Prevalence of Underweight, Wasting and Stunting among Young Children with a Significant Cognitive Delay in 47 Low and Middle-Income Countries

Abstract

Background

Undernutrition in early childhood is associated with a range of negative outcomes across the lifespan. Little is known about the prevalence of exposure to undernutrition among young children with significant cognitive delay.

Method

Secondary analysis of data collected on 161,188 3 and 4-year-old children in 47 low-income and middle-income countries in Rounds 4-6 of UNICEF's Multiple Indicator Cluster Surveys. Of these, 12.3% (95% CI 11.8% - 12.8%) showed evidence of significant cognitive delay.

Results

In both middle and low income countries significant cognitive delay was associated with an increased prevalence of exposure to three indicators of undernutrition (underweight, wasting and stunting). Overall, children with significant cognitive delay were more than twice as likely than their peers to be exposed to severe underweight, severe wasting and severe stunting. Among children with significant cognitive delay (and after controlling for country economic classification group), relative household wealth was the strongest and most consistent predictor of exposure to undernutrition.

Conclusions

Given that undernutrition in early childhood is associated with a range of negative outcomes in later life, it is possible that undernutrition in early childhood may play an important role in accounting for health inequalities and inequities experienced by people with significant cognitive delay in low and middle income countries.

Keywords: cognitive delay, developmental delay, intellectual disability, undernutrition, underweight, wasting, stunting, low-income countries, children

Introduction

Undernutrition has been identified as the largest cause of deaths in children under the age of five globally (World Health Organization 2009). Among children who survive undernutrition in early childhood is associated with a range of negative outcomes including: more frequent and more severe infections in early childhood; impaired motor and cognitive development; apathy and more negative affect; reduced activity, play, and exploration; lower school achievement; adverse pregnancy outcomes in adulthood; high glucose concentrations, blood pressure and harmful lipid profiles in adulthood; and reduced economic productivity (World Health Organization 2009, Walker *et al.* 2007, Liu *et al.* 2012, Victora *et al.* 2008, Black *et al.* 2008). The most commonly used indicators of undernutrition in childhood are underweight (low weight for age), stunting (low height for age) and wasting (low weight for height) relative to WHO growth standards (United Nations Children's Fund *et al.* 2012, Black et al. 2008, Black *et al.* 2013, WHO Multicentre Growth Reference Study Group 2006).

Evidence from high income countries suggests that people with intellectual disability are at increased risk of being underweight (defined by very low body mass index) (Emerson 2005, Bhaumik *et al.* 2008, Temple *et al.* 2014, Hoey *et al.* 2017 , Temple *et al.* 2015, Lloyd *et al.* 2014). While, in the general population undernutrition typically results from inadequate diet and/or frequent infections, among people with intellectual disability, especially those with more severe intellectual disability, undernutrition may also arise as a result of the relatively high prevalence of health conditions or impairments that are associated with difficulties in swallowing and eating (e.g., dysphagia) (Robertson *et al.* 2017, Robertson *et al.* 2018).

We are aware of only four studies that have investigated the prevalence of indicators of undernutrition among children with intellectual disability, all of which focused on underweight. First, analysis of the 2008-2010 US National Health Interview Surveys reported that underweight (defined as a body mass index below the population 5th percentile) was markedly higher among 60 adolescent participants with intellectual disability than among non-disabled adolescents (14.8% vs 3.5%) (Phillips *et al.* 2014). Second, a small clinic-based study in Turkey reported that 5.4% of children and youth with ID were underweight (Sari and Bahceci 2012). Third, high rates of underweight (9.4%) have been reported among 1,905 children and youth participants in Special Olympics activities in Europe (9.4%) (Rintala *et al.* 2017). Finally, high rates of underweight (4.9%) have been reported among 2,024 children and youth participants in Special Olympics activities globally (McConkey *et al.* 2018 online). Unfortunately, the extent to which participants in Special Olympics activities are representative of the wider population of children and young people with intellectual disabilities is unknown.

The aims of the present paper are to add to the existing literature by examining the association between multiple indicators of undernutrition, including underweight, among 3-4-year-old children with and without significant cognitive delay in in a range of low and middle-income countries. Specifically, we aim to estimate: (1) the prevalence of indicators of undernutrition among young children with and without significant cognitive delay; and (2) child and family factors associated with increased risk of undernutrition among young children with significant cognitive delay.

Method

We undertook secondary analysis of data collected in Rounds 4 to 6 of UNICEF's Multiple Cluster Indicators Surveys (MICS: UNICEF 2015). The MICS programme, launched in 1994, seeks to generate robust country-specific data on the wellbeing of young children and mothers. These data formed the basis of measuring progress toward the achievement of many of the Millennium Development Goals and will play an important role in measuring progress toward the achievement of many of the Sustainable Development Goals (UNICEF 2015). Following approval to access these data by UNICEF, data were downloaded from http://mics.unicef.org/. MICS 4 surveys were undertaken between 2009 and 2013 in

49 low and middle-income countries, with data available by the end of the download period (December 2018) for all countries. MICS 5 surveys were undertaken between 2012 and 2017 in 42 low and middle-income countries, with data available by the end of the download period for 40 countries. MICS 6 surveys will be undertaken between 2017 and 2020, with data available by the end of the download period for one country.

MICS contains a number of questionnaire modules. Data used in the present report were extracted from the household module and the module applied to all children under five living in the household. Details of the sampling procedure used in each country are available at http://mics.unicef.org/. In the majority of countries cluster sampling methods were used to derive samples representative of the national population of mothers and young children. In all countries sample weights were generated by the MICS team to take account of 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 contained the Early Child Development Index (ECDI), a ten item scale based on milestones that children are expected to achieve by ages 3 and 4 (UNICEF 2014). The ECDI contains four domains; literacy-numeracy, physical, social emotional, and learning. ECDI data were collected on children in the age range 36-59 months. We replicated methods used in recent research and used all five items from the literacy-numeracy and learning domains to identify children with significant cognitive delay (Emerson *et al.* 2018). All items are based on key informant (primarily maternal) report with simple binary (yes/no) response options.

- *Literacy-numeracy:* Can the child: (1) identify/name at least ten letters of the alphabet; (2) read at least four simple, popular words; (3) name and recognize the symbols of all numbers from 1 to 10?

- *Learning*: Can the child: (4) follow simple directions on how to do something correctly; (5) when given something to do, do it independently?

We defined significant cognitive delay in terms of the reported inability to complete all five items. The five items demonstrated an acceptable degree of internal consistency across the whole sample (mean alpha=0.66, range 0.38-0.77). These data were missing for 2.7% of children in the analytic sample (see below).

Indicators of Undernutrition: Underweight, Wasting & Stunting

Child weight and height data was collected by direct measurement using anthropometric equipment recommended by UNICEF (UNICEF 2014). Following WHO, UNICEF and World Bank procedures, weight-for-height, weight for age and height for age data were transformed into z scores from the median reference population; WHO growth standards (United Nations Children's Fund et al. 2012, Black et al. 2008, Black et al. 2013, WHO Multicentre Growth Reference Study Group 2006).

- **Wasting** was defined as scoring more than two standard deviations below the growth standard weight for height median score. Severe wasting was defined as scoring more than three standard deviations below the growth standard median score.
- **Underweight** was defined as scoring more than two standard deviations below the growth standard weight for age median score. Severe underweight was defined as scoring more than three standard deviations below the growth standard median score.
- **Stunting** was defined as scoring more than two standard deviations below the growth standard height for age median score. Severe stunting was defined as scoring more than three standard deviations below the growth standard median score.

These data were missing for 0.3% of children in the analytic sample.

Household Wealth

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 five 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 (Rutstein 2008, Rutstein and Johnson 2004). These data were missing for 1.4% of children in the analytic sample.

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 binary measure of receipt of secondary or higher-level education. These data were missing for 3.0% of children in the analytic sample.

Child Stimulation

Respondents were asked 'In 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).

Respondents were also 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. We defined low child stimulation as the presence of either low support for learning **or** inadequate books and playthings in the home. These data were missing for 1.4% of children in the analytic sample.

Country Economic Status

Countries were classified as upper middle income, lower middle income and low income according to World Bank criteria for 2019 (https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups). In addition, 2017 per capita Gross National Income (pcGNI; expressed as current US$ rates) using the World Bank's Atlas Method (https://datahelpdesk.worldbank.org/knowledgebase/articles/378832-what-is-the-world-bank-atlas-method) were downloaded from the World Bank website (http://data.worldbank.org/indicator/NY.GNP.PCAP.CD?view=chart).

Approach to Analysis

Our analytic sample consisted of all 3 and 4-year-old children in nationally representative MICS surveys in which EDCI and height/weight data were collected. If countries participated in more than one MICS round of surveys, the analytic sample included only the most recent survey. This approach led to the inclusion of data on 161,188 3 and 4-year-old children from 47 countries. Details of the surveys included in our analyses are presented in Table 1. The combined samples included information on 43,741 children in 16 of the world's 56 upper middle-income countries, 60,158 children in 18 of the world's 47 lower middle-income countries and 57,289 children in 13 of the world's 34 low-income countries.

[Insert Table 1]

In the first stage of analysis we used simple bivariate descriptive statistics to estimate the prevalence of significant cognitive delay, underweight, wasting and stunting (with 95% confidence intervals) among 3/4 year old children for each country economic classification group.

In the second stage of analysis for each country economic classification group we used simple bivariate descriptive statistics to estimate the prevalence of underweight, wasting and stunting among children with/without significant cognitive delay. We also estimated prevalence rate ratios (using generalised linear modelling) adjusted for child age (in months) and child gender.

In the third stage of analysis we examined within the population of children with significant cognitive delay the association between three household contextual factors (wealth, maternal education, level of child stimulation), child age and gender and the probability of underweight, wasting and stunting. Again, we also estimated relevant prevalence rate ratios.

All analyses were undertaken using Stata v12 using the svyset and syv commands to take account of the clustering of observations by country and within country sampling clusters. All surveys contained country-specific child-level weights to take account of biases in sampling frames and household and individual level non-response. For pooled analyses we recalibrated the country specific weights to take account of between country differences in the estimated survey sampling fraction using estimates of the 2015 country-specific base population of children under the age of five years old produced by the United Nations Department of Economic and Social Affairs (United Nations Department of Economic and Social Affairs 2017). This ensured that the pooled estimates were based on an accurate estimate of the total population of 3-4 year old children when pooled across countries within country economic classification groups. Given the small amount of missing data complete case analysis was undertaken.

Results

The estimated prevalence of significant cognitive delay, underweight, wasting and stunting is presented in Table 2 for the three country economic classification groups. Consistent with the results of previous research significant cognitive delay and all indicators of undernutrition were significantly more prevalent in lower income economies when compared with upper middle income economies (Black et al. 2008, Emerson et al. 2018).

[Insert Table 2]

Table 3 presents prevalence rates and adjusted prevalence rate ratios for risk of wasting, underweight and stunting among children with significant cognitive delay for the three country economic classification groups (with children without significant cognitive delay forming the reference group). Overall and for each of the three country economic classification groups significant cognitive delay was associated with an increased prevalence of undernutrition. In the majority of analyses the effect size was markedly stronger for the prevalence of severe when compared to moderate levels of the three indictors of undernutrition. Overall children with significant cognitive delay were more than twice as likely as their peers to be exposed to severe underweight, severe wasting and severe stunting.

[Insert Table 3]

Table 4 presents prevalence rates and multivariate adjusted prevalence rate ratios for risk of wasting, underweight and stunting among children with significant cognitive delay by child and family characteristics. After controlling for country economic classification groups, relative household wealth was the strongest and most consistent predictor of exposure to undernutrition among children with significant cognitive delay.

[Insert Table 4]

Discussion

Our results indicated that: (1) for each of the three country economic classification groups significant cognitive delay was associated with an increased prevalence of undernutrition; (2) overall, children with significant cognitive delay were more than twice as likely than their peers to be exposed to severe underweight, severe wasting and severe stunting; (3) among children with significant cognitive delay (and after controlling for country economic classification group), relative household wealth was the strongest and most consistent predictor of exposure to undernutrition.

Our paper adds to the existing literature in three ways. First, it is the first study (to our knowledge) to use nationally representative data to report prevalence rates for three separate indicators of undernutrition among children with and without significant cognitive delay. Second, apart from a small clinic-based study in Turkey (Sari and Bahceci 2012), it is the first study (to our knowledge) to report prevalence rates for indicators of undernutrition among children with significant cognitive delay in low and middle-income countries. As such, it helps address the dearth of information on the health and wellbeing of people with significant cognitive delay among the majority of the world's population (Emerson *et al.* 2007). Third, our results highlight very high rates of underweight (30%) and stunting (49%) among children with severe cognitive delay in middle and low-income countries. Given that undernutrition in early childhood is associated with a range of negative outcomes in later life (World Health Organization 2009, Walker et al. 2007, Liu et al. 2012, Victora et al. 2008, Black et al. 2008), it is possible that undernutrition in early childhood may play an important role in accounting for health inequalities and inequities experienced by people with significant cognitive delay in low and middle income countries (Emerson et al. 2018). These findings suggest, for example, that children with severe cognitive delay could be considered a high priority group for home and education-based nutritional interventions in early childhood.

The main strengths of the study are: (1) the use of nationally representative datasets from a wide range of low- and middle-income countries; and (2) the direct measurement of child weight and height using anthropometric equipment recommended by UNICEF to determine three separate indicators of undernutrition. The primary limitation of our study lies in the unknown validity of our use of the five selected ECDI items as screening measure of severe cognitive delay. However, some limited circumstantial evidence of the potential validity of the measure is provided by the strength and direction of association between severe cognitive delay and three well-established correlates of severe cognitive delay; male gender; household poverty; and evidence of undernutrition (Maulik *et al.* 2011, Black *et al.* 2016, Walker et al. 2007, Walker *et al.* 2011). As has been argued previously, while use of the ECDI and similar instruments should be considered an asset in epidemiological research in low and middle income countries, future research is needed 'to develop additional, more detailed, and age-specific measures of early childhood development that can more accurately capture children's capacity across a wide range of cultures and local contexts' (McCoy *et al.* 2016).

References

Bhaumik, S., Watson, J. M., Thorp, C. F., Tyrer, F. & McGrother, C. W. (2008) Body mass index in adults with intellectual disability: Distribution, associations and service implications: A population-based prevalence study. *Journal of Intellectual Disability Research,* **52,** 287-298.

Black, M. M., Walker, S. P., Fernald, L. C. H., Andersen, C. T., DiGirolamo, A. M., Lu, C., McCoy, D. C., Fink, G., Shawar, Y. R., Shiffman, J., Devercelli, A. E., Wodon, Q. T., Vargas-BarÓn, E., Grantham-McGregor, S. & the Lancet Early Childhood Development Series Steering Committee (2016) Early childhood development coming of age: science through the life course. *Lancet,* **389,** 77-90.

Black, R. E., Allen, L. H., Bhutta, Z. A., Caulfield, L. E., de Onis, M., Ezzati, M., Mathers, C., Rivera, J. & Group, T. M. a. C. U. S. (2008) Maternal and child undernutrition: global and regional exposures and health consequences. *Lancet,* **371,** 243–60.

Black, R. E., Victora, C. G., Walker, S. P., Bhutta, Z., Christian, P., de Onis, M., Ezzati, M., Grantham-McGregor, S., Katz, J., Martorell, R., Uauy, R. & and the Maternal and Child Nutrition Study Group (2013) Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet,* **382,** 427-51.

Emerson, E. (2005) Underweight, obesity and physical activity in adults with intellectual disability in supported accommodation in Northern England. *Journal of Intellectual Disability Research,* **49,** 134-143.

Emerson, E., Fujiura, G. T. & Hatton, C. (2007) International perspectives. In: *Handbook on Developmental Disabilities* (eds S. L. Odom, R. H. Horner, M. Snell & J. Blacher). Guilford Press, New York.

Emerson, E., Savage, A. & Llewellyn, G. (2018) Significant cognitive delay among 3- to 4-year old children in low- and middle-income countries: prevalence estimates and potential impact of preventative interventions. *International Journal of Epidemiology,* **47,** 1465–1474.

Hoey, E., Staines, A., Walsh, D., Corby, D., Bowers, K., Belton, S., Meegan, S., McVeigh, T., McKeon, M., Trepel, D., Griffin, P. & Sweeney, M. R. (2017) An examination of the nutritional intake and anthropometric status of individuals with intellectual disabilities: Results from the SOPHIE study. *Journal of Intellectual Disabilities,* **21,** 346–365.

Liu, L., Johnson, H. L., Cousens, S., Perin, J., Scott, S., Lawn, J. E. & al, e. (2012) Global, regional, and national causes of child mortality: an updated systematic analysis for 2010 with time trends since 2000. *Lancet,* **379(9832),** 2151-61.

Lloyd, M., Foley, J. T. & Temple, V. A. (2014) Body mass index of children and youth with an intellectual disability by country economic status. *Preventive Medicine,* **69,** 197-201.

Maulik, P. K., Mascarenhas, M. N., Mathers, C. D., Dua, T. & Saxena, S. (2011) Prevalence of intellectual disability: A meta-analysis of population-based studies *Research in Developmental Disabilities,* **32,** 419-436.

McConkey, R., Sadowsky, M. & Shellard, A. (2018 online) Journal of Intellectual & Developmental Disability. *An international survey of obesity and underweight in youth and adults with intellectual disabilities*.

McCoy, D. C., Peet, E. D., Ezzati, M., Danaei, G., Black, M. M., Sudfeld, C. R., Fawzi, W. & Fink, G. (2016) Early Childhood Developmental Status in Low- and Middle-Income Countries: National, Regional, and Global Prevalence Estimates Using Predictive Modelling. *PLoS Medicine,* **13** e1002034.

Phillips, K., Schieve, L., Visser, S., Boulet, S., Sharma, A., Kogan, M., Boyle, C. & Yeargin-Allsopp, M. (2014) Prevalence and Impact of Unhealthy Weight in a National Sample of US Adolescents with Autism and Other Learning and Behavioral Disabilities. *Matern Child Health J () :,* **18,** 1964-1975.

Rintala, P., Temple, V. A., Lloyd, M., Faro, C. & Foley, J. T. (2017) Association of poverty and social exclusion with body mass index among Special Olympics athletes in Europe. *International Journal of Public Health,* **62,** 921–928.

Robertson, J., Chadwick, D., Baines, S., Emerson, E. & Hatton, C. (2017) Prevalence of Dysphagia in People with Intellectual Disability: A Systematic Review. *Intellectual and Developmental Disabilities,* **55,** 377-391.

Robertson, J., Chadwick, D., Baines, S., Emerson, E. & Hatton, C. (2018) People with intellectual disabilities and dysphagia. *Disability and Rehabilitation,* **40,** 1345-1360.

Rutstein, S. O. (2008) The DHS Wealth Index: Approaches for Rural and Urban Areas. DHS Working Papers No. 60. Macro International Inc, Calverton, Maryland.

Rutstein, S. O. & Johnson, K. (2004) The DHS Wealth Index: DHS Comparative Reports No. 6. ORC Macro Calverton, Maryland.

Sari, H. Y. & Bahceci, B. (2012) Nutritional status of children with an intellectual disability. *International Journal on Disability and Human Development,* **11,** 17–21.

Temple, V. A., Foley, J. T. & Lloyd, M. (2014) Body mass index of adults with intellectual disability participating in Special Olympics by world region. *Journal of Intellectual Disabilities Research,* **58,** 277-284.

Temple, V. A., Foley, J. T. & Lloyd, M. (2015) Body Mass Index of adult Special Olympians by country economic status. *Journal of Policy and Practice in Intellectual Disabilities* **12,** 235–243

UNICEF (2014) The formative years: UNICEF's work on measuring early childhood development. UNICEF, New York.

UNICEF (2015) Monitoring the Situation of Children and Women for 20 Years: The Multiple Indicator Cluster Surveys (MICS) 1995–2015. UNICEF, New York.

United Nations Children's Fund, World Health Organization & The World Bank (2012) Levels and Trends in Child Malnutrition: UNICEF-WHO-The World Bank Joint Child Malnutrition Estimates. World Health Organization, Geneva.

United Nations Department of Economic and Social Affairs (2017) World Population Prospects: The 2017 Revision. United Nations Department of Economic and Social Affairs, New York.

Victora, C. G., Adair, L., Fall, C., Hallal, P. C., Martorell, R., Richter, L., Sachdev, H. S. & for the Maternal and ChildUndernutrition Study Group (2008) Maternal and child undernutrition: consequences for adult health and human capital. *Lancet,* **371,** 340–57.

Walker, S. P., Wachs, T. D., Gardner, J. M., Lozoff, B., Wasserman, G. A., Pollitt, E., Carter, J. A. & International Child Development Steering Group (2007) Child development: Risk factors for adverse outcomes in developing countries. *Lancet,* **369,** 145-157.

Walker, S. P., Wachs, T. D., Grantham-McGregor, S., Black, M. M., Nelson, C. A., Huff man, S. L., Baker-Henningham, H., Chang, S. M., Hamadani, J. D., Lozoff, B., Gardner, J. M. M., Powell, C. A., Rahman, S. & Richter, L. (2011) Inequality in early childhood: risk and protective factors for early child development. *Lancet,* **378,** 1325–38.

WHO Multicentre Growth Reference Study Group (2006) WHO Child Growth Standards: Length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: Methods and development. World Health Organization, Geneva.

World Health Organization (2009) Global Health Risks: Mortality and burden of disease attributable to selected major risks. World Health Organization, Geneva.

Table 1: MICS Survey Details					
Country	**Atlas method pcGNI (2017)**	**World Bank region**	**Year of survey**	**Sample size**	**Estimated sampling fraction**
Upper Middle-Income Countries					
St Lucia	8,780	Latin America & Caribbean	2012	122	2.77%
Mexico	8,610	Latin America & Caribbean	2015	3,417	0.07%
Kazakhstan	7,890	Europe & Central Asia	2015	2,277	0.29%
Montenegro	7,350	Europe & Central Asia	2013	649	4.39%
Turkmenistan	6,650	Europe & Central Asia	2015/16	1,518	0.56%
Cuba [a]	6,570	Latin America & Caribbean	2014	2,278	0.91%
Suriname	6,020	Latin America & Caribbean	2011	1,285	6.43%
Thailand	5,960	East Asia & Pacific	2015/16	5,603	0.36%
Serbia	5,180	Europe & Central Asia	2014	1,211	0.65%
Bosnia and Herzegovina	4,940	Europe & Central Asia	2011/12	1,031	1.59%
Macedonia	4,880	Europe & Central Asia	2011	558	1.20%
Iraq	4,770	Middle East & North Africa	2011	13,903	0.62%
Belize	4,390	Latin America & Caribbean	2015/16	1,116	7.15%
Guyana	4,060	Latin America & Caribbean	2014	1,350	4.50%
Algeria	3,960	Middle East & North Africa	2012/13	5,562	0.30%
Paraguay	3,920	Latin America & Caribbean	2016	1,861	0.69%
Lower Middle-Income Countries					
Kosovo	3,890	Europe & Central Asia	2013/14	672	0.67%
El Salvador	3,560	Latin America & Caribbean	2014	3,049	1.31%
Tunisia	3,500	Middle East & North Africa	2011/12	1,164	0.28%
Mongolia	3,290	East Asia & Pacific	2013/14	2,373	1.65%
West Bank and Gaza	3,180	Middle East & North Africa	2014	3,280	1.17%
Eswatini (Swaziland)	2,960	Sub-Saharan Africa	2014	1,091	1.53%
Bhutan	2,720	South Asia	2010	2,422	8.53%
Lao PDR	2,270	East Asia & Pacific	2011	4,476	1.45%
Moldova	2,180	Europe & Central Asia	2012	733	0.83%
Nigeria	2,080	Sub-Saharan Africa	2016/17	11,648	0.09%
Sao Tome & Principe	1,770	Sub-Saharan Africa	2014	867	6.99%
Cote d'Ivoire	1,540	Sub-Saharan Africa	2016	3,730	0.25%
Ghana	1,490	Sub-Saharan Africa	2011	3,069	0.19%
Bangladesh	1,470	South Asia	2012/13	8,801	0.14%
Cameroon	1,360	Sub-Saharan Africa	2014	2,846	0.19%
Congo, Republic	1,360	Sub-Saharan Africa	2015/15	3,675	1.13%
Kyrgyz Republic	1,130	Europe & Central Asia	2014	1,816	0.61%
Mauritania	1,100	Sub-Saharan Africa	2015	4,446	1.74%
Low Income Countries					
Zimbabwe	910	Sub-Saharan Africa	2014	4,009	0.40%
Benin	800	Sub-Saharan Africa	2014	4,880	0.70%
Guinea	800	Sub-Saharan Africa	2016	3,164	0.41%
Nepal	790	South Asia	2014	2,279	0.20%

Table 1: MICS Survey Details					
Country	**Atlas method pcGNI (2017)**	**World Bank region**	**Year of survey**	**Sample size**	**Estimated sampling fraction**
Mali	770	Sub-Saharan Africa	2015	6,550	0.05%
Guinea-Bissau	660	Sub-Saharan Africa	2014	2,970	2.61%
Chad	630	Sub-Saharan Africa	2010	7,139	0.69%
Togo	610	Sub-Saharan Africa	2010	1,804	0.39%
Sierra Leone	510	Sub-Saharan Africa	2017	4,810	1.06%
Congo, DR	450	Sub-Saharan Africa	2010	4,047	0.07%
The Gambia	450	Sub-Saharan Africa	2010	4,027	2.86%
Central African Republic	390	Sub-Saharan Africa	2010	3,771	1.29%
Malawi	320	Sub-Saharan Africa	2013/14	7,839	0.68%
Notes: pcGNI = per capita gross national income [a] pcGNI last updated in 2013					

Table 2: Estimated Prevalence of Significant Cognitive Delay, Underweight, Wasting and Stunting by Country Economic Classification							
Country	*Significant Cognitive Delay*	*Underweight*		*Wasting*		*Stunting*	
		Moderate	*Severe*	*Moderate*	*Severe*	*Moderate*	*Severe*
Upper Middle-Income Countries	2.9% (2.6-3.1)	3.0% (2.4-4.4)	0.8% (0.5-1.4)	1.4% (1.2-1.6)	0.8% (0.5-1.3)	9.7% (9.0-10.5)	1.9% (1.5-2.5)
Lower Middle-Income Countries	12.6% (11.8-13.4)	17.6% (16.9-18.2)	6.5% (6.1-7.0)	4.2% (3.9-4.5)	1.0% (0.8-1.1)	20.9% (20.3-21.5)	17.2% (16.5-18.0)
Low Income Countries	19.8% (18.7-21.0)	15.1% (14.4-15.9)	6.5% (6.0-7.1)	3.9% (3.5-4.3)	1.8% (1.5-2.1)	21.5% (20.6-22.3)	18.6% (17.5-19.8)
Overall	*12.3% (11.8-12.8)*	*13.5% (13.1-14.0)*	*5.2% (4.9-5.5)*	*3.5% (3.3-3.6)*	*1.1% (1.0-1.3)*	*18.5% (18.0-18.9)*	*14.0% (13.5-14.6)*

Table 3: Prevalence Rates and Adjusted Prevalence Rate Ratios for the Risk of Wasting, Underweight and Stunting Among Children with/without Significant Cognitive Delay by Country Economic Classification Groups

	Underweight		Wasting		Stunting	
	Moderate	Severe	Moderate	Severe	Moderate	Severe
Upper Middle-Income Countries						
No SCD	2.9% (2.6-3.4)	0.8% (0.4-1.4)	1.4% (1.2-1.6)	0.8% (0.5-1.3)	9.3% (8.6-10.2)	1.9% (1.4-2.5)
SCD	4.8% (3.4-6.8)	1.8% (1.0-3.4)	2.9% (1.9-4.4)	1.3% (0.8-2.2)	17.4% (14.6-20.5)	3.6% (2.3-5.4)
PRR	1.69** (1.18-2.42)	2.80** (1.39-5.65)	2.04** (1.33-3.15)	1.64 (0.82-3.28)	1.82*** (1.50-2.19)	2.08** (1.31-3.30)
Lower Middle-Income Countries						
No SCD	16.1% (17.4-23.2)	5.6% (6.1-11.6)	4.1% (3.8-4.4)	0.9% (0.7-1.0)	20.3% (19.6-20.9)	15.3% (14.6-16.0)
SCD	23.2% (21.3-25.3)	11.6% (10.4-13.0)	4.3% (3.4-5.4)	1.5% (1.1-2.3)	25.6% (23.8-27.4)	29.8% (27.6-32.1)
PRR	1.52*** (1.38-1.66)	2.23*** (1.96-2.54)	1.08 (0.86-1.37)	1.77** (1.17-2.68)	1.51*** (1.40-1.63)	2.05*** (1.89-2.21)
Low Income Countries						
No SCD	14.4% (13.6-15.2)	5.7% (5.2-6.3)	3.6% (3.3-4.0)	1.6% (1.2-1.9)	21.6% (20.6-22.5)	17.1% (16.0-18.3)
SCD	18.0% (16.3-19.8)	9.8% (8.6-11.2)	4.8% (4.1-5.7)	2.7% (2.2-3.5)	20.7% (19.0-22.6)	24.8% (22.7-27.0)
PRR	1.34*** (1.20-1.51)	1.83*** (1.56-2.15)	1.36** (1.13-1.65)	1.85*** (1.38-2.48)	1.05 (0.95-1.16)	1.43*** (1.31-1.57)
Overall						
No SCD	12.6% (12.2-13.1)	4.4% (4.1-4.7)	3.3% (3.1-3.5)	1.0% (0.9-1.2)	17.8% (17.3-18.3)	12.3% (11.8-12.8)
SCD	20.0% (18.7-21.3)	10.3% (9.5-11.2)	4.5% (3.9-5.1)	2.0% (1.7-2.5)	23.0% (21.8-24.3)	26.2% (24.8-27.8)
PRR	1.72*** (1.60-1.86)	2.57*** (2.31-2.86)	1.39*** (1.20-1.061)	2.06*** (1.62-2.61)	1.52*** (1.42-1.62)	2.23*** (2.08-2.40)

Table 4: Results of Multivariate Analyses of Child and Family Factors Associated with Indicators of Undernutrition Among Children with Significant Cognitive Delay						
	Underweight		Wasting		Stunting	
	Moderate	Severe	Moderate	Severe	Moderate	Severe
Child age	1.01** (1.01-1.02)	1.00 (0.98-1.01)	0.99 (0.97-1.02)	1.00 (0.98-1.03)	1.00 (0.99-1.00)	1.00 (0.99-1.01)
Child gender: Male	1	1	1	1	1	1
Child gender: Female	1.02 (0.91-1.16)	0.93 (0.78-1.12)	0.72* (0.52-0.96)	0.60** (0.41-0.87)	1.04 (0.95-1.15)	1.08 (0.98-1.19)
Upper middle income	1	1	1	1	1	1
Lower middle income	5.35*** (3.62-7.92)	7.28*** (3.78-14.05)	1.60 (0.97-2.65)	1.08 (0.55-2.12)	2.02*** (1.66-2.46)	9.44*** (5.88-15.17)
Low income	4.31*** (2.91-6.39)	6.14*** (3.19-11.83)	1.93** (1.18-3.14)	2.28** (1.23-4.20)	1.59*** (1.30-1.95)	7.79*** (4.84-12.53)
Wealth quintile 5	1	1	1	1	1	1
Wealth quintile 4	1.23 (0.86-1.75)	2.10* (1.02-4.27)	2.11* 1.13-3.95)	1.43 (0.52-3.91)	1.19 (0.91-1.54)	1.86** (1.29-2.67)
Wealth quintile 3	1.53* (1.10-2.13)	2.54* (1.23-5.25)	2.30** (1.23-4.32)	1.43 (0.64-3.18)	1.21 (0.95-1.55)	2.10*** (1.46-3.02)
Wealth quintile 2	1.64** (1.20-2.24)	3.59*** (1.80-7.17)	1.63 (0.93-2.84)	1.65 (0.74-3.70)	1.48** (1.16-1.88)	2.73*** (1.94-3.83)
Wealth quintile 1	1.80*** (1.31-2.48)	3.24** (1.61-6.52)	1.78* (1.01-3.12)	1.38 (0.61-3.09)	1.72*** (1.37-2.17)	2.94*** (2.07-4.16)
Maternal Education: Secondary	1	1	1	1	1	1
Maternal Education: Primary	0.94 (0.77-1.15)	1.08 (0.81-1.44)	0.64 (0.39-1.05)	0.35*** (0.19-0.61)	0.97 (0.84-1.12)	1.04 (0.88-1.22)
Maternal Education: None	0.94 (0.80-1.75)	0.92 (0.71-1.20)	0.77 (0.51-1.17)	0.61* (0.38-0.98)	0.90 (0.78-1.04)	1.00 (0.86-1.15)

Table 4: Results of Multivariate Analyses of Child and Family Factors Associated with Indicators of Undernutrition Among Children with Significant Cognitive Delay						
	Underweight		Wasting		Stunting	
	Moderate	Severe	Moderate	Severe	Moderate	Severe
High home stimulation	1	1	1	1	1	1
Low home stimulation	0.93 (0.81-1.07)	1.04 (0.85-1.27)	1.09 (0.79-1.52)	1.11 (0.65-1.88)	1.01 (0.89-1.14)	1.04 (0.92-1.16)
Note: * p<0.05, ** p<0.01, *** p<0.001						