Carbohydrate malabsorption in acutely malnourished children and infants: A systematic review

Summary of research

Location: Global

What we know: Diarrhoea is commonly associated with SAM; carbohydrate malabsorption may be a contributing factor.

What this article adds: A recent systematic review finds a consistently reported reduced capacity for carbohydrate absorption in severely malnourished children. Evidence is lacking on the extent of malabsorption, the impact on clinical outcomes and the relationship with infections. Malabsorption of monosaccharides and disaccharides is common (most observed is lactose malabsorption); this has implications for current SAM treatment since therapeutic products tend to be high in carbohydrates. Intervention studies are needed to determine whether different therapeutic food carbohydrate profiles affect outcomes of SAM complicated by carbohydrate malabsorption, and how.

Severe acute malnutrition (SAM) accounts for approximately one million child deaths per year. SAM is associated with multiple co-morbidities that may contribute to an increased risk of death, a prominent one being diarrhoea. A common cause of diarrhoea in developing countries is enteric infection, which, when associated with underlying malnutrition, can lead to villous blunting and, as a result, impaired carbohydrate absorption. In turn, significant decreases in carbohydrate absorption can lead to severe osmotic diarrhoea. To inform future modification of therapeutic feeds, it is necessary to determine the prevalence of carbohydrate malabsorption and to understand the possible impact of carbohydrate malabsorption on the recovery of malnourished children. This systematic review aims to evaluate the research to determine the extent to which carbohydrate malabsorption occurs in children with SAM, to find out what types of carbohydrate are malabsorbed, and to find out if carbohydrate malabsorption in children with SAM is associated with osmotic diarrhoea.

A comprehensive literature search was performed in PubMed and Embase and reference lists of selected articles were further screened for additional relevant publications. All observational and controlled intervention studies involving children with SAM in which direct or indirect measures of carbohydrate absorption were analysed were eligible for inclusion. A total of 20 articles were selected for this review.

Some of the included studies performed dynamic tests of carbohydrate absorption in children with malnutrition. The most common technique was blood glucose rise after carbohydrate tolerance tests using a glucose response curve after an oral carbohydrate load. For an oral tolerance test, generally 2g of carbohydrate per kilogram of body weight dissolved in a 10% solution was given orally after a six-hour fast and capillary blood was then sampled every 30 minutes for two hours. If the blood glucose rises less than 30mg/100ml after oral carbohydrate is administered, intolerance is considered likely; increments of less than 20mg/100ml are considered diagnostic of malabsorption. When compared with controls, children with SAM showed a decline in the average maximum glucose rise. Other studies compared malnourished children before and after treatment. One study (Viteri et al, 1973) reporting a significant improvement in carbohydrate absorption after treatment and another (James, 1972) showing no significant improvement after treatment in lactose or sucrose absorption.

Other studies, instead of comparing treated subjects with control subjects, investigated plasma glucose
increments in children with SAM to indicate malabsorption after administration of a carbohydrate load. Rothman et al (1980) showed that glucose increments in eight of 12 children with SAM fell below the cut-off value of 20mg/100ml, while increments in the remaining four were less than 30mg/100ml. These findings indicate that carbohydrate malabsorption is prevalent in children with SAM. Comparison of absorption of different types of carbohydrates was also done in several studies, which revealed that lactose intolerance is a concern for children with SAM. One study in particular looked at lactose malabsorption in different types of SAM and found that the proportion of children with lactose malabsorption was highest in those with kwashiorkor, second highest in those with marasmic kwashiorkor, and lowest in those with marasmus (James, 1972).

Some studies measured faecal pH and output of water and carbohydrate as markers of carbohydrate malabsorption. A pH of less than 5.5 (normal pH values range between 7 and 7.5) and the presence of reducing substances in the faeces are indicative of carbohydrate intolerance and malabsorption as a result of villous atrophy. A higher mean stool weight and a higher lactic acid content are also consistent with carbohydrate malabsorption. Reduced faecal pH was observed in children with SAM compared with controls in the studies that conducted carbohydrate tolerance tests, although the average pH was still more than 5.5 in all malnourished cohorts studied. Four studies demonstrated a significant reduction in mean stool weight in children on a disaccharide-free diet compared with children on a lactose-containing diet. For example, Maclean and Graham (1975) demonstrated that children with SAM on a low-lactose diet had a mean stool weight nearly three times lower than that of convalescent children. Overall, the data from faecal examination in included studies suggests the prevalence of carbohydrate malabsorption in children with SAM, as determined by increased mean stool mass, the presence of reducing substances, and an acidic faecal pH.

The other indirect method used for assessing carbohydrate absorption is the measurement of metabolic enzymes, namely lactase, sucrose and maltase in jejunal mucosal biopsy samples. Mucosal disaccharidases, specifically, are essential for disaccharide absorption. Different studies observed reduced levels of disaccharides in malnourished children. James (1972) further illustrated a rise in disaccharidase levels after treatment of both children with moderately acute malnutrition and children with SAM. In another study, two children with SAM showed normal lactase, sucrose and maltase activities; one child with SAM had low sucrose and maltase activities and borderline low lactase activity, and eight children with SAM had low lactase and sucrose activities, six of whom also has low maltase activity.

Measurement of anthropometric markers can be indirectly related to carbohydrate malabsorption and is harder to control for influencing factors. A study conducted in a cohort of 20 male children with SAM indicated that, despite the increased incidence of diarrhoea in the cohort on a lactose-containing diet compared with the cohort on a lactose-free diet, both cohorts recovered well and in a similar fashion with regard to anthropometric characteristics (Prinsloo et al, 1969). In contrast, two studies showed a decreased weight gain in children on a lactose-free diet. In one study in 20 malnourished children placed on a semi-elemental diet containing glucose and maltodextrin as the carbohydrates, the average weight gain after 21 days was 420g, while in the 18 malnourished children on the cow’s milk-based diet, the average weight gain after 21 days was 110g (Eichenberger et al, 1984).

This review finds a consistently reported reduced capacity for carbohydrate absorption in severely malnourished children. The extent of carbohydrate malabsorption, the impact of malabsorption on severe diarrhoea, dehydration and other adverse clinical outcomes, and the relationship between malabsorption and infection are unclear owing to the lack of conclusive studies. Most of the observational studies reviewed by the authors suggested a prevalence of lactose malabsorption and an increase in diarrhoea and reduced weight gain in children on a lactose-containing diet. The consistent observation of malabsorption of both monosaccharides and disaccharides could have profound implications for current treatment of severe malnutrition, since the therapeutic foods in most treatment protocols have a relatively high carbohydrate content. Additional well-designed intervention studies are needed to determine whether outcomes of SAM complicated by carbohydrate malabsorption could be improved by altering the carbohydrate/lactose content of therapeutic feeds and to explain the precise mechanisms involved.
References


*Kvissberg, MA; Dalvi, PS; Kerac, M; Voskuijl, W; Berkley, JA; Priebe, MG; Bandsma, RH (2015) Carbohydrate malabsorption in acutely malnourished children and infants: A systematic review. Nutrition reviews. ISSN 0029-6643 DOI: 10.1093/nutrit/nuv058

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