0–3 years[a]**

Group	Number of children[b]
A (no failure)	9 806 (40.2)
B (wasting only)	630 (2.6)
C (wasting and underweight)	1 489 (6.1)
D (wasting, stunting and underweight)	1 756 (7.2)
E (stunting and underweight)	6 801 (27.9)
F (stunting only)	2 467 (10.1)
Y (underweight only)	1 447 (5.9)
Total	**24 396**

[a] Calculated from NFHS–2 data.
[b] Figures in parentheses are percentages.

Undernutrition, poverty and morbidity

Analysis of variance was used to examine the relationship between undernutrition and standard of living; age-adjusted logistic regressions were used to examine the relationship between undernutrition and morbidity. Children who were not in anthropometric failure (i.e. group A) are set as the referent group in each analysis.

Undernutrition and poverty

The relationship between poverty and the subgroups of children suffering anthropometric failure was examined by comparing the mean standard of living scores for each subgroup using an analysis of variance. Fig. 1 shows that compared to children in the referent group (group A), undernourished children in each of the other groups had lower mean SLI scores. Two points are worth noting: first, the children who we thought would be most vulnerable (i.e. those in group D) did on average live in the poorest households; second, children with multiple anthropometric failures (i.e. those in groups C, D and E) had lower mean SLI scores than children with only single failures (groups B, F and Y) or no failure (A).

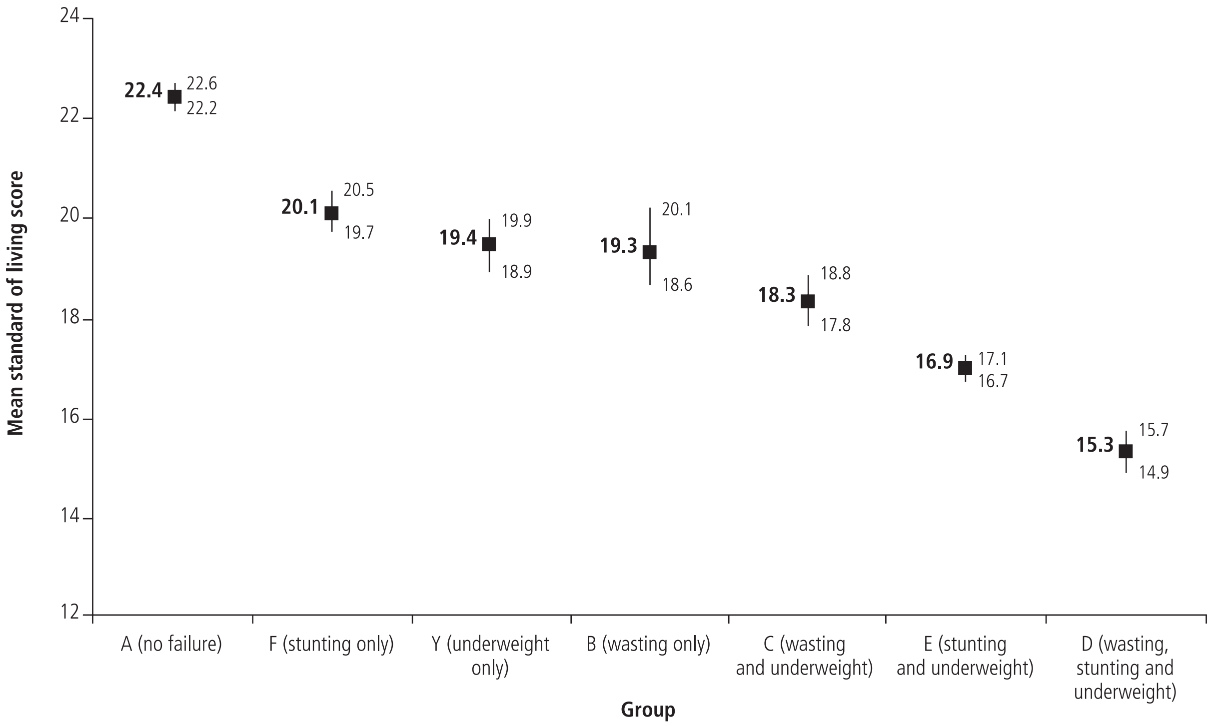
Undernutrition and morbidity

Table 3 shows the associations between the subgroups of children suffering anthropometric failure and three indices of morbidity: diarrhoea, severe diarrhoea, and acute respiratory infection.

Diarrhoea

Children with more than one anthropometric failure, i.e. those who have wasting and are underweight (group C), those who have wasting and are stunted and underweight (group D), and those who are stunted and underweight (group E), were more

Fig. 1. **Mean standard of living score (with 95% confidence interval) by type of anthropometric failure[a]**



[a] Scores calculated from data collected by 1998–99 National Family Health Survey for India.

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likely to have had diarrhoea than children with only a single failure, i.e. those who had only wasting (group B), those who were stunted only (group F) and those who were underweight only (group Y). The highest odds of diarrhoea being reported were from the mothers of children who were simultaneously wasted, stunted and underweight (group D) (odds ratio (OR) = 1.72, 95% confidence interval (CI) = 1.52–1.95).

Severe diarrhoea

Table 3 shows that children from groups D and E, who had multiple anthropometric failures, were twice as likely to have severe diarrhoea (OR for group D = 1.95, 95% CI = 1.45–2.61; OR for group E = 2.03, 95% CI = 1.66–2.49). Children who were in group Y (underweight only) also had higher odds of having severe diarrhoea than the referent group.

Acute respiratory infection

Mothers whose children had multiple anthropometric failures (i.e. those in groups C, D and E) were more likely to report that their children displayed symptoms of ARI. Children who were simultaneously stunted, underweight and had wasting (i.e. group D) had the highest odds (OR = 1.39, 95% CI = 1.23–1.58).

Discussion

This paper has shown that it is possible to construct an aggregate measure of undernutrition that identifies all undernourished children be they wasted, stunted or underweight. The CIAF provides an overall estimate of the number of undernourished children in a population, something conventional indices do not.

Using the CIAF, data on undernutrition can be disaggregated for further analyses, e.g. to see which type of anthropometric failure carries the greatest risk of morbidity or mortality (assuming the data are available). Disaggregating the data in this way enables the identification of groups of children that are missed by conventional indices. It demonstrates that large numbers of undernourished children are not identified by current methods. In Table 2, we see that underweight includes children in groups C, D, E and Y but misses those in groups B and F (13% of children in the sample); stunting misses groups B, C and Y (15% of children in the sample); and wasting misses those children in groups E, F and Y (44% of children).

There is an extensive literature that shows undernutrition is closely associated with a large proportion of child deaths (*6*, *18*), with undernourished children more likely to suffer ill-health than well nourished children (*9*, *19–23*). Undernourished children are also more likely to come from poorer backgrounds (*20*, *24*) where they do not get enough food and are exposed to poor living conditions (e.g. lacking proper sanitation or clean drinking water), which in turn lead to disease and further undernutrition. Given these associations, it is expected that children who are simultaneously stunted, underweight and have wasting (i.e. those in group D) will have the greatest risk of illness and are also more likely to be from more deprived backgrounds.

Fig. 1 shows a clear relationship between standard of living and anthropometric failure, and more importantly, that low SLI correlates with an increased risk of multiple anthropometric failures. The analyses reported in Table 2 show that children with multiple anthropometric failures are significantly more likely to experience ill-health and (it seems safe to assume) more likely to be at risk of dying (*6*, *23*, *25*). The NFHS–2

Table 3. **Age-adjusted binary logistic regressions for anthropometric failure, diarrhoea, severe diarrhoea and acute respiratory infection among Indian children aged 0–3 years.** Information on morbidity was provided by the child's mother or caregiver

Group	Diarrhoea		Severe diarrhoea		Acute respiratory infection	
	Odds ratio	95% CI[a]	Odds ratio	95% CI	Odds ratio	95% CI
A (no failure)	1.00		1.00		1.00	
B (wasting only)	1.06	0.86–1.3	0.45	0.19–1.1	0.92	0.75–1.14
C (wasting and underweight)	1.45[b]	1.27–1.65	1.19	0.82–1.73	1.28[b]	1.12–1.46
D (wasting, stunting and underweight)	1.72[b]	1.52–1.95	1.95[b]	1.45–2.61	1.39[b]	1.23–1.58
E (stunting and underweight)	1.54[b]	1.42–1.67	2.03[b]	1.66–2.49	1.34[b]	1.24–1.46
F (stunting only)	1.04	0.92–1.17	1.08	0.78–1.48	1.02	0.91–1.14
Y (underweight only)	1.19[c]	1.03–1.37	1.64[b]	1.17–2.29	1.16[c]	1.01–1.33

[a] CI = confidence interval.
[b] $P < 0.001$.
[c] $P < 0.05$.

data do not allow for an analysis of the relationship between mortality and anthropometric failure because anthropometric data were not collected for deceased children.

In our analyses, children in groups B and F (wasted only and stunted only) did not have an elevated risk of diarrhoea or acute respiratory infection. It could be argued that these groups should not be included in the definition of undernourished children because they do not suffer adverse health consequences from their anthropometric state. However, further research, using a broader range of outcomes, is required before this conclusion can be reached.

We should point to some potential limitations of this study. First, as noted above, almost one-quarter of the original sample of 32 393 children were excluded from analysis because their anthropometric measurements were considered improbable or because they were not measured or because they were dead. This could conceivably result in an underestimate of the extent of undernutrition in India because it introduces the possibility of selection bias. A review of longitudinal studies found that undernutrition (wasting and underweight) was almost twice as common among deceased children, but it concluded "studies that attempt to link the determinants of growth faltering with those of childhood mortality appear unencumbered by the issue of survivor bias" (*26*). A more recent analysis of longitudinal community-based studies on children aged less than 5 years showed that having a low weight for age (being underweight) resulted in an increased risk of mortality, particularly from infectious diseases like diarrhoea and ARI (*27*). A second limitation relates to possible reporting bias since information on morbidity and the child's age were based on maternal recall. The effects of this will be limited, however, because the time period mothers were asked about was quite recent (i.e. the previous two weeks). WHO has validated this method, and regularly uses similar questions and measures for assessing the prevalence and incidence of diarrhoea and ARI (*13*). It is possible that mistakes were made when taking anthropometric measurements from children in the survey, another limitation that needs to be considered.

There have been concerns about the appropriateness of using the NCHS reference population as the basis for international comparisons (*28*, *29*), e.g. the fact that the reference population data were compiled more than 30 years ago from children in the United States who were primarily formula-fed and therefore may be inappropriate for comparison with children from developing countries (who are mainly breastfed). The narrow ethnic and socioeconomic background of the NCHS sample has also been criticized since it does not sufficiently reflect the ethnic diversity either of the United States or the wider world. Recognizing these concerns, WHO is developing a more appropriate reference population (*30*, *31*), data from which should be available soon.

Since undernutrition is a function of both food deprivation and disease (e.g. repeated bouts of diarrhoea), which are in turn the consequences of poverty, anthropometric indices can serve only as proxies for evaluating the prevalence of undernutrition among children. While this paper has demonstrated that conventional indices underestimate the prevalence of undernutrition, Svedberg notes that such indices may in fact lead to an overestimate because "they capture those who are primarily ill for reasons unrelated to nutrition" (*4*). This implies the CIAF is also vulnerable to these limitations given that it is constructed from the conventional indices.

Conclusions

This paper has shown how, due to the nature of the indicators used, current estimates of child undernutrition may be underestimates. It has shown that an alternative indicator can be constructed to provide a single, aggregated figure of the number of undernourished children in a population. It must be emphasized, however, that conventional indices reflect distinct biological processes and cannot be disregarded, but the CIAF merits further consideration as a policy and monitoring tool for planning purposes.

Efforts to reduce undernutrition, morbidity and mortality depend on reducing poverty and raising people's living standards by improving the quality of homes and by increasing access to clean drinking water and adequate sanitation. Such interventions have positive impacts on health, and implementing these also goes some way towards fulfilling people's basic human rights. ■

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Résumé

Pauvreté, sous-nutrition infantile et morbidité : nouveaux éléments concernant l'Inde

La sous-nutrition continue d'être une cause principale de mauvais état de santé et de mortalité prématurée parmi les enfants des pays en développement. Le présent article examine la façon dont est mesurée la prévalence de la sous-nutrition chez les enfants et soutient que les indices classiques évaluant l'arrêt de croissance prématuré, l'atrophie et l'insuffisance pondérale peuvent tous sous-estimer l'ampleur du problème. Cette sous-estimation a des implications importantes pour les décideurs politiques, les planificateurs et les organisations cherchant à remplir les objectifs de développement internationaux.

A l'aide des données anthropométriques relatives à 24 396 enfants indiens, les auteurs ont construit un indice composite d'insuffisance anthropométrique (CIAF) et l'ont comparé avec les indices classiques. Le CIAF étudie la relation entre des sous-groupes distincts d'insuffisance anthropométrique, de pauvreté et de morbidité et montre que les enfants présentant des insuffisances anthropométriques multiples courent un plus grand risque de morbidité et ont une plus forte probabilité de provenir de foyers pauvres.

Tout en reconnaissant que l'arrêt de croissance prématuré, l'atrophie et l'insuffisance pondérale reflètent des processus biologiques distincts dont l'importance est évidente, les auteurs affirment que le CIAF est la seule mesure fournissant un chiffre agrégé unique du nombre d'enfants sous-nutris dans une population.

Resumen

Pobreza y desnutrición y morbilidad infantiles: nuevos datos desde la India

La desnutrición sigue siendo una causa destacada de mala salud y mortalidad prematura entre los niños en los países en desarrollo. En este artículo se examina la manera de medir la prevalencia de la desnutrición entre los niños y se sostiene que los índices habituales de retraso del crecimiento, emaciación y peso inferior al normal podrían estar subestimando, cada uno de ellos, la magnitud del problema. Esto tiene implicaciones importantes para los formuladores de políticas, los planificadores y las organizaciones que están intentando alcanzar las metas internacionales de desarrollo.

Usando los datos antropométricos de 24 396 niños de la India, se desarrolló un Índice Compuesto de Insuficiencia Antropométrica (ICIA) alternativo, que se comparó con los índices convencionales. Reflejo de la relación entre subgrupos precisos de insuficiencia antropométrica, pobreza y morbilidad, el ICIA muestra que los niños con varias insuficiencias antropométricas presentan un mayor riesgo de morbilidad y tienen más probabilidades de pertenecer a los hogares más pobres.

Si bien hay que reconocer que el retraso del crecimiento, la emaciación y la insuficiencia ponderal reflejan procesos biológicos diferenciados de indudable importancia, el ICIA es la única medida que proporciona una sola cifra agregada del número de niños desnutridos en una población.

ملخص

الفقر ونقص تغذية الأطفال والمراضة: بيِّنات جديدة من الهند

الملخص: لايزال نقص تغذية الأطفال السبب الرئيسي لاعتلال الصحة وللموت الباكر بين الأطفال في البلدان النامية. وتدرس هذه الورقة مدى قياس انتشار نقص التغذية بيت الأطفال وتفترض أن كلاً من المَناسِب القياسية للتقزُّم والهزال ونقص الوزن قد تقلِّل من تقدير المشكلة. ولهذا الأمر أثر كبير على أصحاب القرار السياسي وراسمي الخطط والمنظمات التي تحاول تحقيق الأهداف الإنمائية الدولية.

وقد تم وضع مَنْسَب مركب بديل لفشل القياسات البشرِية وذلك انطلاقاً من المعطيات المستمدة من القياسات البشرية لدى 396 طفلاً في الهند، مع مقارنة هذا المنسب مع المَناسِب المعتادة. واستخدام هذا المنسب لدراسة العلاقة بين مجموعات فرعية خاصة تعاني من فشل القياسات البشرية، ومن الفقر ومن المراضة، مما أثبت أن الأطفال الذين يعانون من فشل القياسات البشرية معرضون أكثر من غيرهم لخطر المراضة، مع احتمال أكبر لكونهم من السكان الفقراء.

ومع ملاحظة أن التقزُّم والهزال ونقص الوزن تعكس ما للعمليات البيولوجية من أهمية واضحة، فإن المنسبِ المعقد لفشل القياسات البشرية هو المقياس الوحيد الذي يعطي رقماً واحداً وتراكمياً لعدد الأطفال الناقصي الوزن بين السكان.

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