SciMedCentral

Annals of Pediatrics & Child Health

Short Communication

# The Composite Index of Anthropometric Failure: Empirical Applications

**Peter Svedberg***

*Institute for International Economic Studies, Stockholm University, Sweden*

*Corresponding author

Peter Svedberg, Institute for International Economic Studies, Stockholm University, Sweden

**Submitted:** 05 December 2023

**Accepted:** 04 January 2024

**Published:** 06 January 2024

**ISSN:** 2373-9312



## INTRODUCTION

Child malnutrition is still one of the most serious problems facing many developing countries in the world. In order to try to come to grips with this problem, I have proposed a measure of child malnutrition, which I dubbed the *Composite Index of Anthropometric Failure (CIAF).* The index is intended to serve two main purposes that previous measures of child malnutrition fail to deliver on. First, the index provides a comprehensive measure of overall prevalence of child anthropometric failure in a country ─ or the total burden of child malnutrition. Second, the index can be used to provide sub-measures of impairments that can direct anti-malnutritional interventions more efficiently than conventional measures do.

Before detailing these claims, let us start by recapitulating the CIAF model briefly with the help of Figure 1. On the horizontal axis children's height-for-specific-age is measured and on the vertical axis, weight-for-specific-age. The intersection of these two axes marks the standard anthropometric cut-off points for stunting and underweight. The south-west to north-east diagonal marks the weight-for-height norm; a child with a weight-for-height failure is found below this line (Figure 1).

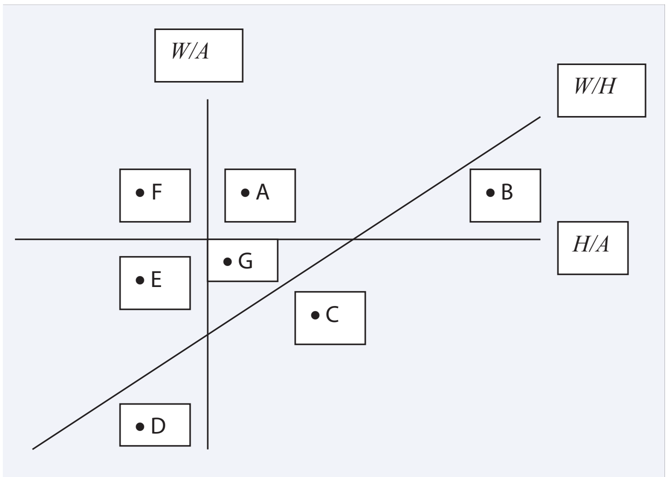


**Figure 1** The total prevalence of child anthropometric failure and the CIAF.

As we can see from the figure, there are six different categories of child anthropometric failure (we disregard overweight for the time being). Only children in section **A** do not suffer from any anthropometric failure; they are in a health-consistent condition. Children in sections B (wasted), F (stunted) and G (underweight) respectively**,** are malnourished in one dimension only (single-burden). Children in areas C and E are malnourished in two dimensions (double-burden). Finally, children in section D are failed in all three dimensions (triple-burden); they are stunted, underweight as well as wasted.

In my original work on the CIAF [1], I did not present any empirical evidence on the extent of child malnutrition as estimated in a real population. I only provided some "guesstimates" on likely orders of magnitude. The first detailed CIAF estimates were provided by Nandy et al. [2], based on data from the Indian NFHS survey (1998-99). Subsequently, Nandy and Svedberg [3], updated the index for India, based on data from NFHS (2005-06), and included obesity as an additional form of child malnutrition. They also provided estimates for seven additional countries.

The estimated CIAF and the sub-categories (A to G), based on two recent Indian NFHS surveys (2005-06 and 2015-16), have been replicated in Table 1.

First, we see what was claimed above: the prevalence of child malnutrition in India, as measured by the CIAF, is much larger than indicated by any of the single-dimension anthropometric

**Table 1:** Estimated CIAF failure by category, children 0-5 y. India

| CIAF category | Area in Figure 1 | 2005-06 | 2015-16 | Change |
|---|---|---|---|---|
| | | Percent failed | | |
| No failure | A | 38 | 45 | 7 |
| Wasted only | B | 2 | 3 | 1 |
| Stunted only | F | 15 | 13 | -2 |
| Underweight only | G | 4 | 6 | 2 |
| Wasted and underweight | C | 7 | 8 | 1 |
| Stunted and underweight | E | 25 | 18 | -7 |
| Stunted, underweight, wasted | D | 9 | 7 | -2 |
| All failure categories | B–G | 62 | 55 | -7 |

Source: Rajpal, S. et al. [4].

indicators. The highest such indicator, stunting at 13 percent in 2015-16, is only about one-fourth as high as the full CIAF Indicator (at 55 percent). The difference between the estimate based on CIAF, and the other two single-dimension indicators, is even larger. It is important to find that relatively few children suffer from single anthropometric failures, especially underweight and wasting. This suggests that stunting is the underlying explanation why children are underweight and wasted. It is also noteworthy that only 45% of the Indian children aged 0-5 years in 2015-16 are totally free from any form of anthropometric failure.

When it comes to changes over time, there are large differences in levels and rates of change depending on what sub-categories of anthropometric failure we consult. The CIAF index suggests that there has been a decline in overall child malnutrition by 7 percentage points over the 10-year period from 2005-06 to 2015-16. The change in malnutrition according to the three single-dimension indicators is smaller.

## CIAF – Indicator of child impairments and guide for interventions

In my opinion, the most important empirical question that the CIAF index can provide answers to, is not the total extent of child malnutrition. It is, in fact, to little surprise that a measure that encompasses three different manifestations of malnutrition produce larger numbers than any single-dimensional indicator. The more important studies are those that show how different sub-indices of CIAF relate to impairments of child health and other dysfunctions.

I will start by showing the main results from one particular study: McDougal et al. [5]. The reason for choosing this study is that its scope is larger and wider than in other related studies, and it is published in one of the top nutritional journals[1]. The study attempts to estimate the relationship between children's initial anthropometric failure in different sub-categories and child deaths in a subsequent period (a year).

The measure estimated is the Hazard Ratio (HR) = λ1/λ2, where λ1 is the risk of premature death of a child in an anthropometric sub-category, say those with triple-burden of failure. That is, those who are simultaneously stunted, underweight, as well as wasted. λ2 is the risk of premature death in the control group, i.e., the children in the same population with no anthropometric failure (category A in Figure 1).

An estimated HR of 2 hence means that the risk of premature death is twice as high in the target group as in the control group. An estimated HR of 10 means that the risk is 10 times higher in the target group. The main results in terms of estimated Hazard Ratios for the 10 countries in the McDougal et al. study [5], are summarized in Table 2.

The numbers in the right-most column are notable. They tell the estimated risk of death in the group of children with triple failure (children in category D in Figure1). In fact, these children are on average 12 times more likely to die within a year than children in the group with no failures. The children with only one failure face a much smaller excess death risk (1.47 to 2.49). There are also marked differences between children in Sub-Saharan Africa and South Asia. The classification of children according to the CIAF index is hence a much more accurate instrument for identifying the children at the most elevated risk of premature death than the traditional single-dimension instruments (stunting, underweight or wasting)[2]. [7,8]

**Table 2:** Estimated Hazard Ratios (HR) in ten developing countries in 1990s.

| | Single failure | Double failure | Double failure | Triple failure |
|---|---|---|---|---|
| Region (no of countries) | Stunted, underweight or wasted | Stunted and underweight | Wasted and underweight | Stunted, underweight and wasted |
| | HR | HR | HR | HR |
| | | | | |
| Africa (4) | - | 2.55 | 3.62 | 6.54 |
| Asia (5) | - | 4.08 | 5.74 | 18.64 |
| | | | | |
| Pooled (all 10 countries)[1] | 1.47–2.49 | 3.36 | 4.69 | 12.25 |

Source: McDougal et al. (2013), based on 53,767 children and 1306 deaths.
[1]Peru is the tenth country.

## Why is not CIAF applied for guiding anti-malnutrition interventions?

The hitherto analysis suggests that interventions guided by the sub-indices of the CIAF should improve targeting efficiency. Choosing first the children for the alleviation of malnourishment with a double anthropometric failure (children in category C and E in Figure1), these children face a risk of premature death about three times larger than healthy children in the absence of intervention. If instead, one targets children who with the CIAF measures have a triple-burden anthropometric failure (stunted, underweight and wasted), we have a chance to save children who have a 12-fold risk of dying. These are the numbers suggested by the McDougal et al. [5], study, as cited in Table 2. However, to my knowledge, not a single intervention based on CIAF estimates has been conducted so far. There are at least three possible reasons for the absence of such studies.

One reason is perhaps a widespread lack of knowledge of the large excess death risk facing children with CIAF handicaps, and the ensuing chance of advancing intervention efficiency, i.e., enhancing the survival ratio in the targeted population. The study by McDougal et al., cited above has been published in one of the leading nutritional journals and should have been widely read. There are a dozen other studies with similar results that are also

[1]*One of the first studies to show increased prevalence of various child diseases with multiple anthropometric failure, based on the CIAF categories, was Nandy et al (2005).*

[2]*There are additional studies that show similar results when it comes to the excess risk of child death. There are also other studies that have used the CIAF classification to estimate risks of other impairments than premature death. Examples are the risks of anemia in pre-school children in West Africa (Magalhäes et al., 2011) and delayed psychomotor development of children in Pakistan (Avan et al., 2015).*

published in peer-reviewed international journals[3]. Moreover, the World Health Organization [6], has so far not published a recommendation to base interventions on the CIAF indicators. It may take time for WHO and other international organizations dealing with child nutrition and health to provide new guidelines, but perhaps better late than never.

A second reason why there are no studies on interventions based on the CIAF indicators is the lack of knowledge of how to best design such interventions. Children suffering from triple-burden anthropometric (or double-burden) failure in many developing countries, probably suffer from both (several) diseases and primary malnutrition in an intertwined and complicated manner. The intervention can in such cases not simply be the provision of energy-dense food. It also requires a thorough medical examination to identify what diseases the individual child suffer from (if possible) and the finding of the most promising remedies. This is, at best, the way severely anthropometrically failed children in advanced and rich countries are treated. This is, however, a very costly and time-consuming intervention.

This fact leads to a third possible explanation for the lack of interventions based on anthropometric CIAF indicators: high economic cost[4]. In rich Western countries, there are most probably many estimates of the overall costs in terms of money and medical personnel involved in the treatment of severely anthropometrically handicapped children. Such studies should be carefully examined in order to find out what could be learnt for conducting such studies in poor countries with rudimentary health-care systems. It may well be that parts of such treatments can be afforded also in developing countries.

## SUMMARY AND CONCLUSION

We have claimed that the CIAF is a more accurate measure of the total extent of child malnutrition than the conventional single-dimension indicators used in most hitherto studies. The index is also a more precise indicator of the mortality and other risks facing children in developing countries. Moreover, the index shows that rather few children suffer from single-burden failures of underweight and wasting. Stunting is the most prevalent form of child malnutrition, which indicates that remedies are more difficult to design than simple weight problems.

The main advantage with anthropometric measures is that the status of children - weight and height - are very easy to measure accurately. An additional advantage is that there is no need for assessing how many units of calories and micronutrients a person consumes or expends for metabolism and physical activity. Anthropometrics simply reflect the (im) balance between intakes and expenditures (as measured by body size). Another advantage is that anthropometric indicators can provide detailed maps of the concentration of malnutrition along age-, gender and geographical lines, important for targeting interventions efficiently. A further advantage is that the anthropometric norms are universal, at least for children below the age of five [6].

This is not, however, to claim that CIAF and anthropometric observations are fault-free indicators that could readily be applied to direct anti-malnutrition interventions. When children suffer from a combination of disease and primary malnutrition, remedies are always very costly. This is probably the chief reason why the CIAF has not been applied for directing intervention.

## REFERENCES

1. Svedberg P. Poverty and Undernutrition: Theory, Empirics and Policy, Oxford University Press. 2000.
2. Nandy S, Irving M, Gordon D, Subramanian SD, Smith GD. Poverty, Child Undernutrition and Morbidity: New Evidence for India, Bulletin of World Health Organization. 2005; 83: 210-216.
3. Nandy S, Svedberg P. The Composite Index for Anthropometric Failure (CIAF): An Alternative indicator of malnutrition in young children. In Handbook of Anthropometry: Physical Measures of human Form in Health and Disease, ed. V Preedy. London: Springer-Verlag. 2011.
4. Rajpal S. FAQ on Child Anthropometric Failure in India. Harvard CPDS Working Paper, volume 18, number. 2018
5. McDougal CM, Olofin I, Flaxman S, Fawzi WW, Speigelman D, Caulfield LE, et al. The effect of Multiple Anthropometric Deficits on Child Mortality: Meta-analysis on Individual Data in 10 Perspective Studies from Developing Countries. Am J Clin Nutrit. 2013; 97: 896-890
6. WHO. WHO growth Standards: Methods and Developments. Geneva WHO. 2006.
7. Avan B, Raza SA, Kirkwood BR. An Epidemiological Study of Urban and Rural Children in Pakistan: Examining the relationship between delayed psychomotor Development and Low Birth Weight", Transactions of the Royal growth of Tropical Medicine and Hygiene. 2015; 109: 189-196.
8. Magalhäes P, Clements ACA. Mapping the Risk of Anemia in Pre-school age Children: the Contribution of Malnutrition, Malaria and Helminth Infection in West Africa. PLsO Med. 2011; 8: e1000438

[3]*Google Scholar shows that several dozen peer-reviewed studies have been published in which the CIAF index has been estimated. All these studies, from every geographical region in the world, show the same main results. The extent of child overall malnutrition is much larger than conventionally presumed; the burden of child malnutrition is severely underestimated by conventional indicators.*

[4]*Another possible reason could be that there are non-anthropometrically based indicators of child malnutrition that should better direct interventions. The main other indicators suggested in the literature are self-reported hunger (mainly from India) and estimates based on food availability (FAO). These measures are blunt methods for estimating the prevalence of malnutrition at the level of large populations but cannot be relied upon for identifying malnutrition in individual children*