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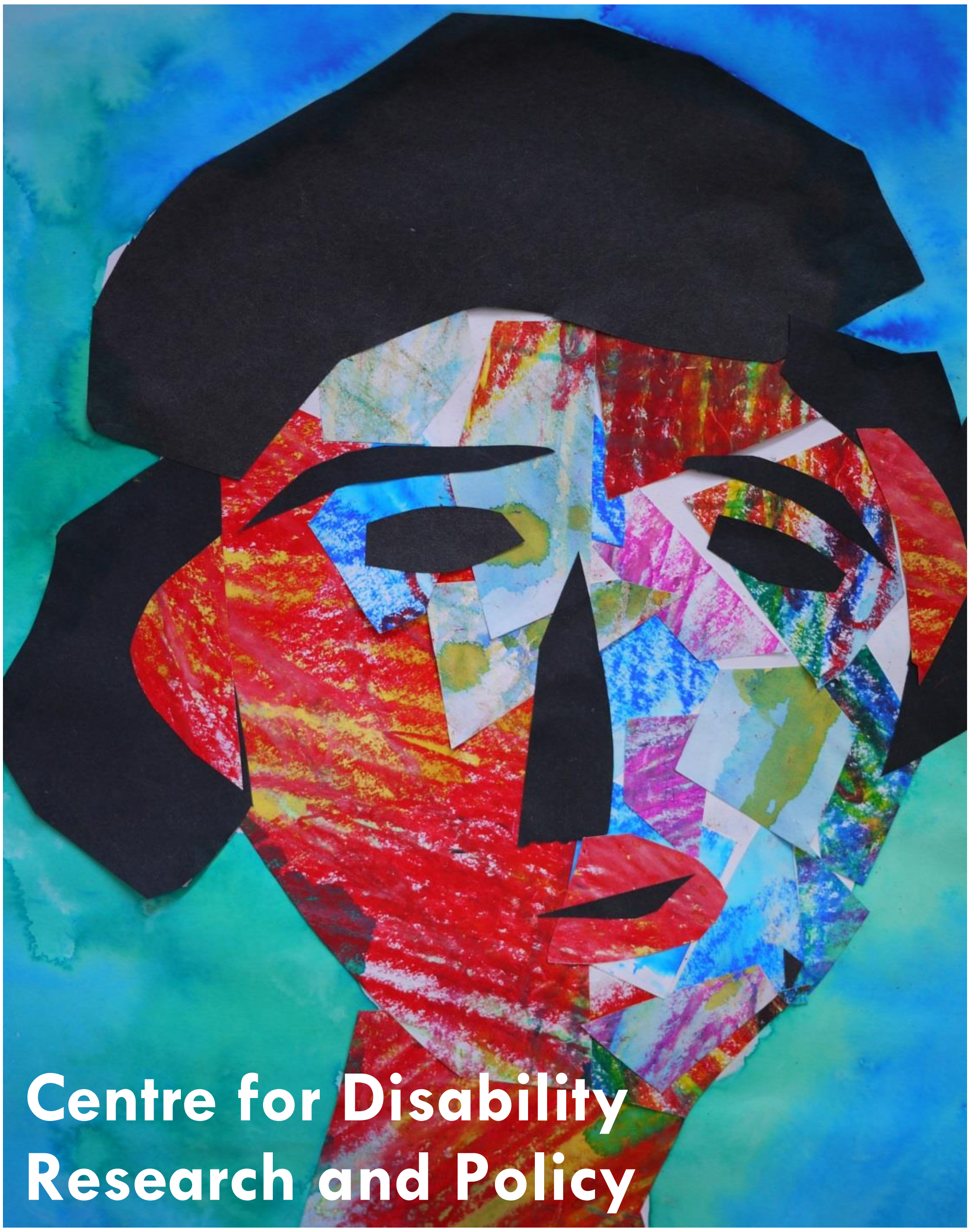
Preventing Significant Cognitive Delay in Young Children in Low and Middle Income Countries by Ensuring that Every Child Receives Adequate Stimulation at Home: Estimating effects in six Asian countries



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Summary

250 million children under the age of 5 years who live in low-income or middle-income countries are at risk of not reaching their developmental potential. Significant cognitive delay in early childhood is associated with low 'school readiness', poor educational attainment, unemployment, social exclusion, poor health (including mental health) and reduced life expectancy.

Loss of developmental potential arises from the exposure of young children to a range of nutritional, environmental and social risks associated with growing up in poverty. Parental stimulation and material quality of home learning environment are two key components of nurturing care that are amenable to intervention.

This report answers the question: **what would be the impact on the prevalence of significant cognitive delay in children growing up in low and middle income Asian countries if we could ensure that every young child received adequate parental stimulation and lived in a home with adequate learning materials?**

To answer this question we used data collected through UNICEF's Multiple Cluster Indicator Surveys programme in six Asian countries; Bangladesh, Bhutan, Laos, Nepal, Pakistan and Vietnam. For each country, we estimated the population attributable fraction (PAF) of significant cognitive delay that could be attributed to low levels of child stimulation. PAFs are useful for providing estimates of the potential impact of an intervention in reducing the prevalence of a given health condition or impairment.

Our analyses suggest that the prevalence of significant cognitive delay could be reduced by 19-24% across these six countries if all children under five were to receive adequate levels of home-based child stimulation. If achieved, this would reduce by up to 500,000 the number of 3-4 year old children with significant cognitive delay in these six countries.

Background

It has recently been estimated that 250 million children under the age of 5 years who live in low-income or middle-income countries are at risk of not reaching their developmental potential.[1] The development of cognitive abilities and learning skills are critical to the attainment of developmental potential. Significant cognitive delay in early childhood is associated with low school readiness, poor educational attainment, unemployment, social exclusion, poor health (including mental health) and reduced life expectancy.[2]

Loss of developmental potential associated with significant cognitive delay arises from the exposure of young children (including prenatally) to a range of nutritional, environmental and social risks that are typically associated with growing up in poverty. [1 3-13] Level of parental stimulation of the child and the material quality of their home learning environment are two key components of 'nurturing care'[14] that are amenable to intervention. There is a robust body of evidence which indicates that: (1) low levels of these factors are causally linked to increased risk of significant cognitive delay; [1 3-15] and (2) interventions that increase levels of parental child stimulation and the material quality of their home learning environment can have a marked positive impact on child development.[5 9 12 14-19]

In this report we set out to answer the question; **what would be the impact on the prevalence of significant cognitive delay in young children growing up in low and middle income Asian countries if we could ensure that every young child received adequate parental stimulation and lived in a home with adequate learning materials?**

Method

We undertook secondary analysis of data collected in rounds four and five of UNICEF's Multiple Cluster Indicator Surveys (MICS).[20] The MICS programme, launched in 1994, seeks to generate robust country-specific data on the wellbeing of young children and mothers. MICS contributed important information to international attempts to monitor progress toward the achievement of the Millennium Development Goals,[20] and is currently contributing to the measurement of progress toward the achievement of the Sustainable Development Goals.[21]

Following approval of access by UNICEF, MICS data were downloaded in November 2015 from http://mics.unicef.org/. MICS 4 surveys were undertaken between 2009 and 2012 in 56 low and middle income countries, with data available at the time of download for 40 countries. MICS 5 surveys commenced in 2012 and at the time of download had been completed in 25 countries, with data available for 10 countries.

MICS contains a number of questionnaire modules. Data used in the present report were extracted from the module applied to all three and four year-old children living in the sampled household and the general household module. Details of the sampling procedure used in each country are available at http://mics.unicef.org/. In the majority of countries cluster sampling methods are used to derive samples representative of the national population of mothers and young children. In all countries sample weights are generated to take into account any biases deriving from the sampling method and household and individual level non-response.

Identification of children with significant cognitive delay

The child under five module in MICS 4 and 5 contained the ten item Early Child Development Index (ECDI). The index is based on selected milestones that children are expected to achieve by ages three and four. The ECDI is calculated as the percentage of children who are developmentally on track in at least three of four domains; literacy-numeracy, learning, physical and social-emotional. We used the five items from the literacy-numeracy and learning domains to identify children with significant cognitive delay.

1. Literacy-numeracy: Children are defined as being developmentally on track based on: (a) whether they can identify/name at least ten letters of the alphabet; (b) whether they can read at least four simple, popular words; and (c) whether they know the name and recognize the symbols of all numbers from 1 to 10. If at least two of these are true, then in the EDCI the child is considered developmentally on track.
2. Learning: Children are defined as being developmentally on track based on: (a) if the child follows simple directions on how to do something correctly; and (b) when given something to do, is able to do it independently. If at least one of these is true, then in the EDCI the child is considered developmentally on track.

We identified children as being significant cognitively delayed if they were reported by their primary caregiver to be unable to complete all five tasks. However, we only included data from countries that met three criteria: (a) the five items demonstrated a modest degree of internal consistency (alpha >= 0.5); (b) the prevalence of significant cognitive delay was greater than 1%; and (c) the number of children identified with significant cognitive delay was greater than 50. These inclusion criteria led to the exclusion of data from one Asian country (Mongolia) due to low internal consistency. A further two Asian countries (Afghanistan and Indonesia) were excluded as ECDI items were not collected. The year of data collection and sample sizes for the included countries is shown below in Table 1.

Table 1: Year of data collection and sample sizes

Country	Year of Data Collection	N Children in sample with SCD[b]	N Children in sample without SCD[b]	Prevalence of SCD[c]	Number of children age 3-4 in population (thousands)[d]	Estimated number of children age 3-4 in population with SCD
Low Middle Income[a]						
Bhutan	2012	106	2,272	4.1%	28	1,150
Laos	2012	221	4,177	5.0%	335	16,750
Pakistan (Baluchistan)[e]	2010	568	3,552	14.4%	8,960	1,290,250
Vietnam	2011	106	1,302	6.3%	2,962	186,650
Low Income						
Bangladesh	2012/13	634	7,959	7.6%	6,180	469,650
Nepal	2014	287	1,937	15.4%	1,142	175,800
Total		1,922	21,199	10.3%	19,607	2,140,250

Notes: SCD = Significant cognitive delay

[a] Income classification based on year of data collection. Classifications taken from that year's *World Development Report* (http://www.worldbank.org/en/publication/wdr/wdr-archive).

[b] Sample sizes are unweighted (i.e., represent to actual number of children participating in the survey).

[c] Prevalence uses child sample weights provided by the UNICEF MICS team to account for any biases deriving from the sampling method and household and individual level non-response.

[d] Population estimates derived from United Nations, 2015 Revision of World Population Prospects (http://esa.un.org/unpd/wpp/)

[e] In Pakistan MICS data was collected for the province of Baluchistan. In all other countries nationally representative samples were collected.

Indicators of child stimulation

Support for learning
Respondents were asked 'Iin the past 3 days, did you or any household member over 15 years of age engage in any of the following activities with (*NAME*): (a) read books to or looked at picture books with (*NAME*)?; (b) told stories to (*NAME*)?; (c) sang songs to (*NAME*) or with (*NAME*), including lullabies?; (d) took (*NAME*) outside the home, compound, yard or enclosure?; (e) played with (*NAME*)?; (F) named, counted, or drew things to or with (*NAME*)? *Support for learning* was defined as an adult having engaged in four or more activities to promote learning and school readiness in the past 3 days (MICS4 indicator 6.1).

Adequate books and playthings in the home
Respondents were asked 'How many children's books or picture books do you have for (*NAME*)?' and 'I am interested in learning about the things that (*NAME*) plays with when he/she is at home. Does he/she play with: (a) homemade toys (such as dolls, cars, or other toys made at home)? (b) toys from a shop or manufactured toys?; (c) household objects (such as bowls or pots) or objects found outside (such as sticks, rocks, animal shells or leaves)?' An adequate number of books (MICS4 indicator 6.3) was defined as having three or more children's books. An adequate number of playthings (MICS4 indicator 6.4) was defined as having two or more playthings. These two items were combined into a single item of having adequate books **and** having adequate playthings.

Low child stimulation
We defined low child stimulation as the presence of either low support for learning **or** inadequate books and playthings in the home. Overall 52% of children were identified as experiencing low stimulation.

Potentially confounding environmental factors related to significant cognitive delay

Poverty
MICS data is released with a derived wealth index for each household. To construct the wealth index, principal components analysis is performed by using information on the ownership of consumer goods, dwelling characteristics, water and sanitation, and other characteristics that are related to the household's wealth, to generate weights (factor scores) for each of the items used. First, initial factor scores are calculated for the total sample. Then, separate factor scores are calculated for households in urban and rural areas. Finally, the urban and rural factor scores are regressed on the initial factor scores to obtain the combined, final factor scores for the total sample. This is carried out to minimize the urban bias in the wealth index values. Each household in the total sample is then assigned a wealth score based on the assets owned by that household and on the final factor scores obtained as described above. The survey household population is then ranked according to the wealth score of the household they are living in, and is finally divided into 5 equal parts (quintiles) from lowest (poorest) to highest (richest). The wealth index is assumed to capture the underlying long-term wealth through information on the household assets, and is intended to produce a ranking of households by wealth, from poorest to richest.[22] [23]

Under nutrition
Child weight and height data was collected by direct measurement using anthropometric equipment recommended by UNICEF.[24] These data were available for five of the six Asian countries for which we were able to identify children with significant cognitive delay. Height-for-age data were transformed into z scores from the median reference population; WHO growth standards.[25] Children whose height-for-age was more than three standard deviations below the median reference population were classified as being severely stunted (typically a consequence of severe under nutrition).

Maternal education
The highest level of education received by the child's mother was recorded using country-specific categories. We recoded these data into a three level measure of: (1) no education; (2) primary level as the highest level of education received; (3) secondary or higher level as the highest level of education received.

Household conditions: Access to improved water & improved sanitation
Access to improved water was defined as the main source of drinking water being piped, public tap/standpipe, tube well/borehole, protected well, protected spring or rainwater collection (MICS4 indicator 4.1). *Access to improved sanitation* was defined as sanitation facilities which are not shared and are based on flush to piped sewer system/septic tank/pit(latrine), ventilated improved pit latrine, pit latrine with slab, composting toilet (MICS4 indicator 4.3). We recoded these data into a simple binary measure of the household having access to both improved water and improved sanitation.

Approach to data analysis

In the following sections we present simple comparisons for each country of the prevalence of significant cognitive delay among children exposed/not exposed to low child stimulation. We also report bivariate prevalence ratios (with 95% confidence intervals) and the statistical significance of the association for low child stimulation.*

We then calculate for each country the unadjusted population attributable fraction (PAF) of significant cognitive delay for low child stimulation. The PAF is commonly considered an estimate of either (1) the proportion of instances of a health condition or impairment causally explained by, or attributable to, the risk factor(s) being considered, or (2) the proportion of instances of a health condition or impairment that would be eliminated from the population if exposure to the risk factor were eliminated (or if exposure were no longer associated with any increased risk).[26] As such, it is useful to provide estimates of the potential impact of an intervention in reducing the prevalence of a given health condition or impairment in a given population.

However, our indicator of low child stimulation is also related to other environmental factors that are themselves associated with risk of significant cognitive delay. Table 2 shows the association between prevalence of exposure to low child stimulation and household wealth, maternal education, severe stunting, access to clean water and improved sanitation and urban/rural location. All the differences seen in Table 2 are highly statistically significant.

Table 2: The association between household wealth, maternal education, severe stunting, access to clean water and improved sanitation, urban/rural location and exposure to indictors of adequate child stimulation

Variable		% children exposed to low child stimulation
Household wealth		
	Q1 (poorest)	63%
	Q5 (richest)	32%
Maternal education		
	None	69%
	Primary	48%
	Secondary	28%
Severe stunting		
	Yes	58%
	No	46%
Access to clean water and improved sanitation		
	Yes	36%
	No	56%
Location		
	Urban	40%
	Rural	54%

* Prevalence ratios (mathematically equivalent to measures of relative risk) are calculated by dividing the percentage of children with developmental delay reported to experience a specific indicator by the percentage of children without developmental delay reported to experience that indicator. Thus, if 20% of children exposed to low levels of stimulation had developmental delay and 10% of children not exposed had developmental delay, the prevalence ratio for developmental delay associated with low level stimulation would be 2 (20/10) or twice as likely. Chi-square tests (with continuity corrections where required) were used to test the statistical significance of observed between-group differences.

Given these associations we used multivariate statistical techniques (log binomial regression) to estimate the adjusted prevalence ratio for significant cognitive delay associated with low child stimulation assuming that the other risk factors did not change.[27] The statistical modelling was undertaken using the GENLIN procedures in IBM SPSS Statistics v22. Finally, we used the results of the multivariate analysis to calculate for each country the adjusted PAF for low child stimulation taking into account the effects of other potential risk factors.

Findings

Table 3: Unadjusted prevalence ratios and population attributable fractions

Country	% of children exposed	Prevalence of SCD if exposed	Prevalence of SCD if not exposed	Unadjusted PR	Unadjusted PAF
Bhutan	60.0%	5.2%	2.5%	2.06** (1.32-3.21)	31.2%
Vietnam	41.9%	9.8%	3.8%	2.60*** (1.70-3.96)	25.7%
Pakistan	75.6%	14.3%	9.1%	1.57*** (1.26-1.94)	27.5%
Laos	61.5%	6.7%	2.3%	2.87*** (2.04-4.03)	40.4%
Bangladesh	35.7%	11.2%	5.3%	2.10*** (1.81-2.44)	18.8%
Nepal	44.4%	21.7%	10.5%	2.07*** (1.69-2.53)	22.9%

Consideration of the unadjusted PAF suggests that if *all* children under five were to receive adequate levels of home stimulation the prevalence of significant cognitive delay among 3-4 year old children in these six countries would be reduced by 24% or one in four or approximately 500,000 3-4 year old children in these six countries no longer having significant cognitive delay.

A more conservative estimate is provided by the adjusted PAF (Table 4). This suggests that if *all* children under five were to receive adequate levels of home stimulation (and there were no associated changes in household wealth, maternal education, under nutrition and access to clean water and improved sanitation) the prevalence of significant cognitive delay among 3-4 year old children in these six countries would be reduced by 19% equivalent to one in five or approximately 400,000 3-4 year old children in these countries no longer having significant cognitive delay.

Table 4: Adjusted prevalence ratios and population attributable fractions

Country	Adjusted RR	Adjusted PAF
Bhutan	1.61* (1.04-2.50)	22.7%
Vietnam	1.60 (0.99-2.59)	15.7%
Pakistan	1.79*** (1.30-2.46)	33.4%
Laos	1.59** (1.12-2.26)	22.8%
Bangladesh	1.90*** (1.63-2.22)	16.9%
Nepal	1.68*** (1.35-2.09)	18.0%

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