Reviews/Analyses

Prevention of diarrhoea in young children in developing countries

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An updated review of nonvaccine interventions for the prevention of childhood diarrhoea in developing countries is presented. The importance of various key preventive strategies (breast-feeding, water supply and sanitation improvements) is confirmed and certain aspects of others (promotion of personal and domestic hygiene, weaning education/food hygiene) are refined. Evidence is also presented to suggest that, subject to cost-effectiveness examination, two other strategies — vitamin A supplementation and the prevention of low birth weight — should be promoted to the first category of interventions, as classified by Feachem, i.e. those which are considered to have high effectiveness and strong feasibility.

Introduction

The main target of diarrhoea control programmes in developing countries is successful case-management, primarily through the use of oral rehydration therapy (ORT) and promotion of appropriate feeding during and after an episode of diarrhoea. Preventive strategies for morbidity are needed, however, if the estimated annual thousand million episodes of diarrhoea among under-5-year-olds are to be reduced and further decreases in the 3.3 million diarrhoea-related deaths are to be achieved (*1*). A systematic review of potential interventions for the control of diarrhoeal diseases was initiated by WHO in 1982 (*2*). A total of 18 interventions were evaluated and classified into three groups based on an assessment of their effectiveness and feasibility (*3*) and the cost-effectiveness of the seven interventions that were identified to have high effectiveness and reasonably strong feasibility was assessed (*4*, *5*).

Subsequently, various questions raised in these reviews have been addressed. In particular, we prepared an updated review of nonvaccine, diarrhoeal interventions for the Xth World Congress of Gastroenterology, and present here a summary of our findings. Focusing on the questions raised in the original reviews, the four nonvaccine interventions identified as being adequately feasible and effective are covered: promotion of breast-feeding; improving weaning practices; improving water supply and sanitation; and promotion of personal and domestic hygiene. Two preventive strategies that were identified as requiring further research are also included: vitamin A supplementation and the prevention of low birth weight. A third, food hygiene, is included here as part of the assessment of improving weaning food practices.

Promotion of breast-feeding

Several updates of Feachem & Koblinsky's review (*6*), which was carried out in 1984, have been published (*7–10*). They identified good quantification of the effect of breast-feeding on diarrhoea mortality among infants in various socioeconomic settings as the highest research priority. Other research needs included clarification of the levels of protection against diarrhoeas of different etiologies and assessment of the relationship between feeding mode and both diarrhoea severity and persistent diarrhoea.

Mortality from diarrhoea

In a landmark study in southern Brazil, Victora et al. (*11*, *12*) found that, compared with exclusively breast-fed (EBF) infants, those who were partially

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breast-fed (PBF) had a 4.2 times higher risk of death caused by diarrhoea, which increased to 14.2 times higher for those not receiving any breast milk (NBF). Protection was greatest among infants aged 0–2 months (relative risk (RR) for PBF = 5.3 and for NBF = 23.3). Each additional daily feed of breast milk reduced the risk of diarrhoea death by 20%. There was no evidence that the protective effect persisted after weaning. Breast-feeding also afforded protection against deaths from persistent diarrhoea (RR for PBF = 4.3 and for NBF = 10.0) and possibly for those from dysenteric infection (RR for PBF = 4.9 and NBF = 3.0) (*13*).

In Bangladesh, Briend et al. (*14*) found that among malnourished children, breast-feeding protected against death from all causes up to 3 years of age. Although the number of deaths was small, breast-feeding protected against death due to bloody diarrhoea (RR = 0.19) and chronic nonbloody diarrhoea (RR = 0.11). Also, in Guinea–Bissau breast-feeding protected against death among older children (*15*). After adjustment for confounding, children aged 12–35 months who were not breast-fed had a risk of death 3.5 times greater than that of their breast-fed counterparts; no breakdown by cause of death was given, but diarrhoea morbidity rates were high (up to eight episodes per child per year) and thus as in many countries in sub-Saharan Africa, diarrhoea is probably a major cause of death among young children in Guinea–Bissau. Protection was therefore probably afforded against diarrhoeal deaths. In Ethiopia, infants who were not breast-fed experienced a tenfold increase in diarrhoea mortality (*16*).

Comparison of children who died because of diarrhoea and those who survived a diarrhoeal episode confirms that breast-feeding protects against case fatality. In India, children aged ≤18 months who were hospitalized for diarrhoea were 2.7 times more likely to die if they were not breast-fed (*17*). The protective effect declined with age, the odds ratio being 6.0 for those aged 0–6 months, 2.6 for those aged 7–12 months, and 1.8 for those aged 13–18 months. Breast-feeding also afforded more protection among children suffering from persistent diarrhoea, those who were malnourished, and those who had no other major infection. In Rwanda, children under 2 years of age who had been admitted to hospital for diarrhoea were more than three times as likely to die if they were weaned than if they were breast-fed (*18*).

Etiology of diarrhoea

In infants breast-feeding affords protection against symptomatic infection with *Shigella* spp. (*8*, *19–21*), *Vibrio cholerae* (*8*, *20*, *22*), *Campylobacter* spp. (*21*, *23*), *Salmonella* spp. (*8*, *21*) and enterotoxigenic *Escherichia coli* producing heat-labile toxin (LT-ETEC) (*24*). Protection against cholera, and *Shigella* spp. appears to extend into the second and third years of life, albeit at a lower level than in infancy. In Bangladesh, breast-feeding was found to reduce the severity of infection with *Shigella* spp. (*25*) and *V. cholerae* (*22*). It is not clear whether breast-feeding offers protection against rotavirus, although breast-fed cases may experience less severe episodes (*19*).

Severity of diarrhoea

As indicated above, breast-feeding protects against the severity of cholera and *Shigella* spp. infections. Substantial protection is also offered against hospitalization for diarrhoea. For example, in Iraq, young infants who were bottle-fed were most at risk, being 55 times more likely to be hospitalized for diarrhoea than their exclusively breast-fed counterparts (*26*). In southern Brazil, infants who started to receive supplements in addition to breast milk during the first week of life were five times more likely to be hospitalized for diarrhoea by 3 months of age (*27*). For infants who stopped breast-feeding during the first week of life the corresponding relative risk was 12.

Results from three case–control studies undertaken to establish risk factors for moderate or severe dehydrating diarrhoea in children aged 0–23 months have been collated (Kirkwood & Morris, unpublished data, 1992). These studies, conducted in Bangladesh, Brazil, and Egypt, showed that breast-feeding provided substantial protection against an episode of diarrhoea that resulted in life-threatening dehydration. After adjusting for appropriate confounders, nonbreast-fed children were at a 2.3 times (Bangladesh) to 3.0 times (Brazil) greater risk of dehydration. In Brazil, the protective effect was greatest among young infants (<6 months), in Bangladesh among the age group 6–11 months, while in Egypt the impact was similar for all age groups. In Ethiopia odds ratios were 4.2 for nonbreast-fed and 2.9 for partially breast-fed relative to exclusively breast-fed children aged 0–6 months, although no adjustment for confounding was made (*28*). This protective effect was not evident in children aged 7–12 months.

The evidence concerning breast-feeding and morbidity caused by persistent diarrhoea is mixed. In southern Brazil, infants who stopped breast-feeding in the first week of life had a five times higher risk than their breast-fed counterparts of persistent diarrhoea before 3 months of age (*27*). Several studies have compared cases of persistent and acute diarrhoea. Sazawal et al. found that exclusive

breast-feeding appeared to offer substantial protection against a persistent episode, although it was not statistically significant (*29*). Baqui et al. showed that reduced breast-feeding during an episode of diarrhoea resulted in an almost two-fold increase in the risk of it becoming persistent (*30*). Also, Lanata et al. reported that the risk of an episode becoming persistent was higher among those not given breast milk during the first week of illness (OR = 1.6), but this was not significant (*31*).

The findings of the above studies confirm the role played by breast-feeding in the prevention of diarrhoea. Although data on diarrhoea mortality are still relatively scarce, those that are available show the strong protective effect of breast-feeding and the results on protection against diarrhoea severity also support this finding. Exclusive breast-feeding during the early months of infancy appears to be of particular importance, and although the value of prolonged breast-feeding has been questioned on nutritional grounds, the answer remains unclear (*32*). The protective effect of breast-feeding among older children against infection with *Shigella* spp. and cholera, overall diarrhoea, and mortality, particularly among those who are malnourished, suggests that mothers should not be discouraged from breast-feeding this age group. The results on progression of diarrhoea episodes to dehydration or to persistent episodes endorse the continuation of breast-feeding during diarrhoea. These benefits have influenced thinking on breast-feeding policy in countries affected by human immunodeficiency virus (HIV). Despite the risk of vertical transmission of HIV infection in affected areas, in many situations the health risks of not breast-feeding far outweigh the potential number of lives saved through abandoning this practice (*33*).

Improving weaning practices

Ashworth & Feachem located no studies which measured directly the impact of weaning education on diarrhoeal disease (*34*). However, data from 12 countries suggested that weaning education can improve the nutritional status of infants and young children. Calculations of the impact on diarrhoea of a weaning education programme yielded estimated reductions of 2–12% in diarrhoea mortality. These estimates were based on the potential impact due to improved nutritional status, but did not include the impact that might be achieved through reduced food contamination. The latter was dealt with in a review by Esrey & Feachem (*35*); however, because of lack of adequate data, only tentative conclusions could be made on the impact of food hygiene practices on childhood diarrhoea. Research was urged into those practices that are risk factors for faecal contamination (and therefore likely to be associated with diarrhoea) and also into interventions to modify such risk-related practices.

Certain food handling, preparation, and storage practices increase the risk of faecal contamination. For example, cooked foods stored at ambient temperatures for more than 3–4 hours have higher levels of bacterial pathogens than those stored for shorter periods (*36–40*). Use of cups rather than feeding bottles reduces contamination of weaning foods (*38, 41*). In Ghana, the effect of fermentation on the bacterial contamination of weaning foods containing maize dough was examined (*42*). Unfermented dough samples were significantly more contaminated; also, 6 hours and 12 hours after being prepared, porridge was more contaminated if it was made from unfermented dough.

The feasibility of improving the hygiene levels of weaning food was investigated in a multidisciplinary project in north-east Brazil, in which novel methods were used to identify four key weaning food hygiene practices to target for change (*43*). The selection of behaviours was based on their prevalence, estimated feasibility for change, and anticipated impact on contamination of weaning foods; feasibility for change was then tested in a 1-month household micro-trial. Messages were developed to promote the following: washing hands before food preparation; use of boiling water to reconstitute powdered milk; feeding of gruels using a cup and spoon instead of a bottle; and avoiding storing gruel and milk. In each case 15 mothers or caretakers were asked to adopt one of these behaviours for the trial period; a fifth group was asked to implement all four behaviours. Most of the mothers were able to maintain the promoted practices for 1 month and at least half were able to practise the behaviour each time the baby was fed, thus demonstrating the feasibility of changing appropriate behaviours.

Several studies are under way to investigate ways of increasing the energy intake of young children. In Jamaica, a preliminary trial showed that consumption of a thick energy-dense porridge was significantly lower than that of a traditional liquid porridge (average, 98 vs 139 $g \cdot kg^{-1} \cdot day^{-1}$) but the energy intake was significantly higher (average, 402 vs 296 $kJ \cdot kg^{-1} \cdot day^{-1}$). Amylase treatment of the thick energy-dense porridge, to reduce its viscosity, did not increase intakes further (*44*). Preliminary results from a weaning intervention in Peru show that the total amount of complementary food consumed varied inversely with its energy density; consumption was greater when more meals were offered (4 or 5 vs 3) (*45*).

All these results can contribute to the formulation of effective weaning intervention strategies for the prevention of diarrhoea morbidity. As with promotion of breast-feeding, however, change in behaviour is involved, which poses particular challenges for health promotion workers.

Improving water supplies and sanitation

Unlike many of the other preventive strategies, improvement of water supplies and sanitation has been the subject of intervention studies worldwide. The original review carried out by Esrey et al. in 1985 summarized results from 67 studies in 28 countries to assess the impact of improved water supplies and sanitation (*46*). In 1991 Esrey et al. reviewed a further 17 studies and obtained very similar findings — a 22% (range, 0–100%) median reduction in diarrhoea morbidity, 26% (range, 0–68%) from those studies considered to be more rigorous (*47*). Several other recent studies (*48–51*) have reported similar reductions. A median reduction of 65% (range, 43–79%) was estimated for diarrhoea-specific mortality, although none of the three studies involved were classified as rigorous (*47*). Based on the results of six rigorous studies, a median reduction of 55% (range, 20–82%) in overall child mortality was found. These reductions, based on a relatively small number of studies, must, however, be interpreted with caution. Water and sanitation would be expected to have little impact on several other major causes of overall infant and child mortality. Thus, a measure which reduced diarrhoea-specific mortality by 65%, would not be expected to have such a sizeable impact on overall mortality.

Esrey et al. also examined the health impact according to the type of intervention (*46*). Their findings suggest that improvements in water quantity and in excreta disposal may be more significant than improvements in water quality alone. However, this was less clear in the later review (*47*), in which the more rigorous studies were examined separately, although the number of studies involved was small. A recent analysis of data from demographic and health surveys conducted in eight countries demonstrated that improvements in sanitation had a greater impact on diarrhoea prevalence than improvements in water supply (*52*). These findings were based on comparisons between studies; however, within-study results also support this idea, particularly in favour of water availability (*48–50*, *53*, *54*). Nevertheless, the limitations of ascribing health impact to one particular component of an integrated intervention programme have to be recognized.

Some intervention studies have assessed the impact of improved services according to the presence of other factors. For mortality (*55*, *56*) and morbidity (*57*) the impact was greater among infants not breast-fed. In Malaysia, sanitation had a greater impact on infant mortality among the children of illiterate mothers (*58*), whereas in Lesotho the reverse was true for the impact on diarrhoea morbidity (*50*).

A number of reasons have been proposed to account for the range of impacts achieved with water supply and sanitation interventions, and have been summarized by Huttly (*59*). The relatively low priority assigned to water supply and sanitation improvements has been challenged by Briscoe (*60*), who describes as misleading those cost-effectiveness analyses that fail to take account of the multiple health benefits, direct or indirect, of sanitary improvements. This author also concludes that the long-term effects on child survival are probably substantial, in addition to the more immediate impacts on morbidity. Thus, while it is clearly complex, improving water supplies and sanitation facilities in development activities seems justified (*60*, *61*). The challenges are great, with approximately a thousand million people remaining unserved by improved water supplies and 1.7 thousand million being unserved by adequate sanitation (*62*).

Promotion of personal and domestic hygiene

As described above, improvements in water quantity may have more impact on diarrhoea than improvements in water quality alone, and this has been attributed to better personal and domestic hygiene. As a consequence, the promotion of hygienic behaviours is receiving increased attention as a preventive strategy against diarrhoeal diseases. In 1984 Feachem (*63*) found only three relevant studies whose health impact could be assessed. Since then, several more studies have appeared, which permits a better assessment, and significant developments are occurring in the design and evaluation of such interventions.

Of 10 studies which aimed specifically at improving hygiene practices (*64*), all showed a positive impact on diarrhoeal morbidity in young children (Table 1), with a median reduction of 33% (range, 11–89%). Five studies focused specifically on hand-washing (median reduction, 35%), while the remainder dealt with a range of behaviours, including hand-washing, (median reduction, 26%). Three projects that were implemented as integrated water supply, sanitation, and hygiene education

Table 1: **Impact of hygiene behaviour interventions on diarrhoea morbidity, according to type of behavioural intervention**

Hand-washing:		Several behaviours:	
Location	% reduction in morbidity	Location	% reduction in morbidity
USA (ref. *87*)	48	Bangladesh (ref. *88*)	ca. 40
Burma (ref. *89*)	30	Zaire (ref. *90*)	11
Bangladesh (ref. *91*)	35	Thailand (ref. *92*)	34
India (ref. *93*)	32	Bangladesh (ref. *94*)	26
Indonesia (ref. *95*)	89	Guatemala (ref. *96*)	14
Median % reduction	35	Median % reduction	26

programmes attempted to relate their health impact to the behaviours being promoted. Their overall impact on diarrhoea was approximately the same as that for water supply and sanitation improvements or hygiene improvements alone. These integrated projects, however, generally had less intensive hygiene promotion than the dedicated hygiene projects.

The results suggest that a greater health impact may be achieved if a single behaviour, in this case hand-washing, is targeted. The number of studies remains relatively small, however, but it is clear that individual hygiene education campaigns should not promote too many different messages. In consequence, WHO has recently identified three key water-related behaviours for promotion (*65*): cleansing of hands — especially after defecation, after cleaning babies and young children's bottoms, and before eating and before preparing food; sanitary disposal of faeces — especially those of young children and babies, and those with diarrhoea; and maintaining drinking-water free from faecal contamination. Advances have also been made in the development of methods for the more efficient promotion of hygiene behaviour change as well as in tools for evaluation of changes (*66*). The results appear promising, especially for communities where substantial hardware improvements remain distant.

Vitamin A supplementation

In 1987, Feachem reviewed the relationship between vitamin A deficiency and diarrhoea in young children (*67*), a topic of considerable interest following the report of Sommer et al. (*68*) that vitamin A supplementation reduced child mortality by 34%. Studies were urged to investigate further the potential of vitamin A supplementation.

There is now scarcely any doubt that prophylactic supplementation with synthetic vitamin A can reduce at least diarrhoea mortality rates in young children. The evidence to support this assertion comes from the results of five large-scale, community-based, randomized controlled trials of vitamin A supplementation in young children (Table 2). A further three similar studies have only reported effects on all-cause mortality, but their pooled results are no different from those of the other five studies.

The estimates of the effect of vitamin A supplementation on diarrhoea mortality are remarkably consistent across the five different studies, despite the diversity of settings and methodologies adopted. Only one study failed to show a beneficial impact on diarrhoea mortality (*100*). This study also found no overall impact on all causes of death combined (in marked contrast to the other four studies, which found that vitamin A supplementation was associated with reductions in the range 19–54%); however, total vitamin A intake was significantly associated with both all-cause and diarrhoea-specific mortality — children at the 90th percentile of the distribution of total vitamin A intake experienced a reduction of ca. 75% in the risk of diarrhoea mortality relative to children at the 10th percentile, after adjusting for socioeconomic confounding (relative risk, 0.25; 95% confidence interval (CI): 0.10–0.65) (*69*).

Table 2: **Impact of prophylactic vitamin A supplementation on diarrhoea mortality**

Location	Relative risk[a]
Nepal, highlands (ref. *97*)	0.65 (0.44–0.95)[b]
Nepal, lowlands (ref. *98*)	0.61
South India (ref. *99*)	0.48 (0.24–0.96)
Sudan (ref. *100*)	1.01 (0.68–1.49)
Ghana (ref. *101*)	
Acute diarrhoea	0.66 (0.47–0.92)
Chronic diarrhoea/malnutrition	0.67 (0.38–1.18)

[a] Vitamin A: placebo group.
[b] Figures in parentheses are 95% confidence intervals.

Two meta-analyses have attempted to synthesize the results from studies carried out in Nepal, India, and Sudan (*70, 71*). Both conclude that vitamin A supplementation is associated with a significant reduction in diarrhoea-specific mortality, with summary relative risks of 0.71 (95% CI = 0.57–0.88) and 0.69 (95% CI = 0.57–0.84). The inclusion of the results from a study carried out in Ghana would presumably have reduced these relative risk estimates still further (closer to the levels of 0.66/0.67 found in that study). Supplementation with synthetic vitamin A may therefore reduce diarrhoea mortality rates in young children by approximately one third.

There has also been considerable interest in establishing the magnitude of the effect of prophylactic vitamin A supplementation on the incidence, duration, and severity of diarrhoea. The most reliable information on these outcomes arises from four intensive, prospective studies (Table 3).

One other study with intensive morbidity surveillance has provided data only on the mean daily prevalence, rather than the incidence, of diarrhoea (*75*). Mean daily prevalences of 15.9% in the vitamin-A-supplemented group and 15.5% in the placebo group were found, giving a prevalence ratio of 0.98. Three further studies evaluated the impact on diarrhoea prevalence at single points in time following the administration of vitamin A or placebo. One study in Haiti (*72*) found that at 2–8-weeks' post-dosing (2-week period prevalence) the prevalence ratio was 1.09, while another in Indonesia (*73*) found that at 9–13-months' post-dosing the prevalence ratio was 0.89. A small study in Thailand (*74*) found that the cumulative incidence of diarrhoea appeared to be reduced by approximately 40% over the first 2-months' post-dosing but did not fall over the following 2-month period (RR = 1.19). Although many of the morbidity studies have been criticized on methodological grounds, and have failed to provide adequately detailed analyses of their results, taken together they seem to indicate fairly unequivocally that vitamin A supplementation has no impact, beneficial or otherwise, on the incidence or prevalence of diarrhoea.

Table 3: **Impact of prophylactic vitamin A supplementation on the incidence of diarrhoea**

Location	Frequency of visits	Relative risk[a]
Brazil (ref. *102*)	3 per week	0.94 (0.90–0.98)[b]
South India (ref. *103*)	1 per week	0.99[c]
Indonesia (ref. *104*)	Every other day	1.06 (0.96–1.19)
China (ref. *105*)	1 per 2 weeks	0.41

[a] Vitamin A: placebo group.
[b] Figures in parentheses are 95% confidence intervals.
[c] Age adjusted.

The only plausible explanation for the marked reduction in diarrhoea mortality that has been observed in the larger mortality studies is that vitamin A supplementation reduces the severity of diarrhoeal disease; however, little information is available to verify this hypothesis. The most detailed account published so far (*102*) appears to indicate that the impact of vitamin A supplementation increases with the severity of the diarrhoea episode, with incidence ratios of 0.97 for mild (1–2 days' duration), 0.91 for moderate (≥3 days' duration, with a mean of ≤4 liquid or semi-liquid motions per 24h) and 0.80 for severe diarrhoea (≥3 days' duration, with a mean of ≥5 liquid or semi-liquid motions per 24h). The authors of this study also report a strong trend in the impact of vitamin A supplementation on the number of days with ≥3, ≥4, ≥5 or ≥6 liquid stools. In a similar study in Ghana (*75*), a significant reduction in diarrhoea associated with signs of dehydration was detected in children supplemented with vitamin A (RR = 0.85); none the less the association between vitamin A supplementation and diarrhoea severity is poorly understood. No information is available on etiology-specific impacts of vitamin A supplementation.

Four studies that gave very large doses of synthetic vitamin A to children hospitalized with measles are a further source of information on the impact on diarrhoeal disease of raising vitamin A levels in young children (*76–79*). Three of these studies reported that during hospitalization children treated with vitamin A had shorter durations of diarrhoea (*77–79*), and Coutsoudis et al. reported less frequent and less severe diarrhoea at 6-weeks' and 6-months' post-discharge, although the number of children in this study were very small and the differences are not statistically significant (*78*).

The above results show that vitamin A supplementation is a very promising preventive strategy for the control of diarrhoeal diseases. Improving the vitamin A status among young children in developing countries on a widespread scale is currently a challenge for which a variety of different strategies are available. While capsule distribution, food fortification and dietary modification are all physiologically capable of improving children's vitamin A stores, their impact at the programme level will depend on the feasibility of achieving broad population coverage at sustainable costs.

Prevention of low birth weight

The prevention of low birth weight (LBW), i.e. <2500g, as a measure against diarrhoeal diseases

in young children was reviewed by Ashworth & Feachem in 1985 (*80*), who were unable to locate any satisfactory data on LBW as a determinant of diarrhoea morbidity or mortality. They concluded, however, for developing countries where diarrhoea is a major cause of infant and child death that LBW is probably associated with diarrhoea mortality. Subsequently, several studies have been conducted that permit examination of the association between LBW and diarrhoea.

Mortality from diarrhoea

Two studies, both conducted in southern Brazil, have assessed the association between LBW and diarrhoea mortality in infants. The first involved over 200 infant deaths among a birth cohort of almost 6000 children, 25 of which were due to diarrhoea. Despite the relatively small number of deaths, an inverse relationship was found between birth weight and diarrhoea mortality (*81*). Death rates ranged from 12 per 1000 in children weighing <2000g at birth to 2 per 1000 for those weighing ≥3500g. The relative risk of infant death due to diarrhoea associated with LBW was 2.5 (95% CI = 0.9–6.7), while that for infant death due to all causes was 11.0 (95% CI = 8.7–14.4). Among deaths not due to perinatal causes, however, the relative risks were broadly the same. In a second study, using the case–control approach, risk factors for post-perinatal mortality were investigated by comparing cases with healthy neighbourhood controls (*82*). After adjustment for confounding factors, LBW infants had twice the risk of death due to diarrhoea (odds ratio (OR) = 2.0; 90% CI = 1.1–4.4) than those weighing ≥2500g at birth. A similar odds ratio was found for deaths due to respiratory infections, but that for deaths due to other infectious diseases was greater (OR = 5.0; 90% CI = 1.3–18.6).

Another study from Brazil examined prognostic factors for deaths due to diarrhoea in Rio de Janeiro by comparing those children <12 months of age who were hospitalized for diarrhoea and died (cases) with those also hospitalized for diarrhoea but who survived (controls) (*83*). LBW infants were three times as likely to die than those weighing ≥2500g at birth. No data from developing countries were found on the effect of LBW on death as a result of diarrhoea after the first year of life.

Morbidity from diarrhoea

Several studies have examined the association between hospitalization for diarrhoea and LBW. A small case–control study in Sri Lanka found a significant inverse relationship between birth weight and risk of hospitalization for diarrhoea, which persisted after adjustment for confounding (*84*). The results also suggest that LBW may be associated with an increased risk of diarrhoea morbidity beyond the first year of life. This has been borne out by subsequent studies (see Table 4).

All but one of these studies, which had a small sample size, reported at least a doubling in the risk of diarrhoea morbidity associated with LBW. Further analyses of data from Brazil (*85*) showed that this risk was more apparent among those LBW children who were born small-for-gestational age than among those born preterm. Also, this association was not present in later childhood (hospitalizations during 24–48 months of age). In Papua New Guinea, Bukenya et al. also showed that the LBW effect was highest in children aged <18 months and absent in those ≥3 years (*108*).

No studies were found that examined the impact of an intervention to improve birth weight on diarrhoea morbidity or mortality, and any likely impact therefore remains theoretical (*80*). The consequences of low birth weight are multifactorial and the above evidence again emphasizes the need for its prevention. Kramer identified several public health interventions likely to have an impact on birth weight (*86*). The potential impacts on diarrhoea morbidity and mortality, as well as the many other benefits, suggest that these preventive strategies deserve evaluation of their effectiveness, feasibility and cost.

Table 4: **Impact of low birth weight on diarrhoea morbidity**

Location	Outcome	Effect measure
Brazil (ref. *106*)	Hospitalization for diarrhoea	Risk ratio = 1.95
Thailand (ref. *107*)	Hospitalization for diarrhoea	Odds ratio approx. 4
Brazil (ref. *108*)	Hospitalization for dehydrating diarrhoea	Odds ratio approx. 3
Gambia (ref. *109*)	Clinic attendance for diarrhoea	No association
India (ref. *110*)	Diarrhoea prevalence	Prevalence ratio approx. 3
Papua New Guinea (ref. *111*)	Diarrhoea incidence	Rate ratio approx. 2

Conclusions

The results of the present review confirm the importance of some key preventive strategies (breastfeeding, water supply and sanitation improvements), refine some others (promotion of personal and domestic hygiene, weaning education/food hygiene), and offer evidence that, subject to cost-effectiveness examination, two other strategies — vitamin A supplementation and the prevention of low birth weight — should be promoted. Martines et al. (*5*) suggest that over the coming years, the effectiveness and cost-effectiveness of many of these preventive strategies will improve since nonvaccine interventions involve behaviour change and public health education to achieve this will become more effective. No national diarrhoeal disease control programme is likely to implement all potential preventive strategies, the choice depending on a number of factors such as different etiologies, existing infrastructure, and government priorities (*5*). Effective implementation of these preventive strategies calls for involvement of a range of sectors (agriculture, water supply and sanitation), more so than for case-management.

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Résumé

Prévention de la diarrhée chez le jeune enfant dans les pays en développement

The prise en charge réussie est le principal objectif des programmes de lutte antidiarrhéique dans les pays en développement; toutefois, il faut des stratégies préventives si l'on veut réduire le fardeau de la morbidité chez le jeune enfant. L'OMS a entamé l'étude systématique de 18 interventions préventives potentielles en 1982, ce qui a permis de classer les interventions en trois groupes, selon leur efficacité et leur faisabilité.[3] Le présent article décrit une étude actualisée qui porte sur sept interventions autre que vaccinales.

Les résultats confirment et renforcent le rôle très protecteur de l'allaitement au sein en ce qui concerne la mortalité et la morbidité diarrhéiques. L'allaitement au sein exclusif durant les premiers mois de la vie semble être particulièrement important et bien que l'on ait mis en doute la valeur nutritionnelle d'un allaitement au sein prolongé, il ne faut pas décourager les mères d'allaiter leur nouveau-né. Plusieurs études ont fait progresser la compréhension des pratiques de sevrage améliorées et de l'hygiène alimentaire, même si la quantification de l'impact sur la diarrhée demeure limitée. De nombreuses études ayant trait à l'effet, sur la morbidité diarrhéique, de l'amélioration des systèmes d'approvisionnement en eau et d'assainissement ont été effectnées ces dix dernières années et nous ont permis de mieux comprendre l'impact de ces systèmes. En conséquence, une attention accrue est accordée à la promotion de comportements hygiéniques en tant que stratégie préventive. Dix études visant plus précisément à améliorer les pratiques d'hygiène ont signalé l'impact positif de celles-ci la morbidité diarrhéique, avec une réduction moyenne de 33%. Des progrès sont realisés en ce qui concerne à la fois l'élaboration de méthodes permettant de promouvoir plus efficacement les changements comportementaux en matière d'hygiène et la conception d'instruments d'évaluation. Les résultats semblent prometteurs à ce jour, notamment pour les communautés où l'amélioration notable de l'équipement est encore lointaine. Il ne fait maintenant pratiquement aucun doute que la complémentation prophylactique par de la vitamine A de synthèse permet de réduire les taux de mortalité diarrhéique chez le jeune enfant. Il semble toutefois que la complémentation par de la vitamine A n'ait aucun impact sur l'incidence ou la prévalence de la diarrhée et il a été suggéré qu'elle devait par conséquent réduire la gravité de la maladie, bien que l'on dispose seulement d'informations limitées pour vérifier cette hypothèse. On a actuellement davantage d'indices montrant l'impact de l'insuffisance pondérale à la naissance à la fois sur la morbidité et la mortalité diarrhéiques.

Les résultats suggèrent que ces deux dernières stratégies – promotion de comportements hygiéniques et complémentation par de la vitamine A de synthèse – devraient, après analyse du rapport coût/efficacité, être ajoutées à la premiére catégorie d'interventions de Feachem. Aucun programme national de lutte antidiarrhéique ne semble en mesure de mettre en oeuvre toutes les stratégies de prévention potentielles, le choix dépendant de plusieurs facteurs tels que des étiologies différentes, les infrastructures existantes et les priorités gouvernementales. Davantage encore que pour la prise en charge des cas, l'application efficace de ces stratégies de prévention exige la participation de plusieurs secteurs autres celui de la santé.

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