

# POOR WATER, SANITATION AND HYGIENE ARE CAUSES OF ENVIRONMENTAL ENTERIC DYSFUNCTION THAT RESULTS IN CHILDHOOD STUNTING

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# INTRODUCTION

Environmental enteric dysfunction (EED), previously known as tropical or environmental enteropathy, is a symptom-free small intestinal disorder highly prevalent among children and adults living in tropical and sub-tropical countries [1]. The condition was first described more than 60 years ago among US Peace Corps volunteers stationed in Thailand and Bangladesh. They presented with unexplained weight loss and abnormal changes in small intestinal biopsy samples upon returning to their home country [2], after which the symptoms resolved within several months. It was therefore hypothesised that the role of the environment is crucial in the development of EED. Recent evidence confirms that EED is a consequence of sustained contact with enteric pathogens due to unhygienic sanitary practices and consumption of contaminated food and water. Frequent contact with intestinal germs induces abnormal activation of the immune system, resulting in inflammation and gut damage. Ultimately, malabsorption of nutrients and malnutrition occur.

## EED IN CHILDREN

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EED is characterised by chronic inflammation, reduced intestinal area for nutrient absorption and disruption of the barrier function in the small intestine [3]. Thus, it causes impaired nutrient absorption and contributes to compromised growth in young children. Recent evidence confirms EED's negative impact on childhood growth and mental development, particularly during the first two years of life. A number of studies done in different geographic locations including Bangladesh have documented EED as an immediate causal factor of linear growth failure [4]. Our recent research has shown a causal relationship between components of germs that inhabit the small intestine, EED and childhood stunting [5]. The condition is also associated with anaemia and iron deficiency in children [6] and results in poor impact of vaccines in children. It has also been suggested that childhood EED may lead to the development of non-communicable diseases in later life.

## EED IN ADULTS

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Adverse consequences of EED, e.g. malabsorption, undernutrition and micronutrient deficiencies, are also evident in adults living in poor environmental conditions [7]. Recent research in Dhaka using endoscopy showed features of EED in undernourished adults compared to their healthy counterparts [8]. Another study on adults conducted in a slum setting in Dhaka revealed that EED is associated with low body mass index and anaemia [9]. Moreover, in an African study, maternal EED was found to be associated with a shorter period of pregnancy and reduced length of new-born infants [10].

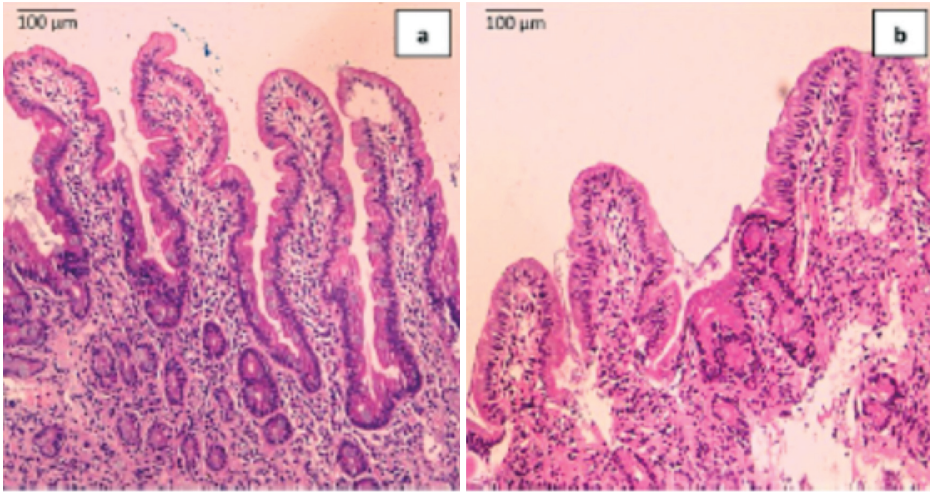
## CAUSATION OF EED

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The exact pathophysiology of EED is poorly understood. However, it is evident that it is associated with an unsanitary environment. The hypothesised causes include (a) environmental exposure to faecal germs, (b) mycotoxins, e.g. aflatoxin, fumonisin, and deoxynivaenol, (c) macro- and micronutrient deficiencies and (d) inflammation caused by recurrent infections [11, 12].

## DIAGNOSIS OF EED

The gold standard to diagnose EED is endoscopy and histopathology of a biopsied specimen. The condition is evidenced by typical histological changes in the small intestine.



**Figure 1.** Histological images of biopsy specimens. (a) Normal architecture of the small intestine. (b) EED [8].

## SIMPLE BIOMARKERS AS A DIAGNOSTIC TEST FOR EED

Endoscopy for obtaining biopsy specimens is challenging due to the procedure's required logistical support and invasiveness. Thus, several plasma, faecal and urinary biomarkers have been proposed to predict the characteristic features of EED. The most common manifestation of EED comprises intestinal inflammation, increased gut permeability and reduction of the absorptive area in the small intestine. Molecules such as myeloperoxidase, neopterin, lipocalin-2, alpha-1 antitrypsin, citrulline and calprotectin are

potential faecal markers for the evaluation of intestinal inflammation caused by EED. These biomarkers are being actively investigated to facilitate the diagnosis of this elusive illness.

## POTENTIAL INTERVENTIONS TO AMELIORATE EED

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It is indeed a challenge to ameliorate EED in both children and adults, as there is no effective and accepted therapy for the ailment. A number of treatment options have been tested or are under evaluation to tackle this problem. Potential interventions to combat EED include the following:

1. Improving water, sanitation and hygiene practices at both the individual and household levels
2. Reducing faecal contamination of food and water
3. Limiting exposure to poultry and other animals
4. Ensuring breastfeeding in children
5. Improving dietary diversity in both children and adults
6. Encouraging use of prebiotics, probiotics and synbiotics
7. Delivering nutrition interventions, including egg, milk and zinc
8. Using therapeutic interventions that can increase the number of beneficial gut germs
9. Providing anti-inflammatory therapy, e.g. 5-aminosalicylic acid
10. Using antimicrobials in the context of acute malnutrition and infection

## RECOMMENDATIONS

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We recommend identification and validation of simple biomarkers, which will enable early diagnosis and prompt management of EED. Since EED is driven by contaminated environmental conditions, specific measures must be taken to improve water, sanitation and hygiene practices at the community level. In addition, emphasis should be given on effective waste disposal system, cleaning of drains and removal of garbage from the domestic environments. It is also necessary to develop effective treatment interventions, e.g. microbiota-directed therapeutics, to ameliorate EED in both children and adults. Further research is required to understand the transmission of EED from mothers to new-borns.

## CONCLUSION

In conclusion, EED is pervasive among the residents of resource-poor environments. Given the high burden and adverse consequences of this asymptomatic pathology, it is considered a major concern for global public health and nutrition. Therefore, it is imperative to inform policymakers regarding EED's pathophysiology, diagnosis, implications and potential therapeutic solutions. This policy brief will advance the understanding of EED and facilitate the development of effective policies to prevent its pathological consequences.

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