Effects of water quality, sanitation, handwashing, and nutritional interventions on diarrhea and child growth in rural Kenya

Null C, Stewart CP, Pickering AJ, Dentz HN, Arnold BF, Arnold CD, Benjamin-Chung J, Clasen T, Dewey KG, Fernald LCH, *et al*. Lancet Global Health. 2018;6:e316-e29

Introduction

Diarrhea and linear growth faltering continue to be public health concerns in low-income countries and are among the most important causes of poor health during early childhood. Stunting is associated with elevated child mortality, impaired cognition and educational performance, lower adult wages and lost productivity and, when accompanied by excessive weight gain later in childhood, increased risk of nutrition-related chronic diseases (1). Diarrhea remains a leading cause of death among young children <5 years of age (2). Because infection can cause linear growth restriction, integrated interventions that combine nutrition and infection control may have a larger impact on stunting than either of these interventions alone.

The current Nutrition News for Africa summarizes a paper reporting the primary findings of the WASH Benefits study in Kenya, which was recently published in the *Lancet Global Health*. The objectives of this study were 1) to assess whether individual water, sanitation, handwashing and nutrition interventions reduce linear growth faltering, and 2) whether combining these interventions is more effective at reducing diarrhea and/or growth faltering than each intervention individually (3). A companion trial in Bangladesh evaluated similar objectives (4).

Methods

The WASH Benefits study was a cluster-randomized trial implemented in rural communities of western Kenya. The study included an active and a passive control group and the following 6 intervention groups, which are described in more detail below: 1) water, 2) sanitation, 3) handwashing, 4) combined water, sanitation and handwashing, 5) nutrition, and 6) combined water, sanitation, handwashing, and nutrition. Households in the active and the 6 intervention groups were visited monthly to measure the child's mid-upper arm circumference (MUAC). Households in the passive control group were not visited by health promoters. Outcomes and characteristics related to water, sanitation and handwashing were assessed in all intervention groups and the two control groups at the same time after 1 and 2 years of intervention. The sample size of the active control group was doubled to increase power for the comparisons between the six interventions and the control group.
Rural communities were eligible, if most of the population relied on communal water sources and had unimproved sanitation facilities. Women were eligible if they were pregnant in their 2nd or 3rd trimester and planned to live at their current residency for the next 2 years. The child(ren) born to the enrolled women were considered the primary study participants (i.e. index children). Clusters of neighboring villages were formed based on the number of pregnant women, and clusters were randomized to any of the groups. Due to the types of intervention, blinding was not possible.
Behavior change strategies were developed based on formative research and pilot tested. Health promoters were instructed to engage study participants through interactive activities, which were

outlined in detailed procedure manuals, including key messages, script for visual aids and other activities. In the 3 interventions that included water treatment, promoters advocated for treatment of drinking water with sodium hypochlorite and chlorine dispensers were installed at the point of water collection. In the 3 intervention groups that included sanitation, promoters advocated for using latrines for defecation and safe disposal of children's and animals' feces. New latrines were installed in study households, or existing unimproved latrines were upgraded to latrines. Children <3 yrs of age received plastic potties. In the 3 intervention groups that included handwashing, promoters advocated for handwashing with soap before handling food and after defecation. Handwashing stations were installed. In the two nutrition intervention groups, promoters advocated for best practices in maternal, infant and young child feeding through behavior change activities. Study mothers with children ages 6 – 24 months were also provided with two 10 g sachets per day of a small-quantity lipid-based nutrient supplement (LNS) to provide 118 kcal per day and 12 essential vitamins and 10 minerals.
Enrollment was followed by a baseline assessment, which included demographic information of the household and the pregnant woman, and characteristics and practices related to water, sanitation, handwashing and nutrition. An unannounced follow up visit was conducted after 1 and 2 years to observe behaviors of interest. The following day growth and health outcomes were assessed at a central location. Adherence was determined using observable indicators if possible. The WHO 2006 growth standards were used to calculate length-for-age (LAZ), weight-for-age (WAZ) and weight-for-length z-scores (WLZ). Caregiver reported diarrhea in the past 7 days was recorded at the follow up visit at year 1 and year 2.

Results

Of 2569 villages, 1226 villages were eligible and grouped into 702 clusters, of which each had 6 or more pregnant women. Household characteristics were similar across groups at enrollment. In the first year of implementation, about 75% of participants reported having been visited by their promoter in the previous months. This fell to 40% in year 2. Free chlorine was detectable in drinking water in slightly less than half of the households in the water group, and about 40% in the group that received all interventions combined. About 75% had access to improved latrines in the sanitation group. Safe disposal of children's feces fell by approximately half in all groups between year 1 and 2, but it was twice as likely in the groups that received the sanitation intervention. Seventy-five percent of households in the handwashing intervention had soap and water available in year 1, but this fell to 20% in year 2. Reported adherence to LNS was very high (>95%). Across all behaviors of interest, adherence was comparable between the combined intervention groups and the respective individual interventions.

None of the interventions reduced reported diarrhea prevalence compared with the active control group. Compared with the active control group, who had mean LAZ -1.54 ± 1.11 by year 2, children were taller if they were in the nutrition group [mean difference in LAZ 0.13 (95% confidence interval (CI) 0.01-0.25)] or in the group which received all interventions including nutrition [mean difference in LAZ 0.16 (95% CI 0.05-0.27)]. The impact on LAZ was already apparent by the end of year 1 in the nutrition groups, and LAZ by year 2 in these two groups did not differ from each other. Compared to the active control group (mean WAZ -0.72 ± 1.01), providing the nutrition intervention either alone [mean difference in WAZ 0.11 (95% CI 0.00-0.21)] or in combination with the other interventions [mean difference in WAZ 0.14 (95% CI 0.04-0.25)] also had an impact on mean WAZ. The individual interventions of water, sanitation and handwashing, and the group combining all of these three interventions (water, sanitation and handwashing) had no impact on final LAZ or WAZ.

Conclusions and policy implications

This large WASH Benefits cluster-randomized trial did not find an impact of improved water quality, safe sanitation, handwashing, nutrition or a combination of these interventions on reported diarrhea prevalence among young children <2 years of age. Only the nutrition interventions, which combined the distribution of LNS and nutrition focused behavior change communication (i.e. promotion of best practices of maternal, infant and young child feeding), improved growth of young children. The lower adherence to some of the practices in year 2 does not seem to be the only explanation as there was also no impact on diarrhea and linear growth in year 1 in the water, sanitation, handwashing and combined water, sanitation and handwashing groups. In contrast, the impact on growth was already detectable in year 1 among children who benefitted from the nutrition components of the interventions and this was maintained in year 2.

A companion trial was implemented in Bangladesh, which used a similar cluster randomized study design and evaluated the same objectives and had comparable findings regarding growth (4). However, in the trial in Bangladesh, diarrhea prevalence was reduced in all intervention groups except water treatment (4). Although there is some inconsistency in the scientific literature, findings from these two WASH Benefits trials suggest that upgrading existing latrines, disposing of children's feces safely, improving drinking water through chlorination and handwashing interventions are not sufficient to improve growth of young children. In contrast, these trials contribute to the increasing evidence that provision of LNS has the potential to improve child growth.

NNA Editor's Comments *

There is a need for scalable interventions to prevent childhood diarrhea and ensure healthy growth. It is noteworthy that even when the above mentioned interventions were provided for free, adherence was not very high and fell off for some practices in year 2 (except for LNS).
Both the WASH Benefits trial in Kenya and Bangladesh were very large, well designed and rigorously implemented cluster randomized trials. The consistent findings of the two trials suggest that water, sanitation and handwashing interventions provided to individual households do not improve growth in programmatic settings, but that LNS has the potential to have a small beneficial impact on children's growth.

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