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:

\[
Y_{t+1} = Y_t \times (1-b\%)
\]

Similarly, for any later year \( t+n \),

\[
Y_{t+n} = Y_t \times (1-b\%)^n
\]

When AARR, i.e. \( b\% \) in the formula above, is unknown, it can be estimated based on \( Y_n \), \( Y_{t+n} \) 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:

\[
Y_t = Y_0 \times (1-b\%)^{(t-t_0)\times t}
\]

so that

\[
\ln(Y_t) = \ln(Y_0) + (t-t_0)\times \ln(1-b\%) = \ln(Y_0) + t\times \ln(1-b\%) - t_0 \times \ln(1-b\%) = \beta t + C_0
\]

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

\[ \beta \]

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

\[
\text{AARR} = 1 - \exp(\beta)
\]
Technical Note, AARR of Underweight Prevalence

An example: Data points of China

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>Prevalence (%)</th>
<th>Log of prevalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>1987</td>
<td>21.3</td>
<td>3.06</td>
</tr>
<tr>
<td>China</td>
<td>1990</td>
<td>19.1</td>
<td>2.95</td>
</tr>
<tr>
<td>China</td>
<td>1992</td>
<td>16.2</td>
<td>2.79</td>
</tr>
<tr>
<td>China</td>
<td>1995</td>
<td>14.5</td>
<td>2.67</td>
</tr>
<tr>
<td>China</td>
<td>1998</td>
<td>10.3</td>
<td>2.33</td>
</tr>
<tr>
<td>China</td>
<td>2000</td>
<td>10</td>
<td>2.30</td>
</tr>
<tr>
<td>China</td>
<td>2002</td>
<td>7.8</td>
<td>2.05</td>
</tr>
</tbody>
</table>

A linear regression of ln(Y) on Year estimated a $\beta$ of -0.06613, thence an AARR of 6.4%.

The graph below shows a linear association between the log of prevalence and year.

![Graph showing linear association between log of prevalence and year]