CME

WASH and Nutrition in Public Health – Common Goals, Common Obstacles

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Abstract

Water, sanitation and hygiene (WASH) have traditionally been linked to acute gastro-intestinal infections. More recently it has been hypothesized that an important pathway through which inadequate WASH access impacts on the burden of disease is via a chronic inflammatory state in the intestines named environmental enteropathy. This condition is strongly associated with an unhygienic living environment and undernutrition in children. Improving WASH as well as macro- and micronutrient intake may be the primary means of preventing or mitigating environmental enteropathy and undernutrition. In this article, we discuss commonalities between the WASH and nutrition sectors with regard to research, advocacy and programmatic integration to tackle undernutrition. It is argued that WASH and nutrition as cornerstones of public health share a number of common goals but also common challenges that put both fields at risk of being de-prioritized in health policy.

Key Words

Water; sanitation; nutrition; hygiene

Introduction

There is increasing interest in international circles in finding ways to link the agendas of the WASH community and the nutrition community [1]. This is a welcome departure from the usual compartmentalized approach to public health practice, funding and research. The current interest in identifying and utilizing linkages between WASH and nutrition has been expressed in a series of articles and research studies that might open up a new approach to thinking about the role of both fields in public health.

What WASH and nutrition have in common

WASH and public health nutrition share a number of key features (Table 1). Both are 'upstream' relative to standard public health interventions in the sense that until people have enough food to eat and water to drink, there is little scope for other public health interventions. Unlike, for example, malaria or HIV interventions, WASH and nutrition are not disease-specific but have an impact on a wide range of communicable and non-communicable diseases. Adequate nutrition reduces infections by enhancing immune function. WASH interventions are likely to reduce the transmission of a wide range of human pathogens. While interrupting disease transmission directly may not be the main goal of nutritional interventions, improving food supply and handling may well have an effect on food borne transmission [2].

Both WASH and nutrition interventions contribute to child development and, consequently, general socio-economic development [3, 4]. While nobody likes to

study on an empty stomach, adequate nutrition [5] and WASH (for example by reducing soil transmitted helminth infections) improve cognitive functioning and school attendance [6-8]. The availability of functional school toilets promotes school attendance especially of girls. Obtaining sufficient amounts of food and water, as well as going to the toilet if there isn't any, consumes a large part of the time of families in low income settings, time that could be spent more productively pursuing educational or economic activities, or taking it easy [3].

The WASH and nutrition sectors face a number of common obstacles that make the eradication of WASH and nutrition related diseases appear like a distant dream. Both are complex public health interventions, requiring the engagement of a range of actors from government, international and local agencies and the private sector, as well as academics from diverse disciplines. Both tend to improve in line with economic development. WASH and nutrition interventions both interfere with cultural norms and long standing habits that may be difficult to change overnight. People going to the fields for defecation may find confinement to a smelly and dark latrine full of flies unattractive, while those used to eating white rice may be put off by the sight of rice that looks anything but white, regardless of the vitamin content.

WASH and nutrition – why do intervention studies show limited effects?

The WASH and nutrition sectors share another commonality; a sense of frustration that interventions are not making big enough inroads into the underlying problem of infectious disease and undernutrition. This is one of the reasons for the current calls for more joint action. Nutrition interventions only partially mitigate lower weight- and height-for-age in malnourished children [9, 10]. The evidence for water, sanitation and hygiene interventions is characterised by great difficulties in conducting high quality studies including trials in settings where they are most needed [11]. The methodological challenges of conducting high quality studies on WASH interventions include random allocation, complex logistics of implementation (often taking years to achieve meaningful coverage or behaviour change), and the large potential for confounding and bias [11]. Though many systematic reviews of the health impact of WASH interventions have shown water, sanitation and hygiene together and apart reducing diarrhoea risk by some 30-50% [12-17] these results are susceptible to bias due to lack of blinding and may be severe overestimates [18, 19]. Further, while reducing diarrhoea is a valuable goal, the main outcomes of public health interest are severe, life-threatening diarrhoea, mortality and nutritional status, which were rarely measured in adequately powered WASH trials. Also, recent cohort studies have identified viruses as leading causes for moderate to severe diarrhoea in children that are unlikely to be controlled by WASH [20].

The interaction between undernutrition and infection has many facets. Undernutrition leads to an increased susceptibility to infection. Many micronutrients are directly involved in different immune responses. Conversely, acute infection leads to a loss of appetite and nutrient loss [21]. The interaction between infection and undernutrition has often been described as a vicious circle [22, 23].There is good evidence that persistent diarrhoea has a negative impact on weight gain and linear growth in the short term [24-26], but it has also been suggested that catch-up growth after the episode often compensates for the short term growth impairment [9]. While there is no doubt that in poor settings many children experience frequent diarrhoea episodes and associated decreases in weight gain and linear growth especially in the first 6-24 months of life (Victora et al, 2010; Prentice et al, 2013), it is not clear to what extent diarrhoea contributes to inadequate growth [9].

Environmental enteropathy

Child under-nutrition, mortality and morbidity tend to improve when communities undergo profound socio-economic changes [27]. For example, many parts of Africa and South Asia have experienced sustained economic growth and decreases in child mortality over the past decade [28]. The causes for the mortality decrease are not clear. Parts of it may be explained by better medical treatment, improved access to healthcare and treatment seeking behaviour, but this may only be part of the story. As most health care staff working in low income settings can attest, children from poor families are more

often stunted [29], "look" unhealthier and tend to experience more severe disease and disease complications than children from wealthier families. However, as outlined above providing better nutrition to such children seems to improve their health only partially [9, 30].

One way to reconcile the relatively poor effects of nutrition interventions on growth outcomes with the astonishing improvements in child mortality and growth outcomes witnessed in many emerging countries is "environmental enteropathy", a disease concept that has been studied extensively in the past but only recently gained more recognition outside expert circles [9, 31]. Studies in malnourished children and persons temporarily living under poor hygienic conditions have suggested a direct link between exposure to poor hygiene and chronic inflammatory changes in the intestines that are characterised by a decrease in the villous height, infiltration of inflammatory cells, increased intestinal permeability (= impairment of the gut's barrier function against unwanted products), and a worsening of the intestinal absorption of essential nutrients [9, 31]. Evidence that "environmental enteropathy" (EE) may play an important role in the development of undernutrition in low income settings is mounting. Studies in the Gambia have suggested that environmental enteropathy may explain about half of the growth faltering in infants [32-34]. Environmental enteropathy usually only develops after the introduction of weaning and complementary foods when children become exposed to contaminated food and start to explore their environment (Ziegler Ann Nutr Rev 2003). It has further been shown that environmental enteropathy is strongly associated with socio-economic status [35], and in particular several indicators of high environmental exposure to pathogens such as water quality, sanitation and personal hygiene [36]. Gut permeability is improved after food interventions with high energy and micronutrient content in severely malnourished Bangladeshi children [37]. Another study from Bangladesh shows that the normal gut flora in healthy children undergoes physiological changes with increasing age and that this "maturing" of the gut flora is severely delayed in malnourished children and only partially catches up after a feeding intervention [38]. A third study from Bangladesh added to the evidence by showing that most infections with known or presumed gastro-intestinal pathogens are subclinical, and that the number of different asymptomatic pathogen species is much higher in poor than in wealthier settings, creating what has been termed a "pathobiome" in the intestines [39, 40]. These findings overall suggest that exposure to environmental pathogens may not only cause overt disease such as diarrhoea, but also a subclinical, chronic disease state that prevents children from making use of the available nutrition [9, 31]. Diarrhoea may only be the tip of the iceberg. Further, undernutrition including micro-nutrient deficiency as the main result of EE most likely is also an important cause of it [41]. For example, deficiencies in nutrients important for maintaining the integrity of the intestinal mucosa (for example Vitamin A, Zinc or glutamine) contribute to impaired functioning of the small intestines [41].

Can WASH interventions prevent environmental enteropathy and undernutrition?

If EE is a major cause for child undernutrition, and is part of the vicious cycle linking infection, undernutrition, and poverty (Figure), then cleaning up the contaminated environment in which children in poor settings tend to live might be the obvious answer. It is in this context that WASH interventions have attracted attention, curiously at about the same time as serious concerns as to their effectiveness on diarrhoea have been raised [42].

Independent of whether there is a marked impact of WASH on diarrhoea, WASH interventions may play a key role in preventing EE [9]. Access to sanitation, for example in the form of pour-flush toilets connected to a septic tank or sewer, may be considered the most "upstream" intervention by removing faecal matter at a place where it arises. Cleaner hands by washing frequently with soap may reduce the ingestion of pathogens via food, faecal-orally or via direct person-to-person contact. It may also be time to re-think the role of water quality, which continues to be a hotly debated issue in the WASH sector. While studies have shown that improving water quality at the household or source level has little impact on the risk of diarrhoea [19], it is possible that long-term exposure to water contaminated with pathogens may contribute to EE. WASH interventions may reduce undernutrition primarily

not only by reducing diarrhoea but by impacting on EE.

However, a recent Cochrane review looking at interventions to improve water quality and supply, sanitation and hygiene practices, and their effects on the nutritional status of children was unable to clarify the role of WASH to mitigate undernutrition [43]. The available evidence was suggestive of a small benefit of WASH interventions on length growth in children under five years of age. However, the duration of the intervention studies was short (perhaps too short to show any credible nutritional benefit to start with) and all were of low methodological quality. This conclusion probably not only highlights the relative neglect of WASH interventions in public health research but also the tremendous logistical and ethical challenges in undertaking high quality trials over long periods of time. Water and sanitation are part of the bare necessities of life that cannot be withheld from a control group for very long [11]. Despite these challenges, several high quality cluster-randomised trials are currently underway that investigate the effect of WASH interventions on nutrition. The SHINE trial in Zimbabwe is a factorial trial that tests the single and combined effects of nutrition and WASH on nutrition and gut permeability [44]. The WASH benefits trial conducted in Bangladesh and Kenya is a multi-arm trial looking at the single and combined effects of sanitation, handwashing, water and child nutrition on child growth [45]. The results from these trials may transform the way we think about child undernutrition, child survival, education and general socio-economic development in low income settings. By contrast, if these trials show little impact on health we may not be able to say why – it could be due to incomplete intervention coverage, lack of compliance with the intervention, effect dilution due to difficulties in outcome measurement or in deed due to a genuine ineffectiveness of WASH interventions. A negative result would almost inevitably confirm the current research priorities for the control of gastro-intestinal infections, which clearly emphasises vaccination against single diarrhoea pathogens and the delivery of curative, medical interventions [46]. Interventions that are difficult to prove in randomised trials risk being de-prioritized in a figure-driven health policy process failing to see the forest because there are too many trees [47].

However, there may be reasons to be pessimistic with regard to the potential of the classic water, sanitation and hand washing interventions to affect EE and undernutrition. Human societies are complex, as are the environments they create. Apart from water, sanitation and hand washing, there are many factors that distinguish poor communities from richer communities and that may explain the profound differences in child nutrition and mortality as well as of enteropathy. Table 2 lists some of the factors that may be involved in the evolution of EE in poor settings but is likely to be incomplete. While water, sanitation and hygiene feature prominently in this list, there are many other potential sources of environmental exposure in low income communities, including poor house structure, inadequate waste management, crowding, animal keeping, low quality food products and lack of time to clean up the living space. To change all this may appear a daunting task, requiring the whole society to change, which may not be possible in the absence of substantial increases in wealth or an unusually determined and powerful governmental sector.

WASH interventions should nevertheless remain a policy priority. As long as human faecal matter is present in the environment, no amount of clean-up may make much of a difference. Without sufficient water availability, keeping a home, its inhabitants and the food they eat clean is impossible. Improved water access and sanitation, and the concomitant improvements in home and personal hygiene may not only stand at the end of socio-economic development but also at its beginning, by saving time and facilitating economic and educational activities. If this in the end also means better housing, safer animal keeping, and better waste management, then environmental enteropathy may vanish as silently as it crept onto the public health agenda, and with it the high prevalence of undernutrition in poor settings.

WASH and nutrition – a common agenda?

Undernutrition remains a leading cause of morbidity and mortality in low income settings [42]. WASH and nutrition may have a key role to play in addressing this public health problem. There are at least three areas where a closer collaboration between the two

fields may be worthwhile: research, programme implementation and advocacy.

A research agenda with regard to environmental enteropathy has been outlined by Keusch and colleagues, largely focussing on obtaining a more detailed understanding of the microbiology and pathology of the condition, which is likely to enhance our knowledge on causative factors as well [31]. McKay and colleagues suggest more research into the potential for nutrition interventions to prevent or mitigate environmental enteropathy [41]. The evidence for a link between EE and undernutrition identified in observational studies appears already strong, even when accounting for the possibility that some of the associations seen may be due to confounding. It may not be needed to demonstrate an effect of WASH on undernutrition directly. Vaccination against rotavirus, for example, was introduced without clear evidence on an effect on undernutrition or mortality [48]. The great challenge lies in investigating the role of inadequate WASH access in contributing to EE and especially in testing whether a limited number of scalable WASH interventions can mitigate EE. It is not clear how much cleaner an environment needs to become in order to reduce EE and improve nutritional status. Whether intervention trials with follow up period limited to a few years will shed further light remains to be seen. There is a clear scope for nutritionists and WASH researchers to conduct additional large scale observational studies including birth cohorts as are already underway. A closer collaboration is likely to enhance the methodological quality of such studies.

Second, there is the question whether it is worth integrating WASH and nutrition programmatically in some sort of intervention package. This is not immediately obvious. Programmatically, WASH and nutrition are very different. Even within the WASH sector, it often makes sense to keep interventions separate. For example, while improving water access is often best led by governmental agencies, the private sector has an important role to play in providing sanitation services other than large-scale sewage networks. Evidence from other fields, for example the efforts to integrate HIV and family planning services suggests a risk of one intervention being prioritised over the other, depending on the public profile [49]. Beyond this, food hygiene is one area with a clear programmatic link between WASH and nutrition that may have an important role to play in reducing exposure to gastro-intestinal pathogens [2, 50]. Developing food hygiene interventions requires expertise from both fields since complex behaviour change is needed, ranging from water and food handling to food storage and distancing animal husbandry from the kitchen area. There may be further opportunities for integrating WASH and nutrition programmatically in general child health promotion activities in low income settings by using common platforms and communication channels.

Finally with respect to advocacy, both the WASH and nutrition sectors have a major task ahead that may be best tackled by joining forces. Because of the complexity of interventions and the difficulty in obtaining high quality evidence on effectiveness (unlike most medical interventions) WASH and nutrition have been and continue to be at risk of being de-prioritised. The potentially strong epidemiological link between WASH and nutrition suggests a need for a more long-term and interdisciplinary thinking. Wider awareness among the general population and policy-makers about the potential synergy between WASH and nutrition interventions to improve health and nutrition of children may increase demand for WASH access and nutritious foods, and possibly increase resource allocation for WASH and nutrition programmes, both separately and together.

Authors Contribution

WS, AE and VC jointly drafted this article. WS prepared figures and Tables.

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Tables

TABLE 1 COMMON GOALS AND OBSTACLES OF WASH AND NUTRITION INTERVENTIONS

Common goals	
	Upstream interventions – broad effect on wellbeing
	Improve nutritional status
	Improve immune function in general
	Interrupt disease transmission
	Contribute to child development by improving physical and cognitive function
	Free time to pursue educational, economic and leisure activities
Common obstacles	
	Complex interventions
	Interfere with cultural norms and long standing habits
	A task for the whole society
	Short term effectiveness elusive
	Long term effectiveness difficult to measure

TABLE 2 WHY POOR HOUSEHOLDS MAY BE MORE CONTAMINATED THAN RICH HOUSEHOLDS

Poor households	Rich households
Sanitation	
No toilet at all, or badly maintained latrine with leakage	Flush toilet connected to sewer or septic tank
Exposed to open defecation and waste water leakage in poor neighbourhoods	Most neighbours will have adequate sanitation – little environmental exposure to faecal matter
Water quality	
Water sources may be contaminated	Access to treated tap water
Contamination during water storage	Water either not stored at all or stored in sealed central tank e.g. on rooftop
Water untreated at home	Sufficient resources to treat water, e.g. by boiling or filtration
Water Quantity	
Water for personal hygiene and toilet flushing scarce	Sufficient water 24h/day for hand-washing, bathing and flushing
Water for home hygiene and food hygiene scarce	Sufficient water 24h/day for home hygiene, washing food and washing kitchen utensils
Waste management	
Waste dumped in immediate environment which attracts vectors such as flies and rats.	Waste taken away from home
Housing	
Fragile house structure with dirt soils	Solid houses with smooth, easy to clean surfaces
Subject to flooding	Functioning rainwater / surface water drainage
Crowding	No crowding
Food	
Inadequate food storage	Fridge
Lack of space – food preparation done close to other activities (e.g. animal keeping, child care)	Separate kitchen for food preparation
Food acquired from local markets and street vendors that may maintain poor hygiene.	Foods bought from supermarkets with higher hygiene standards and accountability.
Animals	
Livestock animals, often in close proximity with humans	Either no livestock at all or in a stables away from humans
Livestock manure collected and possibly used as fuel or other purposes	Resources to safely dispose of animal manure
Time	
Time used for making ends meet and fetching water	Time available for keeping environment clean, and educational activities (which may improve hygiene)
Most things have to be done by householders themselves	Time can be “bought” from others to do housecleaning, water fetching or food preparation.

Figures

FIGURE 1 THE VICIOUS CYCLES OF POVERTY, INFECTION, ENVIRONMENTAL ENTEROPATHY AND UNDERNUTRITION