Estimating the Impact of Two Common Risk Factors for Stunting – Inadequate Dietary Diversity and Teenage Pregnancy: Models in PROFILES for Country-Level Advocacy

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Introduction

Malnutrition has significant negative consequences for many developing countries, particularly in terms of poor human health, lost human capital, and decreased economic productivity. Investment in nutrition was identified in 2012 by the Copenhagen Consensus (Copenhagen Consensus 2012) as a best investment for developing countries; for every US$1 spent on nutrition, there is a US$16 return in health and economic benefits (International Food Policy Research Institute 2015). Despite this, funding and support for nutrition programming is often lacking.

To address this urgent need for attention and commitment to reducing malnutrition, the U.S. Agency for International Development (USAID)-funded Food and Nutrition Technical Assistance III Project (FANTA) at FHI 360, supports evidence-based country-level nutrition advocacy. The approach FANTA uses engages governments and national stakeholders to develop a shared vision and promote accountability and commitment for nutrition using a tool called PROFILES. Developed to support country-level nutrition advocacy, PROFILES

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Nutrition advocacy is a planned, systematic, and deliberate process that is defined and shaped by the specific-country context. FANTA's nutrition advocacy planning process engages national stakeholders by using a participatory and consensus-building approach toward a shared national vision for nutrition. It can support a given country at any stage along the way to providing nutrition services and reducing malnutrition. A central focus of the process is to promote accountability for nutrition and strengthen nutrition governance. For example, it can serve to support the development of a nutrition policy, encourage investment of resources to strengthen and expand implementation of nutrition services, and increase greater coordination between government and nongovernmental organizations that play a role in providing nutrition services across a country. By examining the context of the nutrition situation and tailoring advocacy needs to that situation, advocacy can be more effective in igniting change and making strides toward the desired outcome.

FANTA has created a **manual** that provides step-by-step instructions for facilitating a country-level nutrition advocacy planning process using the PROFILES nutrition advocacy tool and nutrition costing. Based on a process FANTA developed by facilitating nutrition advocacy in developing countries, the manual includes planning guidance; session plans and handouts for workshops and meetings; presentations with notes; and templates.

consists of a set of computer-based models that calculate consequences if malnutrition does not improve over a defined time period (e.g., 10 years) and the benefits of improved nutrition over the same time period, including lives saved, disabilities averted, human capital gains, and economic productivity gains. The estimates generated from the tool and its models are the cornerstone of the nutrition advocacy process and can be used to identify, prioritize, and advocate for evidence-based actions to reduce malnutrition. PROFILES estimates are calculated assuming there are reductions in the prevalence of country-specific nutrition indicators, such as iron deficiency anemia, low birth weight, vitamin A deficiency, iodine deficiency, suboptimal breastfeeding practices, and childhood chronic and acute malnutrition (i.e., stunting, underweight, and wasting). The country-specific information that is needed to calculate the estimates is discussed and agreed upon by participants during an in-country participatory PROFILES workshop.

In 2017, FANTA updated PROFILES to include two new models that estimate the number of children with stunting related to two risk factors of stunting: inadequate dietary diversity among children age 6–23 months and being born to a teenage mother age 19 or younger. Estimates calculated by these models refer to the number of children 24–35 months who are stunted related to each of the two risk factors and the number of these children for whom stunting is averted related to reduced prevalence of the risk factors. The models were developed to bring additional attention to stunting, one of the long-standing and intractable nutrition problems in many developing countries. This brief explains why the models were developed, how estimates are calculated, and how the estimates can be used for nutrition advocacy.

Why Advocate for a Reduction in Stunting?

Globally, it is estimated that nearly 155 million children under 5 years of age are stunted or short for their age (measured as low height-for-age) (United Nations Children's Fund, World Health Organization, World Bank 2017). Evidence shows that the period from pregnancy through the first 2 years of life (known as the first 1,000 days) is a critical window of opportunity for the prevention of malnutrition, as after a child's second birthday it becomes increasingly difficult to reverse growth faltering and prevent stunting (Victora et al. 2010; Martorell et al. 1994). The majority of a child's brain development is complete by age 2 and malnutrition during this time increases the risk of developmental and cognitive delays in children (Wachs et al. 2014). As such, stunting is a marker for both chronic malnutrition and consequently poor child development outcomes. Stunting often begins in utero due to young maternal age and/or poor maternal nutrition and continues during the first 2 years of life due to inadequate hygiene and infant and young child feeding practices, and results in the failure to reach one's genetic potential for height (Frongillo 1999; Golden 2009, Fink et al. 2014).

> Globally, it is estimated that nearly 155 million children under the age of 5 are stunted. Outcomes associated with stunting include:
>
> - Increased risk of mortality
> - Poor health and increased disease risk
> - Developmental delays
> - Diminished ability to learn and lower school achievement
> - Reduced lifelong productivity

Globally, 45 percent of under-5 child mortality is attributable to various forms of malnutrition, of which stunting is a significant contributor (Black et al. 2013). Children who are stunted are at an increased risk for repeated infections and are more likely to die from diarrhea, pneumonia, and measles, and may be at an increased risk in adulthood for chronic diseases such as cardiovascular disease (ibid.).

Childhood stunting is associated with developmental delays that can significantly and adversely impact a person's ability to learn (both during and after schooling) and a person's ability to reach their full potential. It is associated with impaired socio-emotional, motor, and cognitive development. A stunted child may have altered socio-emotional behaviors, including increased apathy, negative affect (e.g., crying and fussiness), and reduced activity, play, and interest in exploring their environment (Gardner et al. 1999). These negative behaviors often reduce the level of stimulation children receive from their interactions with the environment and their caregiver, further impeding their development (Yousafzai et al. 2012).

Stunting is associated with poor performance on cognitive tests, including deficits in literacy, numeracy, reasoning, and vocabulary (Grantham-McGregor and Baker-Henningham 2005). It is also associated with lower overall school achievement, and stunted children are more likely to be older at school enrollment, repeat grades, be absent from school, drop out of school, and fail at least one grade (Grantham-McGregor et al. 2007; Martorell et al. 2010). Losses in learning are not only related to fewer overall years in school and therefore lost learning potential (i.e., due to late enrollment or repeated grades), but once children are in school they have a reduced capacity to learn, meaning they learn less per school year (Grantham-McGregor et al. 2007). For example, a stunted child in third grade is more likely to read and understand math at a first-grade level compared to a non-stunted peer who is able to learn at grade level or above grade level. In fact, it is estimated that the deficit in school grades attained, combined with the deficit in learning ability, results in a deficit of 2.91 grade equivalents (ibid.). Among stunted children who are also poor, this rises to a total deficit of four years in grade equivalents because poverty compounds the risk for poor child development.

Loss in learning among stunted children has a direct impact on their income-earning potential. The 2007 *Lancet* series on child development estimates that every additional year of schooling increases adult yearly income by 9 percent (ibid). A study conducted in the Philippines found that stunting at 2 years of age was associated with a reduced likelihood of formal employment (a form of higher wage employment) (Carba et al. 2009), while a large cross-sectional study in Brazil found that a 1 percent increase in height was associated with a 2.4 percent increase in wages (Thomas and Strauss 1997). In addition, a follow-up to a large-scale supplementation trial conducted in Guatemala between 1969–1977, which provided children with the nutrient-rich supplement *atole*, found that when the men in the cohort were 26–46 years of age, those who had received the *atole* supplement between birth and 2 years of age were taller and had 46 percent higher average wages as compared to men who received a less nutritious supplement when they were 2 years or less in the control villages (Hoddinott et al. 2008). Taken together, stunting's impact on cognitive development, reduced learning and educational attainment, and subsequently lower productivity leading to reduced wages is a significant impediment to national development.

FANTA developed two models that estimate the risk of stunting related to inadequate dietary diversity and teenage pregnancy (two risk factors of stunting) to support evidence-based country-level nutrition advocacy.

Why Are the PROFILES Models Relevant?

Many developing countries have succeeded in implementing programs at scale to reduce several nutrition problems, such as iodine deficiency by iodizing salt and vitamin A deficiency by distributing vitamin A capsules to supplement children under age 5 through child health days. For countries that have consequently reduced or eliminated iodine and vitamin A deficiencies and where wasting prevalence is below 5 percent, the more intractable problems that remain—for which PROFILES can calculate estimates—are stunting and iron-deficiency anemia. Interventions to address iron-deficiency anemia are relatively efficacious and effective, although programmatic implementation at scale remains difficult. In contrast, for all countries where stunting is prevalent, reducing stunting is more complex and requires a wide range of interventions implemented in tandem and at scale. For example, a comparative risk assessment analysis across 137 countries estimated the number of children 2 years of age with stunting attributable to 18 different risk factors (Figure 1) (Danaei et al. 2016). The authors of that study conclude that programs to prevent stunting should shift from a narrow focus on infants and children to include improvements in the general living conditions of mothers and families (ibid.). For the purposes of nutrition advocacy, it is therefore important to convey the complexity of reducing stunting and consider how addressing each risk factor could contribute to reducing the prevalence.

For this reason, FANTA developed two additional models that are included in the PROFILES workbook to quantify the reduction in stunting if dietary diversity in children age 6–23 months were improved and if the proportion of births to mothers below age 20 were reduced. The two models focus on two common risk factors for stunting for which we have both an adequate body of research to develop the models and sufficient country-level survey data to calculate the impact on stunting prevalence.

Figure 1. Risk Factors of Stunting

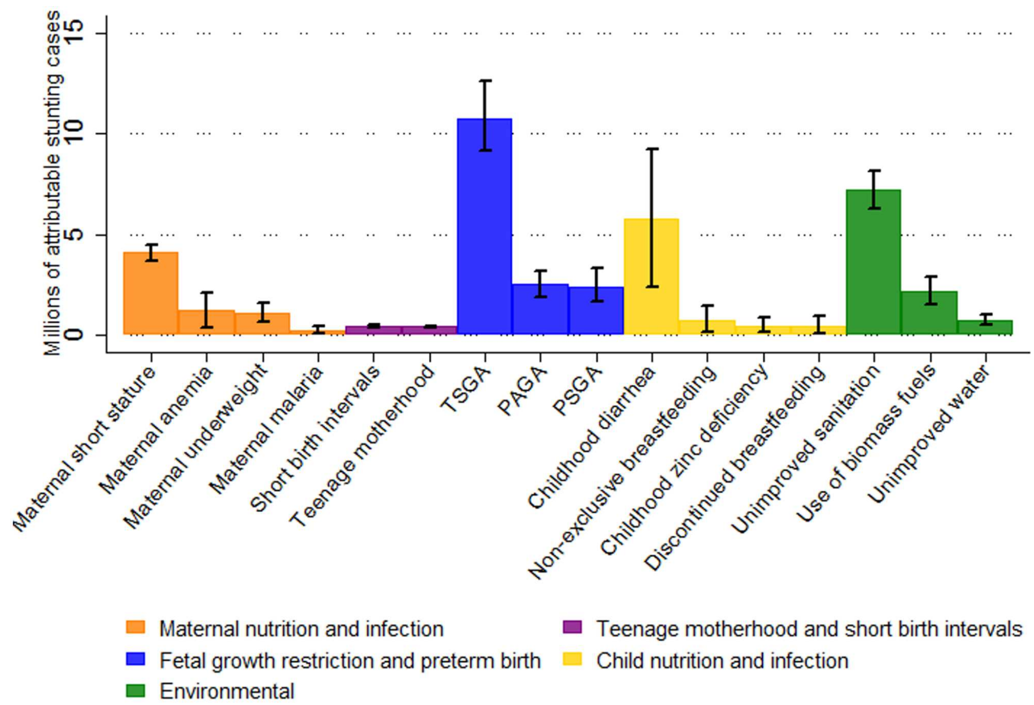

Fig 1. Risk factors ranked within each cluster by number of attributable stunting cases in children aged 2 y in 137 developing countries in 2011. Whiskers indicate 95% confidence intervals. Effects are not additive because each case of stunting can be attributed to more than one risk factor. Untreated HIV infection is not included because exposure data for all countries were not available. PAGA, preterm, appropriate for gestational age; PSGA, preterm, small for gestational age; TSGA, term, small for gestational age.

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Source: Danaei et al. 2016.

Inadequate dietary diversity. Among the many factors thought to influence child health and nutrition, including stunting, complementary feeding (after 6 months, when breast milk alone is no longer sufficient) is among the most important. Stunting typically begins and increases among children 6–23 months of age (during the complementary feeding period), since children that age have high demands for nutrients but often suffer from inadequate quantity, quality, and diversity of foods. Also, exposure to pathogens due to the introduction of unhygienic foods can cause illness and reduce the body's ability to absorb nutrients. However, although complementary feeding is a complex set of behaviors with many dimensions, dietary diversity during the critical period from 6–23 months has proven to be the aspect most consistently correlated with child growth (Onyango et al. 2013, Arimond and Ruel 2004, Marriott et al. 2012).

In 2007, the World Health Organization (WHO) released definitions for a set of infant and young child feeding indicators that have been recommended for global use to track progress and trends in infant feeding practices, and these indicators have been included in the Demographic Health Surveys (DHS), the Multiple Indicator Cluster Surveys, and are now used as standard indicators in many population-based surveys that seek to measure infant and young child feeding practices (WHO 2007). Among these indicators, the dietary diversity indicator has been consistently shown to be associated with the prevalence of stunting. The availability of this indicator for most countries is another reason why this model was created.

> Optimal complementary feeding practices include: continued breastfeeding, appropriate timing of introduction of complementary foods, and optimum quantity and quality of the foods consumed (WHO 2010).

Teenage pregnancy. Another risk factor for stunting is young maternal age (19 years or younger). Young maternal age is associated with poor maternal health and nutrition and with a variety of adverse consequences for the child, such as poor birth outcomes and growth deficits, including stunting (Ramakrishnan et al. 2012; Black et al. 2013). Adolescent pregnancy is associated with a 50 percent increased risk of stillbirths and neonatal deaths, and an increased risk of low birth weight, premature birth, asphyxia, and maternal mortality (Bhutta et al. 2013; Black et al. 2013). In fact, children born to adolescent mothers weigh, on average, about 200 g less than those born to adult women (WHO 2011). The connection between teenage pregnancy and reduced birthweight is critical, as according to the 137-country analysis by Danaei et al. (2016) cited above, fetal growth restriction and preterm birth was the leading risk factor for stunting (Figure 1). In addition, an analysis of data from 153 DHS surveys from 61 low- and middle- income countries on the impact of early childbearing on child nutrition found that the risk of stunting was 38 percent higher among firstborn children of adolescent mothers age less than 18 years than firstborn children of adult women age 27–34 years (Fink et al. 2014). However, the relationship between teenage pregnancy and child stunting can depend on socioeconomic status and tended to be stronger in urban settings. It also varied across countries and regions (Fink et al. 2014). Although the relationship between teenage pregnancy and child stunting may depend on the context, there is a need in all countries to appreciate the potential impact of improvements on the timing of pregnancy and childbirth. The availability of information on the proportion of births that are to teenage mothers among births to mothers of all ages in the DHS country reports is another reason why this model was created.

It is important to stress that although the two models illustrate how stunting could be reduced by addressing the two risk factors, unless the many other risk factors for stunting are also addressed, the prevalence of stunting would likely remain high.

Global evidence has established that to effectively prevent stunting, a broad public health approach is essential (WHO 2014b). Intensive efforts across multiple levels and by various stakeholders are required not only to support national-level policy changes but also community-level implementation of effective interventions and services. This requires advocacy to create an enabling environment for political commitment, multisectoral collaboration, and integrated service delivery.

The World Health Assembly's 2025 Global Nutrition Targets

"Recognizing that accelerated global action is needed to address the pervasive and corrosive problem of the double-burden of malnutrition, in 2012 the World Health Assembly (WHA) unanimously agreed to a set of 6 global nutrition targets that by 2025 aim to:

- Achieve a 40% reduction in the number of children under 5 who are stunted
- Achieve a 50% reduction of anemia in women of reproductive age
- Achieve a 30% reduction in low birth weight
- Ensure there is no increase in childhood overweight
- Increase the rate of exclusive breastfeeding in the first 6 months up to at least 50%
- Reduce and maintain childhood wasting to less than 5%"

Source: WHO. 2014a. *Global Nutrition Targets 2025: Policy Brief Series.* Geneva: WHO.

The World Health Assembly (WHA) has set the goal of reducing the number of children under 5 who are stunted by 40 percent by 2025 (WHO 2014a) and USAID, as described in its Multi-Sectoral Nutrition Strategy, seeks to reduce stunting by 20 percent over the next 5 years (USAID 2014). Country-level advocacy to promote a multisectoral approach is essential to address the multiple causes of stunting, which will enable countries to mitigate the harmful effects on their population and fulfill their national commitments to the WHA targets to reduce stunting and child mortality. In addition to the existing models in PROFILES that estimate the impact of stunting on mortality, economic productivity, and human capital, the two new models can be used to highlight the multiple causes of stunting and bring attention to the need for a multisectoral and multi-pronged approach. The two models also provide a starting point for country-specific discussions that focus not only on the detriments of stunting but how the problem can be addressed.

Information Needed to Generate PROFILES Estimates

Every model in PROFILES utilizes the following information to generate estimates:

- A **time period** to determine the number of years for which the estimates should be calculated (e.g., 10 years).
- **Prevalence information** provides the magnitude of the nutrition problem (for example, percent of children 24–35 months who are classified as moderately and severely stunted). Current prevalence information is needed to serve as a baseline for the equations in the model.[a] Information on dietary diversity and teenage pregnancy are often included in nationally representative household surveys such as the Demographic and Health Survey (DHS) and Multiple Indicator Cluster Surveys.[b]
- **Targets** are set to determine what the goal should be with regard to prevalence of the nutrition problem at the end of the given time period (e.g., reduce stunting prevalence from 40 percent to 18 percent). The targets reflect the proportion by which the nutrition problem will be reduced (or in this case improved) over the chosen time period and therefore influence the outcome of interest.[c]
- **Demographic information** serves as the basis for the population projections by providing population size and structure.
- **Mortality, economic, employment, or education-related information** provides details to estimate the outcome of interest. This information is needed to compute the consequence of the nutrition problem on the outcome of interest.

a PROFILES uses the best available, most recent information on point prevalence, which is the prevalence at a point in time, often referred to as a snapshot of a population.

b See Sethuraman et al. (2018) for more information on how to calculate the proportion (among all births) of children born to mothers less than 20 years of age (%) from the DHS or other relevant resources.

c It is important to note that specific nutrition interventions are not entered into the model to develop the PROFILES estimates. Rather, the improvement in the nutrition situation is based on the expectation that if nutrition interventions that are known to be effective are implemented at scale, they will succeed in reaching the stated targets.

How Do the Models Work?

The basic approach in PROFILES is to provide two scenarios: a status quo scenario and an improved scenario. The status quo scenario assumes there will be no change in the current situation throughout a chosen time period (e.g., 10 years), aside from projected changes in population size and structure, and that the prevalence of the risk factor for stunting remains unchanged each year. In contrast, in the improved scenario—with results estimated for the same time period—it is assumed that the prevalence of the risk factor for stunting is reduced. For the improved scenario, it is necessary to set targets for the reduction in prevalence of the risk factor for stunting; these targets are discussed and agreed upon by participants during PROFILES workshops, taking into account various national priorities and development objectives. The improved scenario assumes a linear reduction in prevalence levels with a gradual reduction in the risk factor from the first year (when prevalence equals that in the status quo scenario) to the last year when the target prevalence is reached.

Inadequate Dietary Diversity and Stunting Model

Models in the PROFILES spreadsheet workbook rely on coefficients based on the scientific literature to show the association between a nutrition problem and an outcome of interest. To create the dietary diversity and stunting model, FANTA reviewed peer-reviewed literature that quantified the association between inadequate dietary diversity and stunting. PROFILES uses a relative risk (RR) of stunting related to not meeting minimum dietary diversity of 1.22, derived from information provided by Marriott et al. (2012).

In addition to this coefficient, the model also uses country-specific stunting prevalence among children 24–35 months of age,[1] and information on the proportion of children 6–23 months not receiving food from at least four defined food groups in the previous 24 hours, which is the measure used by the model for inadequate dietary diversity (WHO 2010).[2] The 24–35 months age group is

1 Defined as the percentage of children with a height-for-age z-score below -2 SD units from the median of the WHO 2006 standard population.

2 Minimum dietary diversity is defined as the proportion of children 6–23 months of age who receive foods from four or more food groups. Dietary diversity serves as a proxy for adequate nutrient density of foods, and evidence indicates that consumption of at least four food groups would mean that the child had a high likelihood of consuming at least one animal-source food, one fruit or vegetable, and a staple food. The seven food groups used to define minimum dietary diversity include: 1) grains, roots, and tubers; 2) legumes and nuts; 3) dairy products (milk, yogurt, cheese); 4) flesh foods (meat, fish, poultry, and liver/organ meats); 5) eggs; 6) vitamin-A-rich fruits and vegetables; and 7) other fruits and vegetables.

used for stunting prevalence because it represents the age by which stunting has occurred and when stunting generally is most prevalent and usually irreversible. The population attributable fraction (PAF)[3] is calculated as a function of the prevalence of inadequate dietary diversity and the relative risk of child stunting related to inadequate dietary diversity. The number of children who are stunted related to inadequate dietary diversity is then calculated by multiplying the PAF by the total number of children with stunting in the population age 24–35 months.

Estimates calculated by this model refer to the total of number of children age 24–35 months who are stunted related to inadequate dietary diversity and, if dietary practices improve, the total number of children age 24–35 months for whom stunting is averted related to improved dietary diversity. In the status quo scenario the results would be presented as "[number] children age 24–35 months who are stunted related to inadequate dietary diversity at 6–23 months over the course of the time period." Whereas for the improved scenario the results would be presented as "[number] children age 24–35 months for whom stunting is averted related to improved dietary diversity at 6–23 months over the course of the same time period."

Teenage Pregnancy and Stunting Model

Similarly, to create the teenage pregnancy and stunting model, FANTA examined peer-reviewed literature that quantified the association between teenage pregnancy and stunting. Among the literature reviewed, an analysis by Fink et al. (2014) served as the starting point for the development of the PROFILES model. PROFILES uses an RR of stunting related to teenage pregnancy of 1.20, derived by pooling RRs provided by Fink et al. (2014) for children born to mothers in different age strata (<18 and 18–19 years).

In addition to this coefficient, the model also uses country-specific stunting prevalence among children 24–35 months of age, and information on the proportion (among all births) of children born to mothers less than 20 years of age, which is the measure used by the model for teenage pregnancy. The 24–35 months age group is used for stunting prevalence because it represents the age by which stunting has occurred and when stunting generally is most prevalent and usually irreversible. The PAF is calculated as a function of the proportion of births to mothers less than 20 years of age (among all births) and the relative risk of child stunting related to teenage pregnancy. The number of children stunted related to teenage pregnancy is then calculated by multiplying the PAF by the total number of children who are stunted among the population of children age 24–35 months.

Estimates calculated by this model refer to the total of number of children age 24–35 months who are stunted related to teenage pregnancy and, if teenage pregnancy is reduced, the total number of children age 24–35 months for whom stunting is averted related to a reduction in teenage pregnancy. In the status quo scenario the results would be presented as "[number] children age 24–35 months who are stunted related to teenage pregnancy over the course of the time period." Whereas for the improved scenario the results would be presented as "[number] children age 24–35 months for whom stunting is averted related to a reduction in teenage pregnancy over the course of the same time period."

How Can These Models be used to Support Country-Level Advocacy?

Stunting is one of the most concerning long-term nutrition problems in developing countries, a complex problem that is the result of a wide range of context-specific risk factors. While the two new PROFILES models calculate the effect of only two risk factors that commonly affect the prevalence of stunting, they provide an avenue to begin the discussion about country-specific drivers of stunting, as they suggest that a more comprehensive set of effective interventions at scale is needed to achieve a more significant reduction in stunting. The use of these models as part of a larger advocacy process can help countries create effective plans to reduce stunting in order to reach the WHA targets and the Sustainable Development Goals.

For more information from FANTA on using PROFILES for country-level nutrition advocacy, visit www.fantaproject.org/tools/profiles.

3 The population attributable fraction is the proportion (or fraction) of the condition (stunting) that is attributable to the risk factor (inadequate dietary diversity).

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