

# Undernutrition and water, sanitation and hygiene

Water, sanitation and hygiene (WASH) play a fundamental role in improving nutritional outcomes. A successful global effort to tackle undernutrition must include WASH.

## Background

Almost half of all under-five child deaths globally are attributed to undernutrition.<sup>1</sup> Defined as an outcome of insufficient food intake or nutrient absorption, and repeated infectious diseases, undernutrition manifests as stunting (low height-for-age), wasting (low weight-for-height) and deficiencies in micronutrients. In 2014, 159 million children around the world were stunted and 50 million were wasted,<sup>2</sup> while an estimated 2 billion people suffer from micronutrient deficiencies.<sup>3</sup> The World Health Organization (WHO) estimates that 50% of undernutrition is associated with infections caused by unsafe water, inadequate sanitation or insufficient hygiene.<sup>4</sup>

## What are the links between undernutrition and WASH?

The relationship between nutrition and WASH is complex, with multiple and overlapping pathways.

**Direct links:** Unsafe water, poor sanitation and hygiene are directly linked to undernutrition in children through three key pathways: diarrhoea, intestinal worms (soil-transmitted helminths) and environmental enteric dysfunction (EED).<sup>5</sup>

- **Diarrhoea:** Diarrhoea, a consequence of poor WASH, is a leading cause of death in children, resulting in 8% of all under-five deaths globally.<sup>6</sup> Repeated episodes of diarrhoea contribute to undernutrition by hindering the absorption of nutrients. Children who are undernourished are also at high risk of suffering more frequent and severe episodes of diarrhoea, creating a vicious cycle.<sup>7</sup>
- **Intestinal worms (soil-transmitted helminths):** Without safe sanitation and hygiene, these infections are transmitted via contact with or ingestion of soil contaminated with human faeces that contain worm eggs. It is estimated that around 2 billion people globally are infected<sup>8,9</sup> and 4.5 billion are at risk of infection.<sup>10</sup> Such infections can lead to anaemia, poor growth and impaired cognitive development. Recent reviews have shown that improvements in sanitation can reduce the risk of infection by approximately 50%.<sup>10</sup>
- **Environmental Enteric Dysfunction (EED):** EED (also referred to as environmental or tropical enteropathy) is a sub-clinical condition affecting both the structure and function of the gut, which has been found to be associated with chronic enteric pathogen exposure and poor WASH conditions.<sup>11</sup> This condition may be a major cause of growth faltering because of the associated nutrient malabsorption and systemic inflammation. Although more rigorous

experimental evidence is needed to understand if and how improvements in WASH can reduce EED, at least three large intervention studies are currently addressing this (see below).

**Indirect links:** The **time** taken to fetch water, and the **cost** of water purchased from vendors when it is not readily available in the home, impact on the amounts and quality of water consumed, and on hygiene practices, which in turn impact on nutrition. Additionally, time spent sick with waterborne diseases or collecting water impedes educational attainment, which has a significant impact on health, wellbeing and poverty over a lifetime, and potentially over multiple generations.

### A growing evidence base

To date, there have been very few rigorous trials to determine the magnitude of the effect of WASH on undernutrition, because WASH has been given relatively low priority in medical research. However, in recent years, the need for better evidence in this area has been increasingly recognised.

- The first systematic review of the available evidence of the effects of WASH on childhood undernutrition was published in 2013. Conducted by the London School of Hygiene & Tropical Medicine through the Cochrane Collaboration, it found suggestive evidence of “a small benefit of WASH interventions (specifically solar disinfection of water, provision of soap, and improvement of water quality) on length growth in children under five years of age”.<sup>12</sup> In a subgroup analysis, the biggest effect on height growth was found in children younger than 24 months. Most of the studies included used point-of-use water treatment, and did not examine water supply or sanitation.
- Five randomised controlled trials on WASH and undernutrition have been published since the Cochrane Review. Results of two of these showed a significant effect on childhood stunting,<sup>13,14</sup> and three found no effect.<sup>15,16,17</sup> However, these latter three studies had very low uptake and compliance.
- Analysis in *The Lancet* in 2013 shows that a quarter of cases of stunting can be attributed to the occurrence of five or more episodes of diarrhoea before two years of age.<sup>18</sup>
- Econometric analysis of cross-sectional data from 65 countries reports that open defecation explains 54% of international variation in children’s height. This link is even stronger when population density is high. Although not evidence of causality, this suggests that India’s widespread open defecation and high population density place children at an increased threat of stunting, and may help explain the “Asian enigma”, whereby despite increases in economic growth, children in Asia are shorter on average than are those in Africa, who are poorer.<sup>19</sup>
- Although limited, the evidence linking EED to undernutrition is growing, with a number of large intervention studies underway with some results expected next year. The Sanitation Hygiene Infant Nutrition Efficacy (**SHINE**) study is a four-arm randomised trial in Zimbabwe examining the independent and combined impact of WASH and nutrition interventions on child growth.<sup>20</sup>

Similarly, the **WASH Benefits** trial in Bangladesh and Kenya is a cluster randomised trial investigating whether WASH and nutrition interventions alone or in combination lead to better improvements in linear growth during the first two years of life.<sup>21</sup> Meanwhile, the Maputo Sanitation (**MapSan**) controlled before-and-after trial is estimating the health impacts of a decentralised urban sanitation intervention in informal neighbourhoods of Maputo, Mozambique. It will assess whether exposures and health outcomes (including, among others, anthropometric measures) vary by population density.<sup>22</sup>

## Recommendations for research, policy and practice

Efforts to improve nutrition have focused on the immediate causes of undernutrition, including the quantity and quality of foods and micronutrients. Much less attention has been paid to the underlying causes of undernutrition, particularly the role of WASH. In the context of the new Global Goals, particularly Goals 2, 3 and 6, integration across multiple sectors, with joint targets, indicators and accountability will be critical to progress all goals. Action and collaboration between the WASH and nutrition sectors are urgently needed at global, national and programmatic levels, including:

- **Integrating WASH into national nutrition policies, strategies and plans**, with relevant targets, joint indicators and funding to measure progress and outcomes, including within the Global Goals framework.
- **Joint multi-sector action** from national governments, nutrition experts, health-care providers, WASH practitioners, academics and research institutions, donors and civil society. This requires strengthened accountability for nutrition-sensitive commitments, including WASH, made by governments and development partners.
- **Increased domestic and international funding for WASH** as a key 'nutrition-sensitive' intervention.
- **Improving the evidence base** through ongoing randomised control trials, which is important to fill knowledge gaps. Increased efforts should also be directed at understanding how WASH interventions can be tailored to support nutrition programmes to maximise efficiencies and health impact. Experiences of effective implementation of integrated programmes need to be evaluated, documented and included in programmatic guidance.

**WaterAid** is an international organisation working to transform lives by improving access to safe water, sanitation and hygiene in the world's poorest communities. We work with partners in 37 countries in Africa, Asia, Central America and the Pacific Region, and influence decision makers to maximise our impact. WaterAid contributes to the generation of evidence on the links between health and WASH through its research initiatives and partnerships.

**The Sanitation and Hygiene Applied Research for Equity (SHARE) Consortium** comprises eight organisations that have come together to generate rigorous and relevant research for use in the field of sanitation and hygiene. An eight-year initiative (2010–18) funded by the UK Department for International Development, SHARE brings together the energy and resources of our partners to make a real difference to the lives of people all over the world who struggle with the realities of poor sanitation and hygiene.

## References

- <sup>1</sup> Black RE, Victoria CG, Walker SP et al. (2013) Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet* 382: 427–51.
- <sup>2</sup> UNICEF, WHO & World Bank Group (2015) 'Levels and trends in child malnutrition: UNICEF – WHO – World Bank Group join child malnutrition estimates.
- <sup>3</sup> Bailey RL, West KP, Black RE (2015) The epidemiology of global micronutrient deficiencies. *Annals of Nutrition & Metabolism* 66 (suppl 2): 22-33.
- <sup>4</sup> WHO (2008) Safer water, better health: Costs, benefits and sustainability of interventions to protect and promote health. Available online at: [http://whqlibdoc.who.int/publications/2008/9789241596435\\_eng.pdf](http://whqlibdoc.who.int/publications/2008/9789241596435_eng.pdf)
- <sup>5</sup> Cumming O, Watson L, Dangour AD (2015; In Press) *Water, Sanitation and Hygiene - A Missing Link to Food and Nutrition Security*. In: Pritchard W, Ortiz R, Shekhar M, editors. Routledge Handbook on Food and Nutrition Security. London: Routledge.
- <sup>6</sup> UNICEF, WHO, World Bank Group & UN (2015) Levels and Trends in Child Mortality: Report 2015 Estimates developed by the UN inter-agency group for child mortality estimation. Available online at: [http://www.unicef.org/publications/files/Child\\_Mortality\\_Report\\_2015\\_Web\\_8\\_Sept\\_15.pdf](http://www.unicef.org/publications/files/Child_Mortality_Report_2015_Web_8_Sept_15.pdf)
- <sup>7</sup> Mara D, Lane J, Scott B and Trouba D (2010) Sanitation and health. *PLoS Med* 7, e1000363.
- <sup>8</sup> Brooker S, Clements AC, Bundy DA (2006) Global epidemiology, ecology and control of soil-transmitted helminth infections. *Advances in Parasitology* 62: 221-61.
- <sup>9</sup> World Health Organization (2012) Eliminating soil-transmitted helminthiases as a public health problem in children: Progress report 2001- 2010 and strategic plan 2011-2020. Available online at: [http://whqlibdoc.who.int/publications/2012/9789241503129\\_eng.pdf](http://whqlibdoc.who.int/publications/2012/9789241503129_eng.pdf)
- <sup>10</sup> Ziegelbauer K, Speich B, Mausezahl D et al (2012) Effect of sanitation on soil-transmitted helminth infection: Systematic review and meta-analysis. *PLoS Med* 9(1): e1001162, doi: 10.1371/journal.pmed.1001162
- <sup>11</sup> Lin A, Arnold BF, Afreen S et al. (2013) Household environmental conditions are associated with enteropathy and impaired growth in rural Bangladesh. *The American Journal of Tropical Medicine and Hygiene* 89 (1): 130-7.
- <sup>12</sup> Dangour AD, Watson L, Cumming O et al. (2013) Interventions to improve water quality and supply, sanitation and hygiene practices, and their effects on the nutritional status of children. *Cochrane Database of Systematic Reviews* DOI: 10.1002/14651858.CD009382.pub2
- <sup>13</sup> Hammer J and Spears D (2013) Village sanitation externalities and children's human capital: Evidence from a randomized experiment by the Maharashtra government. Available at: [https://www.princeton.edu/rpds/papers/Village\\_Sanitation\\_Externalities\\_February2013.pdf](https://www.princeton.edu/rpds/papers/Village_Sanitation_Externalities_February2013.pdf)
- <sup>14</sup> Pickering A, Djebbari H, Lopez C et al., Effect of a community-led sanitation intervention on child diarrhoea and child growth in rural Mali: a cluster-randomised controlled trial. *Lancet Glob Health* 2015; 3: e701–11
- <sup>15</sup> Clasen, T, Boisson S, Routray P et al., (2014) Effectiveness of a rural sanitation programme on diarrhoea, soil-transmitted helminth infection, and child malnutrition in Odisha, India: a cluster-randomised trial. *Lancet Glob Health* 2: e645–53
- <sup>16</sup> Patil S, Arnold B, Salvatore A et al. (2014) The Effect of India's Total Sanitation Campaign on Defecation Behaviors and Child Health in Rural Madhya Pradesh: A Cluster Randomized Controlled Trial. *PLOS Medicine* Vol 11; Issue 8; e1001709

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- <sup>17</sup> Cameron L, Shah M, Olivia S (2013) Impact of a large-scale rural sanitation project in Indonesia. Policy Research Working Papers. The World Bank Group. Available at: <http://elibrary.worldbank.org/doi/abs/10.1596/1813-9450-6360>
- <sup>18</sup> Walker CL, Rudan I, Liu L et al. (2013) Global burden of childhood pneumonia and diarrhoea. *The Lancet* 381 (9875):1405-16. DOI: 10.1016/S0140-6736(13)60222-6. Epub 2013 Apr 12.
- <sup>19</sup> Spears D (2013) How much international variation in child height can sanitation explain? The World Bank, Sustainable Development Network, Water and Sanitation Program. Available online at: <http://sanitationdrive2015.org/wp-content/uploads/2013/09/sanitation-height.pdf>
- <sup>20</sup> Humphrey J et al. SHINE Sanitation, Hygiene, Infant Nutrition Efficacy Project. Clinical Trials.gov <https://clinicaltrials.gov/ct2/show/NCT01824940>
- <sup>21</sup> Arnold BF, Null C, Luby SP et al. (2013) Cluster-randomised controlled trials of individual and combined water, sanitation, hygiene and nutritional interventions in rural Bangladesh and Kenya: the WASH Benefits study design and rationale. *BMJ Open* 3: e003476. DOI:10.1136/bmjopen-2013-003476
- <sup>22</sup> Brown J, Cumming O, Bartram J et al (2015) A controlled, before-and-after trial of an urban sanitation intervention to reduce enteric infections in children: research protocol for the Maputo Sanitation (MapSan) study, Mozambique. *BMJ Open* 5: e008125. DOI: 10.1136/bmjopen-2015-008215

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