Technical Note
How to calculate Average Annual Rate of Reduction (AARR) of Underweight Prevalence

Statistics and Monitoring Section/Division of Policy and Practice/UNICEF
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Background

In the analysis for monitoring and evaluation of the global trend in underweight prevalence among children under five, a statistic is needed to quantify the rate of change of the prevalence from baseline to the current year.

Introduction

Change in prevalence is assumed to take an exponential function similar to the one calculated as "compound interest rate" in financial terms. For any given year t, if the prevalence is known to be Y_t, and the annual rate of reduction is constantly $b\%$, then the prevalence of the next year, denoted as Y_{t+1}, can be calculated as:

$$Y_{t+1} = Y_t*(1-b\%)$$

Similarly, for any later year $t+n$,

$$Y_{t+n} = Y_t*(1-b\%)^n$$

When AARR, i.e. $b\%$ in the formula above, is unknown, it can be estimated based on Y_t, Y_{t+n} and n.

Estimating AARR

When prevalence estimates are available for multiple years in a country, the AARR can be calculated using a regression analysis as follows

If the prevalence in a baseline year t_0 is Y_0 (both can be unknown) and five data points after t_0 are available for trend analysis, then each of the five points can be written as:

$Y_{ti} = Y_0*(1-b\%)^{(t_i-t_0)}$, so that

$\ln(Y_{ti}) = \ln(Y_0) + (t_i-t_0)*\ln(1-b\%) = \ln(Y_0) + t_i*\ln(1-b\%) - t_0*\ln(1-b\%) = \boldsymbol{\beta * t_i + C_0}$

Where $\beta = \ln(1-b\%)$ and $C_0 = \ln(Y_0) - t_0*\ln(1+b\%)$, a constant

β , the coefficient of t_i , in a simple linear regression of $\ln(Y_i)$ against t_i can then be translated into $b\%$, the AARR, by the following formula:

AARR = 1 - EXP(β)

An example: Data points of China

Country	Year	Prevalence (%)	Log of prevalence
China	1987	21.3	3.06
China	1990	19.1	2.95
China	1992	16.2	2.79
China	1995	14.5	2.67
China	1998	10.3	2.33
China	2000	10	2.30
China	2002	7.8	2.05

A linear regression of ln(Y) on Year estimated a **β** of -0.06613, thence an **AARR** of **6.4%**. The graph below shows a linear association between the log of prevalence and year.