GLOBAL STUNTING REDUCTION TARGET:

FOCUS ON THE **POOREST** OR LEAVE MILLIONS BEHIND

KEY FINDINGS AND RECOMMENDATIONS

Save the Children welcomes the World Health Organization (WHO) proposed global target for a reduction in the number of children who are stunted. This briefing summarises the interim results of research we supported into stunting trends, drawing out the policy implications for governments and the international community to achieve the target.

The target is ambitious. Stunting trends vary substantially within the 36 high-burden countries (those responsible for 90% of stunting)[1] in particular, so pursuit of the target must recognise this and address the major obstacles. Our main scenario predicts that by 2025 the 36 high-burden countries as a group could achieve stunting reductions of 42%. However, **only 15 of the 36 countries are projected to meet the target individually**. Three countries – Malawi, Niger and Zambia – are projected to see stunting prevalence fall by just 0% to 2%, while a further five countries – Afghanistan, Burkina Faso, Madagascar, Tanzania and Yemen – see projected reductions of less than 20%, or half the proposed target.

The determinants of stunting in the 36 high-burden countries are different than those in lower-burden countries. Most importantly, we find that the income share of the poorest quintile of the population is an important driver of stunting in the high-burden group – but not elsewhere. A higher share of income for this group is significantly associated with a lower prevalence of stunting, so **inequality plays a significant role**. Policy responses must reflect this and other differences or high-burden countries will continue to under-perform. In order to ensure that all countries make strong progress against stunting, policy-makers should address the important drivers and pay particular attention to policies that enable progress among the poorest and most vulnerable groups.

Governments and the international community should prioritise and make more resources available for nutrition – above all for those countries that will find it most difficult to reduce stunting. National nutrition policies and international organisations must ensure that inequalities are addressed by prioritising nutrition in rural areas and among the poorest groups in society. Policies that support a fairer distribution of national income, such as social protection policies, could play an important role in improving nutrition. **Action on other drivers of stunting is also necessary**: female education, family planning and key maternal and child health interventions.

1. INTRODUCTION

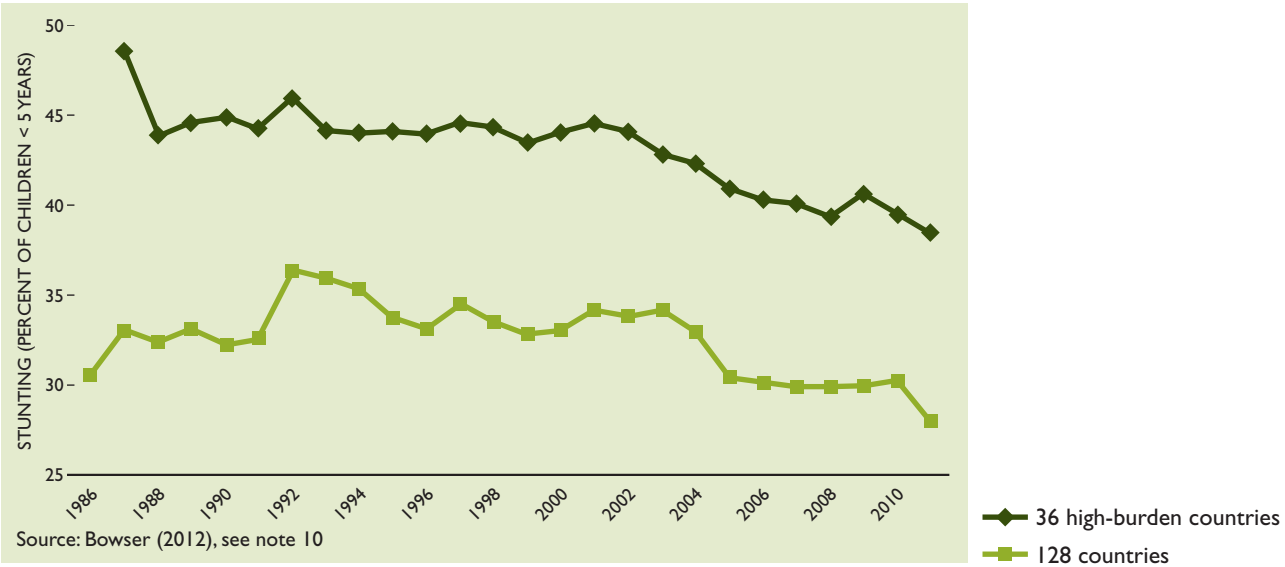
Malnutrition is an underlying cause in more than a third of children's deaths – 2.6 million a year. But it is not always recognised or recorded on death certificates, which is in part why it has not been effectively addressed.[2] For those children who survive, chronic malnutrition causes devastating long-term damage to their physical and cognitive development. Today, 170 million children under five are stunted,[3] meaning they are too short for their age and more likely to have poor cognitive development.[4]

Millennium Development Goals (MDGs) 1 and 4 focus specifically on reducing hunger and under-five mortality, but there is no indicator specific to stunting within these goals. Over the past 20 years, progress against stunting has been extremely slow. Globally, rates of stunted children have decreased by just 0.6 percentage points per year since 1990. Save the Children estimates that **if the current slow rate of progress continues, over the next 15 years 450 million children will be affected by stunting** and will suffer long-term consequences in their physical and cognitive development.[5]

In the face of this high prevalence of stunting, which is concentrated in some of the world's poorest countries, the World Health Organization (WHO) has proposed a global target of a 40% reduction in childhood stunting by 2025 as part of its Maternal, Infant and Young Child Comprehensive Implementation Plan. This reduction applies to the number of children under five years of age whose height-for-age is below minus two standard deviations from the median of the WHO Child Growth Standards.[6] This target, along with other targets for breastfeeding, maternal anaemia, low birth weight, and childhood overweight, will be discussed by Member States at the World Health Assembly in May 2012.

Figure 1 shows the mean stunting prevalence using actual data for relevant years and interpolated data for missing years (based on the annual rate of change between available years), as well as extrapolated data after 2006 for certain countries to control for selection bias. It indicates that after interpolation, the 36 high-burden countries still have higher stunting prevalence than the entire cohort (N=128) and that the stunting prevalence trend curves are smoothed, demonstrating the traditional 'S' shape, especially

Figure 1: Stunting S trends 1986–2011[8]



Source: Bowser (2012), see note 10

after the year 1992. As is noted in the United Nations 2010 report on world nutrition, there are periods of faster improvement and periods of stability, as well as periods where average stunting prevalence increases.[7]

A global stunting reduction target is important to rallying the appropriate response to address the hidden problem of stunting. It has the potential to put the issue on the agenda of donors, governments and stakeholders. Monitoring progress against the goal could hold those responsible to account. When backed with resourced and well-implemented national plans that address the key obstacles, **it could deliver reductions in stunting at an unprecedented rate**. Reducing stunting is important to improving children's life chances and boosting national development. Left untackled, the World Bank estimates that countries could lose up to 3% of their GDP due to malnutrition.[9]

This policy briefing presents the results of an extensive analysis of stunting prevalence data over the past two decades, in order to assess the feasibility of the proposed WHO target at country level. The analysis, based on the available data, identifies both the underlying and structural (socioeconomic) drivers of stunting. Using the results of a regression analysis, stunting prevalence figures are predicted for each country in 2025. This is the first study to use trends over a 25-year period (1986–2011, see Figure 1) – including 291 surveys from 128 countries – to predict future stunting prevalence at the global level as well as for individual countries. In this briefing we focus on the projections for the 36 high-burden countries.

The results of this research should inform ambitious and appropriate national targets aligned with the global target. The findings on the key drivers of progress against stunting should inform priorities at national and international level.

2. METHODS AND RESULTS

The following steps were taken, in order to analyse the drivers of stunting and produce estimates for 2025:

i. developed a model of stunting based on the existing literature which incorporates both underlying and structural (socioeconomic) drivers
ii. conducted a regression analysis to establish the relative and absolute importance of each driver in the 128-country data set
iii. used these results to generate estimates of stunting reductions, by country, in the period to 2025 for the 36 high-burden countries.

The methodology for the study is set out in full in the research paper.[10] Here, we present the key points for each step.

i. The variables and model

We investigated trends in stunting reduction based on the contribution from both underlying and structural drivers and used these results to estimate future stunting trends under various scenarios. Several key studies have examined the factors that contribute to a reduction in stunting prevalence.[11] We used the conceptual models of those studies to inform our approach, investigating those variables that have been included in two or more previous studies. While many previous studies have included immediate drivers in their theoretical models, they have often been excluded in empirical analysis due to lack of data. The variables we investigated as drivers of nutrition are listed in Table 1.

Data on stunting prevalence (defined as the percentage of children below five years of age whose height-for-age score was less than two standard deviations below the mean from the WHO reference population[12]) were retrieved from 291 surveys in 128 countries over the period 1986–2011. For each country with at least two stunting prevalence data points, prevalence was interpolated for missing years, assuming an exponential rate of change.

Table 1: Variables and data used

	Variable	Previous studies in which this variable has been included	Description of variable as we use it	Source
Underlying factors	Stunting prevalence		Moderate and severe stunting prevalence, <-2SD height for age according to the NCHS/WHO Population Reference Data	DHS, UNICEF, WHO
	Daily energy consumption	Frongillio *et al* 2007; Headey 2011; Shrimpton and Saldanha 2011	Daily energy supply (mean Kcal/day); interpolated between years; extrapolated 2008, 2009 based on rate between 2002 and 2007	FAO
	Water availability	Frongillio *et al* 2007; Headey 2011; WHO 2012	Population using improved drinking water sources in rural areas (%); interpolated between years; extrapolated to 2009 based on rate between 2005 and 2008	WHO
	Female literacy	Frongillio *et al* 2007; Headey 2011	Literacy rate, adult female (% of females aged 15 and above); interpolated between years; extrapolated to 2009 (varies by country)	World Bank, WDI
	Fertility rate	Frongillio *et al* 2007; Headey 2011; Shrimpton and Saldanha 2011	Total births per woman	World Bank, WDI
	DTP3 immunisation	Frongillio *et al* 2007	Coverage among 1-year-olds (%)	WHO
	Specific MCH interventions		Variety and time of implementation of different maternal and child health (MCH) interventions including CCT, CBHI, vouchers, HEF, and P4P (see Table 3 for detail on country-specific MCH programmes)	Author's calculation
Structural factors	Income share held by lowest 20% (quintiles of income)	WHO 2012	Income share held by lowest 20% (%); interpolated between years; extrapolated 2009 based on rate between most recent years	World Bank, WDI
	Total health expenditure (% of GDP)	Frongillio *et al* 2007; Shrimpton and Saldanha 2011	Total expenditure on Health as % of GDP	WHO National Health Accounts
	Urban population	Frongillio *et al* 2007	Urban population (% of total population)	World Bank, WDI
	Population density	Frongillio *et al* 2007	People per sq. km of land area	World Bank, WDI
	Female labour force participation rate	Frongillio *et al* 2007	Percentage of female population aged 15+	World Bank, WDI
	GDP per capita	Frongillio *et al* 2007; Headey 2011; WHO 2012		World Bank, WDI
	Population estimates	Frongillio *et al* 2007; Headey 2011	UN population estimates for number of children under age five	UN

Based on a conceptual framework drawing on the relevant literature, we estimated a model incorporating the variables listed in Table 1, as well as a dummy variable for each country to account for fixed differences between countries, and a time variable to control for any fluctuations in stunting that are not captured by other variables. This regression model is estimated over the period 1995–2009.*

The results from the regression were used to estimate stunting prevalence in 2025 in the 36 high-burden countries, on the basis of projections made for the independent variables. The predicted 2025 stunting figures are compared to 2010 figures for each country.[13]

ii. Main results

The main results of regression on the above model are shown in Table 2.

The first regression includes the full panel of 124 countries. The results show that the significant predictors of reductions in stunting include both:

- the underlying drivers (of which, lower fertility rate and sustainability of specific maternal and child health (MCH) interventions are significantly correlated with lower levels of stunting prevalence, as is higher health expenditure as a ratio to GDP)
- the structural drivers that reflect socio-economic characteristics. Of these, higher urban population and higher mean GDP per capita are significantly correlated with lower levels of stunting prevalence.

The second regression includes only the 36 **high-burden countries**. The results show that what drives stunting reduction in these countries is different than what drives stunting in all countries. **Access to water and the per capita income of the poorest 20%** are significant drivers in high-burden countries, with higher values associated with reduced stunting levels.

iii. Estimates of stunting reduction by 2025: high-burden countries only

Table 3 presents the difference in the actual number of children under the age of five who are stunted in 2025 in comparison to the baseline number of under-five-year-olds who are stunted in 2010. The results are estimated based on the time trend and the five main drivers of stunting: GDP per capita,

* The following empirical model was estimated:

$$\ln\left(\frac{y_{it}}{1-y_{it}}\right) = \beta_0 + \beta_1 x_{it} + \beta_2 g_{it} + \beta_3 h_{it} + \beta_4 c_{it} + \beta_5 j_{it} + \beta_6 s_{it} + f_i + d_t + e_{it}$$

where y_{it} = actual combined with interpolated stunting prevalence for relevant years
x_{it} = underlying drivers (energy availability, female literacy rate, fertility rate, access to safe water, immunisation coverage, purchasing power of families (income share of the poorest 20%), health expenditures, and specific MCH interventions)
g_{it} = structural drivers (urban population, population density, female labour force participation and GDP per capita)
f_i = country fixed effects
d_t = time trends
e_{it} = error term

Four countries – Somalia, Libya, Nauru and Tuvalu – are excluded from the regression analysis because of missing data on the underlying and structural drivers.

Table 2: Panel results 1995–2009[14]

	Regression 1: All countries	**Regression 2: High-burden countries**
Energy availability	0.0002 (0.0001)**	0.0003 (0.0001)**
Female literacy (%)	0.005 (0.003)	0.008 (0.004)*
Fertility rate (births/woman)	0.146 (0.039)**	0.022 (0.068)
Access to water (%)	-0.004 (0.002)	-0.015 (0.003)**
DPT vaccination rate (%)	0.001 (0.001)	0.0004 (0.001)
Specific MCH interventions:		
– number	0.044 (0.017)**	0.056 (0.019)**
– years	-0.006 (0.003)*	-0.010 (0.004)**
Total health expenditure/GDP	0.013 (0.005)*	0.007 (0.008)
Urban population (%)	-0.024 (0.007)**	-0.001 (0.010)
Labour force (%)	-0.003 (0.005)	-0.011 (0.008)
Population density	0.0001 (0.001)	-0.001 (0.001)
GDP per capita:		
– log	-0.200 (0.061)**	-0.561 (0.106)**
– *log of share of poorest quintile*	–	*-0.124 (0.056)**
Time	-0.005 (0.005)	0.006 (0.008)
Constant	12.328 (9.355)	-6.453 (15.522)
With-in R-square	0.988	0.978
N (Countries)	508 (124)	217 (36)

* significant at 5%; ** significant at 1%; each model controls for country-fixed effects and time trends

fertility rate, GDP per capita share of the poorest quintile, urban population and access to water in rural areas.

The scenario assumes a (possibly rather optimistic) doubling of GDP over the period to 2025; a doubling of GDP per capita; an increase of one percentage point in the income share of the poorest quintile; a decrease in fertility rate of one birth per woman; a one percentage point increase in rural water access; and a one percentage point increase in the urban population.

Table 3 shows the country projections for the change in stunting prevalence, in the projection, that can be attributed to the changes in each driver. The unweighted average percent reduction in stunting taking into consideration all six factors is 35.2% for the 36 high-burden countries. **The reduction in the number of under-five-year-olds stunted, taking into consideration all six factors, is 63.7 million – a 41.4% reduction.**

The reduction in the number of children aged less than five years who are stunted ranges from a 65% reduction in Vietnam to just 0% to 2% in Malawi, Niger and Zambia. A further five countries – Afghanistan, Burkina Faso, Madagascar, Tanzania and Yemen – see projected reductions of less than 20%, or half the proposed target. Fifteen of the 36 high-burden countries meet the individual target of a 40% reduction in the number of children

Table 3: Estimated change in the number of children aged less than 5 years (in thousands of children) who are stunted in year 2025 compared to the baseline year of 2010[15]

Country	Effect from 2010 to 2025							
	Time	Time + GDP/ capita	Time + GDP/ capita share	Time + fertility rate	Time + urban	Time + water	All six drivers	% impact
Afghanistan	687	-202	496	654	685	665	-462	-14%
Angola	108	-263	17	92	107	97	-350	-36%
Burundi	-66	-209	-97	-71	-66	-69	-250	-36%
Burkina Faso	352	-93	246	333	351	339	-202	-20%
Bangladesh	-1975	-3240	-2268	-2027	-1978	-2010	-3568	-57%
Côte d'Ivoire	94	-296	3	78	94	84	-395	-33%
Cameroon	36	-327	-50	21	35	26	-417	-37%
Congo, DR	703	-987	312	634	699	657	-1426	-28%
Egypt	-481	-1212	-660	-513	-483	-503	-1385	-53%
Ethiopia	-620	-1995	-933	-675	-623	-657	-2361	-42%
Ghana	33	-321	-54	17	32	23	-404	-41%
Guatemala	83	-223	13	70	82	74	-305	-29%
Indonesia	-2603	-4290	-3004	-2675	-2607	-2651	-4710	-59%
India	-13431	-26404	-16378	-13951	-13460	-13780	-29872	-49%
Iraq	298	-284	154	272	296	280	-419	-31%
Kenya	387	-488	178	350	385	362	-703	-30%
Cambodia	-163	-295	-194	-169	-164	-167	-328	-55%
Madagascar	385	-153	264	364	384	371	-300	-18%
Mali	318	-125	213	299	317	305	-237	-21%
Myanmar (Burma)	-437	-742	-510	-450	-438	-446	-816	-59%
Mozambique	194	-353	68	172	193	179	-496	-29%
Malawi	641	112	520	620	640	627	-29	-2%
Niger	742	137	604	717	740	725	-24	-2%
Nigeria	2734	-1344	1783	2565	2725	2621	-2387	-22%
Nepal	-348	-716	-431	-363	-349	-358	-815	-47%
Pakistan	-1271	-3609	-1811	-1367	-1277	-1335	-4218	-45%
Peru	-163	-355	-211	-172	-164	-169	-399	-57%
Philippines	-215	-1345	-488	-264	-218	-248	-1618	-45%
Sudan	221	-619	24	186	219	197	-832	-33%
Turkey	-236	-448	-291	-246	-237	-243	-494	-64%
Tanzania	1342	-48	1019	1285	1339	1304	-406	-12%
Uganda	709	-272	477	667	706	681	-517	-21%
Vietnam	-892	-1341	-1001	-912	-893	-905	-1448	-65%
Yemen	378	-249	242	354	376	362	-430	-18%
South Africa	-303	-633	-386	-318	-304	-313	-709	-58%
Zambia	614	132	504	595	613	601	5	0%
Mean/Sum (N=36)	-12,146 (7.9%)	-53,100 (34.5%)	-21,628 (14.0%)	-13,828 (9.0%)	-12,242 (8.0%)	-13,275 (8.6%)	-63,729 (41.4%)	-35.2%

stunted between 2010 and 2025. **It is crucial that a better understanding of the drivers is developed to improve the prospects of meeting the target in more of the 36 high-burden countries.**

The greatest reductions in the number of children under five years who are stunted are due to GDP/capita, followed by the GDP/capita share of the poorest. The projection indicates, as would be expected, that a doubling of GDP per capita would deliver a substantial share of the reduction required. There is little room to see how growth could exceed this level, across the group. However, an increase of just one percentage point in the income share of the poorest also makes a substantial contribution. And experience shows that there is space for policy to have a significantly larger impact here. In the past, we have seen cases where countries have been able to redistribute income to the poorest segment of the population. A recent analysis shows that social transfers (cash and in-kind) raised the income of the bottom 20% by 15% in the UK and by around 5% across all quintiles in six Latin American countries (Argentina, Bolivia, Colombia, Guatemala Nicaragua and Peru).[16]

Finally, Table 4 shows the unweighted average values of the driver variables in the period to 2009. The table distinguishes between the group of 15 countries projected to achieve the 40% target, and the 21 countries that are not. The right-hand column shows the ratio of the value for countries projected to miss the target to the value for countries projected to achieve the target. In each case, as might be expected, the drivers are less helpful in the countries that are projected to miss the target: higher fertility rates, lower access to water in rural areas, lower urban population, lower GDP per capita and a lower per capita income for the poorest quintile. Specifically, **the average per capita income of the poorest quintile in the countries projected to miss the target is barely a third of the value in the countries projected to hit the target**.

The results suggest that the WHO's 40% reduction target by 2025 is ambitious but may be achievable in high-burden countries, and that addressing income inequality can be a powerful tool.

These results are not without their limitations. First, the analysis uses only national level data for all the indicators. The results would be stronger if household level data could be used from original surveys such as the Demographic and Health Surveys (DHS), Multiple Indicator Cluster Surveys (MICS) or other national surveys. This would increase the sample size and allow for additional measurements of error and increased variance.

Table 4: Values of key stunting drivers, by projected success of countries

	Mean values of drivers		
	High-burden countries projected to hit target	**High-burden countries projected to miss target**	**Ratio of off-target to on-target country values**
Fertility Rate	3.30	5.89	179%
Water	70.20	47.97	68%
Lowest quintile share of GDP	6.96	5.92	85%
Urban	38.40	31.52	82%
GDP per capita	1176.1	442.3	38%
Implied per capita income of lowest quintile	81.8	26.2	32%

Second, there were several data limitations to the analysis. While our model attempted to include as many of the variables that have been identified as important predictors of stunting, data limitations did not allow for the inclusion of any immediate drivers (measuring nutrient intake of mother and child, foetal growth, etc). The variable included in the model that is most associated with these immediate drivers is daily energy consumption, which was associated with higher stunting rather than lower stunting as is shown by Headey and Frongillio *et al.*[17] Another limitation is the use of stunting prevalence rates for children under five years of age.

Some argue that stunting prevalence measured in children under two years is a better indicator of childhood nutritional levels. However, due to more data points being available, stunting prevalence for children under five years was used in this analysis. Also, while the analysis controls for fixed effects and time trends, the estimated coefficients still suffer from bias due to reverse causality which can only be eliminated with additional, more sophisticated modelling or by conducting the analysis at the individual level. Finally, the general caveat is that these results are interim findings.

Further research is urgently needed to extend and deepen these findings. Substantial improvements are needed in our understanding of the key drivers identified here, and the current context in individual countries – above all those projected to make least progress towards the target. Save the Children is committed to pursuing this research agenda, in particular with respect to the role of major inequalities in hindering progress, and to policies to address them such as social transfer programmes.

3. CONCLUSION

Focus on the poorest or leave millions of children behind

This briefing presents important discussion points on WHO's proposed 40% global stunting reduction target. It provides an in-depth analysis of the trends and drivers of stunting in 128 countries, paying particular attention to the 36 high-burden countries. A key finding is that the drivers of stunting are different in high-burden countries, with the income share of the poorest quintile of the population playing a significant role.

The findings related to the income share of the poorest group are important. First, they resonate with the ambition of WHO's proposed target and suggest that accelerating stunting reductions requires a deviation from current trends. Second, they indicate that achieving the target depends on strong commitment and efforts that are particularly focused on the poorest groups of people. A global stunting reduction target that is adopted and implemented by national governments could present an outstanding opportunity to rally commitment and effort to this long-hidden crisis.

ENDNOTES

[1] Bhutta *et al.*, 2008, 'What works? Interventions for maternal and child undernutrition and survival', *The Lancet* Volume 371, Issue 9610, pp.417 – 440. http://www.thelancet.com/journals/lancet/article/PIIS0140-6736(07)61693-6/fulltext

[2] Save the Children (2012) *A Life Free from Hunger: Tackling child malnutrition*

[3] M de Onis, M Blossne and E Borghi (2011) 'Prevalence of stunting among pre-school children 1990–2020', Growth Assessment and Surveillance Unit, *Public Health Nutrition*, 2011, July 14:1-7

[4] S Horton (1999) 'Opportunities for investments in low-income Asia', *Asian Development Review*, 17:246-73

[5] Save the Children (2012) *A Life Free from Hunger: Tackling child malnutrition*

[6] World Health Organization (2012) *Proposed global Targets for Maternal, Infant and Young Child Nutrition*, WHO Discussion Paper

[7] United Nations (2010) *Sixth Report on the World Nutrition Situation* (6RWNS)

[8] Note: Figure shows actual stunting data combined with interpolated data for missing years. Any country with a data point in 2006 is assumed to maintain this same stunting prevalence until 2011 to control for selection bias in reporting.

[9] World Bank (2006) *Repositioning Malnutrition as Central to Development: A Strategy for Large-Scale Action*

[10] The model, regression results and projections are drawn from a working paper prepared for Save the Children UK by Diana Bowser, a senior research associate at Brandeis University who has consulted for WHO, the Global Fund and the Inter-American Development Bank among others.

[11] E Frongillo, M de Onis and K Hanson (1997) 'Socioeconomic and Demographic Factors Are Associated with Worldwide Patterns of Stunting and Wasting of Children', *The Journal of Nutrition* 127 (1997): 2302-2309; World Health Organization (2012) *Proposed Global Targets for Maternal, Infant and Young Child Nutrition*, WHO Discussion Paper; D Headey (2011) 'Turning economic growth into nutrition-sensitive growth' in *Proceedings of the 2020 Conference: Leveraging Agriculture for Improving Nutrition and Health*, New Delhi, India; R Shrimpton and L Saldanha (2011) *The Kenya Nutrition Programme Review*, Public Nutrition Solutions Limited

[12] WHO population reference. Stunting data from prior to 2006 were adjusted to account for the change from NCHS to WHO reference populations, using formula provided in Yang, Hong and Mercedes de Onis (2008) Algorithms for converting estimates of child malnutrition based on the NCHS reference into estimates based on the WHO Child Growth Standards. 8: 19

[13] For those countries without a stunting prevalence figure in 2010, the stunting prevalence figure for the most recent year prior to 2010 is extrapolated to the baseline year of 2010 using time trends and impact from changes in GDP/capita.

[14] Table shows results of logistic regression analysis, where the dependent variable the logistic transformation of stunting prevalence (actual and interpolated data points).

[15] Each column, for each country, shows the projected change in stunting numbers. Eg, in the 1st row, the 1st data column shows the pure time trend: a growth in stunting numbers of 687,000 (largely due to population projections). The 2nd column shows a fall of 202,000, when GDP per capita growth projections are accounted for – projected per capita growth is expected to more than negate the pure time trend effect here. The 3rd–6th columns each show a projected rise in stunting numbers when the income of poorest quintile, fertility rate, urban population and rural water access are individually taken into account. Note, however, that in each case the projected rise is less than that from the time trend alone – so that the additional drivers are each projected to reduce the stunting from the time trend-only case. For this reason, the final 2 columns showing the effects of time plus all drivers are strongly negative, and much more so than the case of per capita growth and time only.

[16] Breceda *et al* (2008) in N Lustig (2011) *Fiscal policy and income redistribution in Latin America: Challenging the conventional wisdom*, Society for Study of Economic Inequality Working Paper Series–227

[17] D Headey (2011) and E Frongillo *et al* (1997), see note 11

This briefing was written by Alex Cobham, Maricar Garde and Liam Crosby, Policy and Research Department, Save the Children UK, with grateful thanks to all those who commented on previous drafts.

savethechildren.org.uk

Save the Children
1 St John's Lane
London EC1M 4AR
Tel: +44 (0)20 7012 6400
Fax: +44 (0)20 7012 6963

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