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Articles

Effects of water quality, sanitation, handwashing, and nutritional interventions on diarrhoea and child growth in rural Kenya: a cluster-randomised controlled trial

Clair Null, Christine Stewart, Amy Pickering, Holly Willets, Benjamin Arnold, Charles D Arnold, Jade Benjamin-Chung, Thomas Clasen, Kathryn Dewey, Lia Fernald, Alan E Hubbard, Patricia Kariger, Austin Lin, Stephen P Luby, Andrew Martens, Sammy Njeng'a, Geoffrey Njoroge, Richard K Nzi, John M Gribble

Summary

Background Poor nutrition and exposure to faecal contamination are associated with diarrhoea and growth faltering, both of which have long-term consequences for child health. We aimed to assess whether water, sanitation, handwashing, and nutrition interventions reduced diarrhoea or growth faltering.

Methods The WASH Benefits cluster-randomised trial enrolled pregnant women from villages in rural Kenya and evaluated outcomes at 1 year and 2 years of follow-up. Geographically-adjacent clusters were block-randomised to active control (household visits to measure mid-upper arm circumference), passive control (data collection only), or compared-level interventions including household visits to promote target behaviours: drinking chlorinated water (water); safe sanitation consisting of disposing faeces in an improved latrine (sanitation); handwashing with soap (handwashing); combined water, sanitation, and handwashing; counselling on appropriate maternal, infant, and young child feeding plus small-quantity lipid-based nutrient supplement from 6–24 months (nutrition); and combined water, sanitation, handwashing, and nutrition. Primary outcomes were caregiver-reported diarrhoea in the past 7 days and length-for-age Z score at year 2 in index children born to the enrolled pregnant women. Masking was not possible for data collection, but analyses were masked. Analysis was by intention to treat. This trial is registered with ClinicalTrials.gov, number NCT018794185.

Findings Between Nov 27, 2012, and May 21, 2014, 8246 women in 782 clusters were enrolled and randomly assigned an intervention or control group. 1787 women were assigned to the active control group; 938 to passive control; 904 to water; 932 to sanitation; 927 to handwashing; 932 to combined water, sanitation, and handwashing; 943 to nutrition; and 933 to combined water, sanitation, handwashing, and nutrition. Data on diarrhoea at year 1 or year 2 were available for 4676 children, and data on length-for-age Z score in year 2 were available for 4583 children (96% of living children were measured at year 2). Adherence indicators for sanitation, handwashing, and nutrition were more than 70% at year 1, handwashing fell to less than 20% at year 2, and for water was less than 45% at year 1 and less than 20% at year 2; combined groups were comparable to single groups. None of the interventions reduced diarrhoea prevalence compared with the active control. Compared with active control (length-for-age Z score < -5.4) children in nutrition and combined water, sanitation, handwashing, and nutrition were taller by year 2 (mean difference 0.13 [95% CI 0.06–0.20]) in the nutrition group; 0.16 (95% CI 0.08–0.25) in the combined water, sanitation, handwashing, and nutrition group. The individual water, sanitation, and handwashing groups, and combined water, sanitation, and handwashing group had no effect on linear growth.

Interpretation Behaviour change messaging combined with technologically simple interventions such as water treatment, household sanitation upgrades from unimproved to improved latrines, and handwashing stations did not reduce childhood diarrhoea or improve growth, even when adherence was at least as high as has been achieved by other programmes. Counselling and supplementation in the nutrition group and combined water, sanitation, handwashing, and nutrition interventions led to small growth benefits, but there was no advantage to integrating water, sanitation, and handwashing with nutrition. The interventions might have been more efficacious with higher adherence or in an environment with lower baseline sanitation coverage, especially in this context of high diarrhoea prevalence.

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Introduction

An estimated 136 million children worldwide suffer from chronic (slow growth faltering) and are unlikely to reach their full potential as adults. Linear growth faltering

is the most apparent sign of chronic undernutrition and is the physical manifestation of combined physiological and developmental results. Early-life malnutrition leads to poor cognitive development in childhood, reduced

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Supplementary appendix

This appendix formed part of the original submission and has been peer reviewed.
We post it as supplied by the authors.

Supplement to: Null C, Stewart CP, Pickering AJ, et al. Effects of water quality, sanitation, handwashing, and nutritional interventions on diarrhoea and child growth in rural Kenya: a cluster-randomised controlled trial. *Lancet Glob Health* 2018; published online Jan 29. [http://dx.doi.org/10.1016/S2214-109X\(18\)30005-6](http://dx.doi.org/10.1016/S2214-109X(18)30005-6).

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Methods The WASH Benefits cluster-randomised trial enrolled pregnant women from villages in rural Kenya and evaluated outcomes at 1 year and 2 years of follow-up. Geographically-adjacent clusters were block-randomised to active control (household visits to measure mid-

upper-arm circumference), passive control (data collection only), or compound-level interventions including household visits to promote target behaviours: drinking chlorinated water (water); safe sanitation consisting of disposing faeces in an improved latrine (sanitation); handwashing with soap (handwashing); combined water, sanitation, and handwashing; counselling on appropriate maternal, infant, and young child feeding plus small-quantity lipid-based nutrient supplements from 6–24 months (nutrition); and combined water, sanitation, handwashing, and nutrition. Primary outcomes were caregiver-reported diarrhoea in the past 7 days and length-for-age Z score at year 2 in index children born to the enrolled pregnant women. Masking was not possible for data collection, but analyses were masked. Analysis was by intention to treat. This trial is registered with ClinicalTrials.gov, number NCT01704105.

Findings Between Nov 27, 2012, and May 21, 2014, 8246 women in 702 clusters were enrolled and randomly assigned an intervention or control group. 1919 women were assigned to the active control group; 938 to passive control; 904 to water; 892 to sanitation; 917 to handwashing; 912 to combined water, sanitation, and handwashing; 843 to nutrition; and 921 to combined water, sanitation, handwashing, and nutrition. Data on diarrhoea at year 1 or year 2 were available for 6494 children and data on length-for-age Z score in year 2 were available for 6583 children (86% of living children were measured at year 2). Adherence indicators for sanitation, handwashing, and nutrition were more than 70% at year 1, handwashing fell to less than 25% at year 2, and for water was less than 45% at year 1 and less than 25% at year 2; combined groups were comparable to single groups. None of the interventions reduced diarrhoea prevalence compared with the active control. Compared with active control (length-for-age Z score -1.54) children in nutrition and combined water, sanitation, handwashing, and nutrition were taller by year 2 (mean difference 0.13 [95% CI 0.01 – 0.25] in the nutrition group; 0.16 [0.05 – 0.27] in the combined water, sanitation, handwashing, and nutrition group). The individual water, sanitation, and handwashing groups, and combined water, sanitation, and handwashing group had no effect on linear growth.

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