
2.7 Application I: tracking a Sustainable Development Goal

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The Sustainable Development Goals (SDG) formulated by the United Nations (UN) set targets to promote prosperity while protecting the planet. One or more indicators quantify the progress towards each target.

This section explores the use of the D-score to monitor the progress of the indicator for healthy child development, SDG 4.2.1. We propose a method to define on-track development and show how the application of this method pans out for the GCDG data. More in detail, the section deals with the following topics:

- Estimating SDG 4.2.1 indicator from existing data (2.7.1)
- Defining *developmentally on track* (2.7.2)
- Country-level estimations (2.7.3)
- Relation to other estimates (2.7.4)

2.7.1 ESTIMATING SDG 4.2.1 INDICATOR FROM EXISTING DATA

The UN Sustainable Development Goals form a universal call to action to end poverty, protect the planet and improve the lives and prospects of everyone, everywhere. All UN Member States adopted the 17 Goals in 2015. The SDG 4 target to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. SDG 4.2 reads as:

By 2030, ensure that all girls and boys have access to quality early childhood development, care and preprimary education so that they are ready for primary education.

To measure progress, the UN defined indicator 4.2.1 as follows:

Proportion of children under 5 years of age who are developmentally on track in health, learning and psychosocial well-being, by sex.

On July 22, 2020, the indicator was changed into

Proportion of children aged 24–59 months who are developmentally on track in health, learning and psychosocial well-being, by sex.

The exclusion of children 0–24 months is at variance with the importance of healthy growth and development during the first 1000 days of life. Indeed, the UN restricted the age range for practical concerns. Loizillon *et al.* (2017) report:

The initial recommendation was for the ECDI to measure child development from birth–5 years, but the range was restricted to 3–5 years due to time and resource constraints and limited availability of comparable measurement tools for children under age 3.

The careful scientific approach underlying the D-score fills the gap for children aged 0–24 months. Also, the D-score methodology enables extensions to ages beyond 24 months, permits back-calculation of D-scores from existing data, and acts as a linking pin to compare child development from birth onwards.

The cohorts included in the GCDG study represent a wide range of countries and instruments (see Section 2.2.1). Combining existing data from such a wide range of countries to create the D-score, is undoubtedly challenging, but doable. Although, in all fairness, we note that obtaining accurate comparisons between world-wide populations requires additional representative (existing) data beyond what is available here.

2.7.2 DEFINING DEVELOPMENTALLY ON TRACK

In 2006, the World Health Organization (WHO) published the WHO Child Growth Standards. These standards specify “how children should grow” and form the basis for widely used anthropometric indicators such as stunting and wasting. We advocate a similar approach for child development. More in particular, the following steps:

1. Measure child development on an interval scale;
2. Estimate the age-conditional reference distribution for normal child development;
3. Define the indicator *developmentally on track* as the proportion above a chosen cut-off.

Step 1 is solved by the D-score. Step 2 borrows from well-tested statistical methodology for constructing growth standards (Borghi *et al.*, 2006). Step 3 can be done in different ways, but applying a simple cut-off fits easily with regular practice in reporting international comparisons.

Figure 2.7.1 demonstrates steps 2 and 3 in more detail. In the online visualization you can click “Next” to advance these series of six steps:

1. Plot the D-score by age;
2. Model the relation between age and D-score by an LMS model. In practice, this amounts to smoothing three curves representing the median, coefficient of variation and the skewness.
3. Present the centile lines for the model;
4. Plot the age-standardized scores for development (DAZ);
5. Draw standard deviation lines to indicate the location at ± 1 and ± 2 standard deviation from the mean;
6. Count observations above the -2 SD line as on-track. Count observation below the -2 SD line as off-track (red dots).

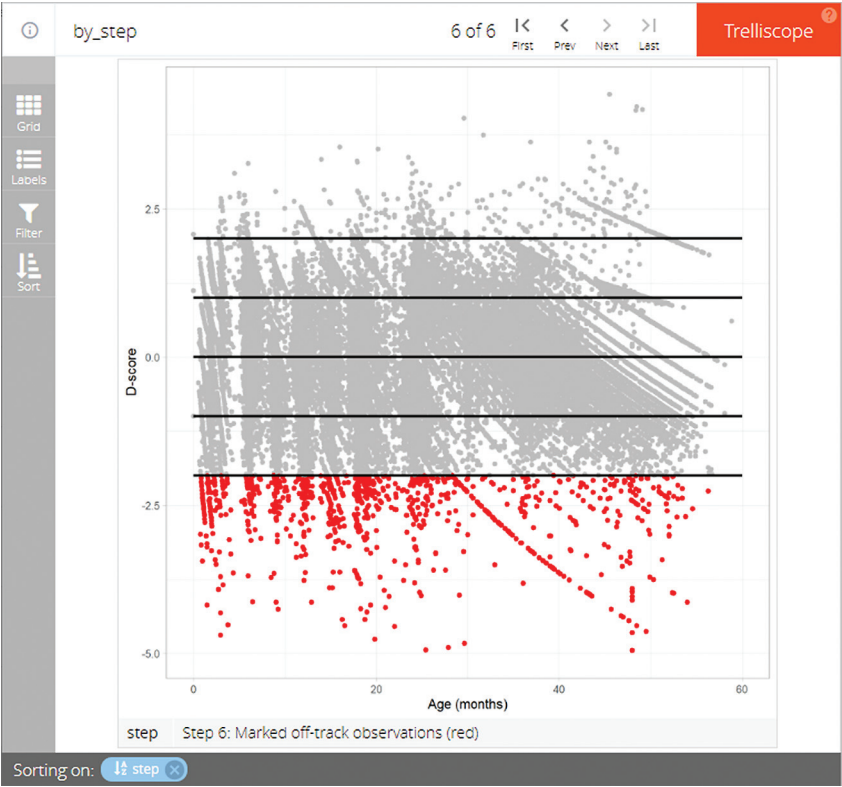


FIGURE 2.7.1 Illustration of the method to define on-track development (<https://d-score.org/dbook-apps/gcdreferences/>).

Note: The SD lines as presented in Figure 2.7.1, are built upon on a convenience sample. The GCDG cohorts are not representative samples, and the countries are not representative of the world. While we should not over-interpret these references, they play a central role in a stepwise, principled approach to define “developmentally on track.”

2.7.3 COUNTRY-LEVEL ESTIMATIONS

Using the definition from the previous section, we can calculate the percentage of children that are developmentally on track. Table 2.7.1 summarizes this statistic by country. At a cut-off value of -2 SD, we expect that about 97.7% of the children will be on track. The actual country estimates fall into the range 93.9 - 99.9 and are thus near the theoretical value. This close correspondence shows that the definition and estimation procedure work as expected.

Bear in mind that the measurements leading up to these estimates come from different instruments. It is gratifying to see how well we can do with historical data, thanks to the robust underlying measurement model. Of course, comparability only gets better if all countries would use the same instrument. However, using the same tool everywhere is not a requirement.

2.7.4 OFF-TRACK DEVELOPMENT AND STUNTED GROWTH

Weber *et al.* (2019) thoroughly discuss concurrent, discriminant and predictive validity of the D-score using the GCDG data. In this section, we concentrate on the relation between the D-score and stunting, a popular measure of impaired height growth in children due to nutrition problems. The WHO defines stunted growth as a height-for-age Z-score below the -2 SD line of the WHO Child Growth Standards ($HAZ < -2.0$).

TABLE 2.7.1
Percentage of on-track children per country.

Country	Percentage on-track
BGD	94.9
BRA	99.5
CHL	98.3
CHN	99.9
COL	98.8
ECU	93.9
ETH	99.4
JAM	99.6
MDG	96.6
NLD	96.8
ZAF	97.4

Figure 2.7.2 plots the percentage off-track and percentage stunting per country. This plot reveals two exciting features:

- *The variation in stunting is much larger than the variation off-track development.* One might speculate that height is more dependent on the environment than off-track development, and hence more variable.
- *Stunted growth and off-track development are unrelated.* Ranking countries by stunting or by off-track development yields substantially different orders. This finding provides clear counter-evidence to the argument that stunted growth is as a proxy for delayed development. It may even be the case the child development and physical growth are different maturation processes that develop largely independently.

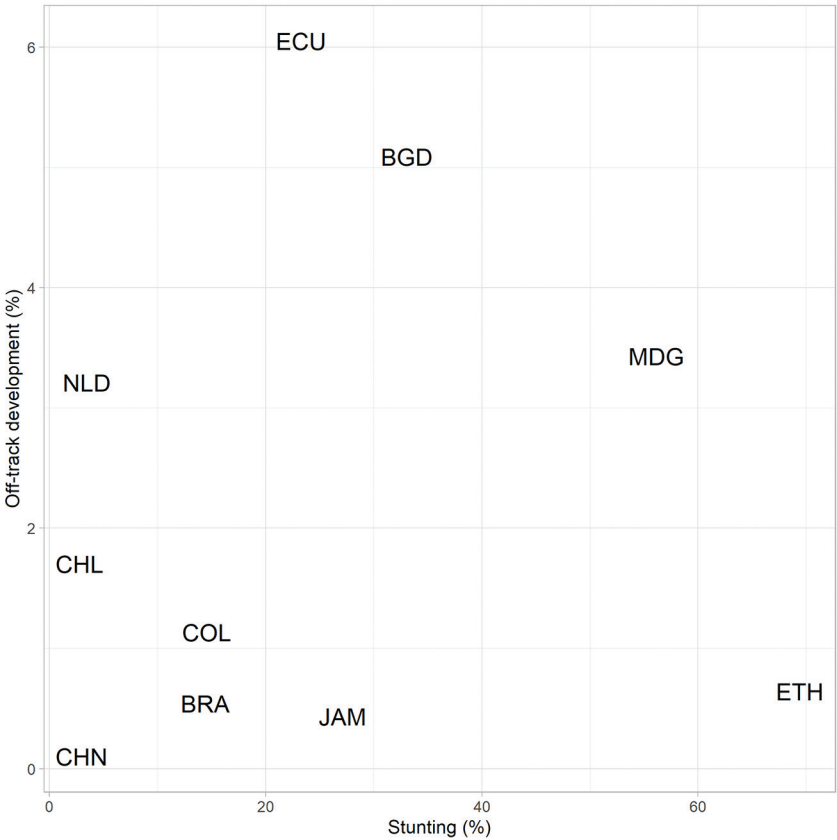


FIGURE 2.7.2 Off-track development (%) versus stunting (%) per country.

However, this is not the whole story. Figure 2.7.3 reveals a consistent difference in DAZ between stunted and non-stunted children of about 0.2-0.3 SD. There could be factors at the child level that affect both development and height growth. For example, low-income families may lack the resources for adequate nutrition, which may impact both child development and physical growth.

The exact nature of the relation between stunting and development is still obscure. The D-score provides a means to study the intriguing interplay between both measures in more detail.

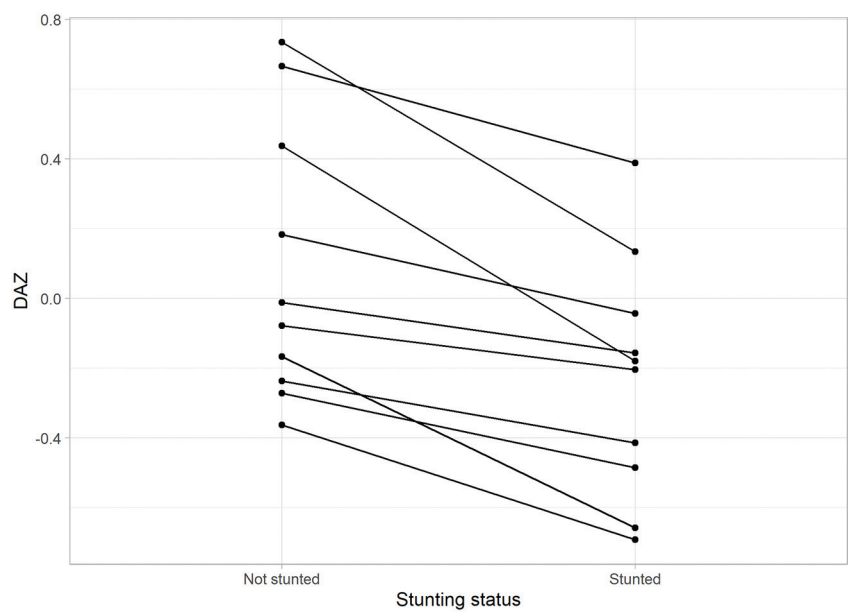


FIGURE 2.7.3 Difference in mean DAZ per country between stunted and not stunted children.