

## NUTRITION-INFECTION INTERACTIONS

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*Nutrition and health are closely related to each other. Adequate nutrition leads to good or normal health. The focus of this paper is on the interaction of, and relationships between, nutrition and infection (as a health aspect). Nutrition influences infection in the following ways: adequate nutrition promotes the immune system and hence reduces the rate and severity of infection; malnutrition has a depressing effect on the immune system, which consequently increases vulnerability to infections and aggravates their incidence, severity and duration. On the other hand, infections lead to growth failure and malnutrition. They operate through anorexia, changes in metabolism, malabsorption, as well as behavioral changes affecting feeding practices, ultimately leading to malnutrition. The nutrition-infection interactions are cyclic, closely related and complex. The nutrition cycle, the infection cycle, and the malnutrition/infection cycle are used to illustrate these interactions. Nutrition interventions, which in most cases form part of health programmes, will help to prevent infections, and are an important feature of an effective management of diseases. Nutrition programmes, whether or not operated through health services, will benefit health. Similarly, access to adequate health services, which decreases the adverse effects of infection, improves nutrition.*

**KEY WORDS:** *Cycle, health, infection, interactions, interventions, malnutrition-infection complex, nutrition.*

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## INTRODUCTION

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The interactions of nutrition and infection have been recognised for many years. The combination of malnutrition and infection causes most of the preventable deaths particularly among infants and young children. It is estimated that each year, about 13 million infants and children die in the developing countries (Tomkins and Watson, 1989). The majority of these deaths are due to infections and parasitic diseases, and many if not most of the children die malnourished. Malnutrition increases the risk and worsens the course of infectious diseases; and infection leads to malnutrition. The expression "malnutrition-infection complex" is used to describe that relationship. That complex remains the most prevalent public health hazard worldwide. Nutrition and health are closely linked. Good nutrition is a major factor in better health, and both need to be addressed at the same time.

Infection can cause malnutrition through its effect on intake, absorption and utilisation of nutrients and in some cases the body's requirements for them. Growth retardation has been shown to have a synergistic relationship with disease (Scrimshaw *et al.*, 1968; Black *et al.*, 1984), decreased efficiency of food and nutrient utilisation (Briscoe, 1979), increased energy requirements (Tomkins, 1983), and decreased rates of child growth (Baumgartner and Pollit, 1983). On the other hand, malnutrition is known to have a depressing effect on the immune system, hence growth failure is, sometimes, found to be associated with lowered immunity.

This paper highlights and discusses the close relationships between, and interactions of, nutrition and infections and the implications of the "malnutrition-infection complex" on human health.

## THE CYCLES AND INTERACTIONS

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### THE NUTRITION CYCLE

Figure 1 which is a representation of the "Nutrition Cycle" shows the various factors that affect nutritional status. Debilitating adult infections such as schistosomiasis, onchocerciasis, trypanosomiasis, and malaria can prevent

economically-active household members from working and so providing food. The whole household may suffer as a result and marginally deficient members are especially vulnerable. It has recently been suggested that the spread of the AIDS virus throughout substantial areas of Africa could disrupt food production to the extent that widespread famine results (Kingman, 1968). Furthermore, it is important to recognise that food may not be equitably distributed nationally or between different family members and that individuals do not have identical rates of nutrient utilisation.

There are a number of important factors that affect the nutrition cycle. The main factors include:

- Physical fitness and health (e.g., injury, illness, disability)
- Employment opportunities (e.g., economic/social status, market forces)
- Agricultural patterns (e.g., land, climate, seeds and fertiliser availability, food prices, markets, transport)
- Households (e.g., family size, number of dependents per food producer or wage earner, age distribution of the family members)
- Social (e.g., differential in food distribution within a family, beliefs about appropriate foods).

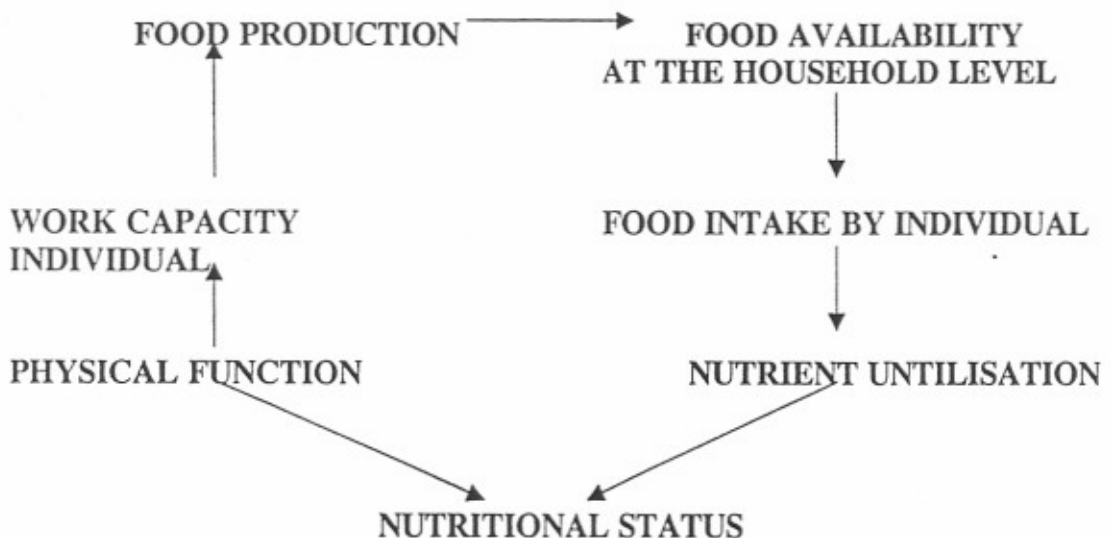


Figure 1: The nutrition cycle (Tomkins and Watson, 1989)

## THE INFECTION CYCLE

The terms "disease" and "infection" are often used synonymously, but there are important distinctions between them. Disease is only present when the host displays clinical manifestations of infection and where infection leads to abnormalities of organ function. In addition a certain number of organisms must be present before an infection can be termed disease.



**Figure 2: The infection cycle**  
(Tomkins and Watson, 1989)

Figure 2 shows the way in which infection can take place. Most pathogens which affect nutrition are temporary residents in the human host. Indeed, the sophisticated immune defence systems which protect against colonisation and tissue invasion are remarkably effective in the well-nourished host. Once the pathogen is established within the body there are variations in the severity, duration and extent of the infection which may be affected by the following factors:

- . Health care factors: these fall under
  - Preventive (e.g., immunisations),
  - Promotive (e.g., Vitamin A/Iron supplementation)
  - Curative (e.g., Chemotherapy - antimalarials, and antibiotics)

. Environmental factors: these include:

- Water supply,
- Sanitation,
- Personal hygiene,
- Crowding (can cause respiratory infections)
- Insects (e.g., malaria-causing)
- Climate (e.g., as measles-causing factor)
- Sexual patterns (e.g., AIDS-causing)
- Care during illness factors, eg., breast feeding, oral rehydration, appropriate re-feeding diet, time available to feed child.

## **MALNUTRITION/INFECTION CYCLE**

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The interaction between nutrition and infection is cyclic, and closely linked, and it is appropriate to describe it as a "malnutrition-infection complex". Figure 3 summarises the principles underlying malnutrition and infection. It indicates that inadequate dietary intake can cause weight loss or growth failure (particularly in children) and leads to low nutritional reserves. This is associated with a lowering of immunity, probably with almost all nutrient deficiencies. Particularly in protein-energy and vitamin A deficiencies, there may be progressive damage of mucosa, lowering resistance to colonisation and invasion by pathogens. Lowered immunity and mucosal damage are the major mechanisms by which defences are compromised. Under these circumstances, diseases will be of potentially increased incidence, severity, and duration. The disease process itself leads to loss of nutrients, both by the host's metabolic response, and by physical loss from the intestine. These factors themselves exacerbate the malnutrition leading to further possible damage to defence mechanisms. At the same time, many diseases are associated with a loss of appetite, and other possible disabilities, cycling back to further lower the dietary intake.

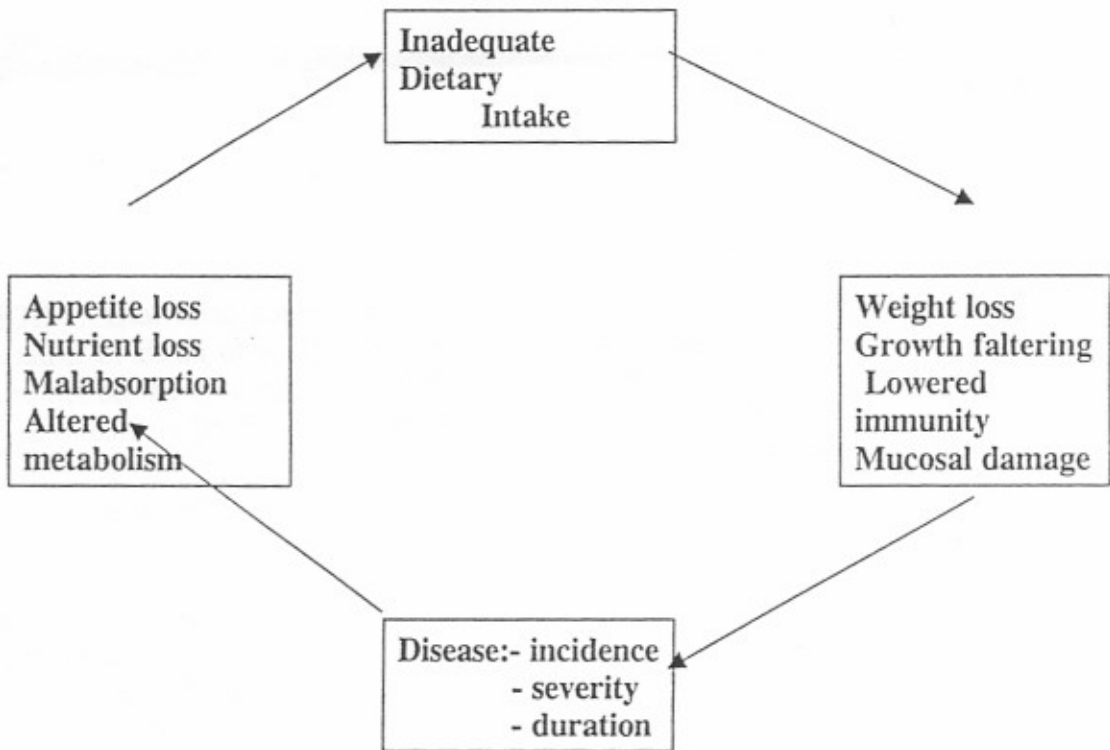


Figure 3: Malnutrition/infection cycle

### INFECTION AND RISK OF MALNUTRITION

Most infections are associated with a reduced food intake. In some illnesses such as gastroenteritis, vomiting and abdominal pain are obvious signs. In others there appears to be a centrally controlled anorexia. A variety of metabolic responses occur during infection which have profound effects on utilisation of diet and endogenous nutrient stores. There is increased energy expenditure, ranging from 10% to 15% increase per 1 degree C rise in body temperature. There are a number of infections which have been identified as having a close relationship with poor growth, particularly among children. These include:

1. **DIARRHOEA:** Diarrhoea associated with malnutrition is probably the most common cause of death of infants and young children worldwide. Diarrhoea has less impact on the nutritional status of younger infants than on that of older children. Exclusively breast fed infants are the least affected. The danger of contamination of infant food with diarrhoea-causing pathogens has been emphasised by many workers (Black *et al.*, 1989).
2. **MEASLES:** Measles is known to interact particularly with deficiencies of protein-energy and of vitamin A. Weight loss during measles attack is found to be a common feature. Preventive nutritional measures for reducing the severity of measles and its consequences relate to both vitamin A deficiency, and to protein-energy malnutrition. The measles virus may damage the intestinal mucosa sufficiently to cause malabsorption and protein loss.
3. **MALARIA:** The impact of malaria on nutrition varies according to age, immunological status and intensity of infection. Impaired growth and anaemia may occur among older children and adolescents. Equally important is the immune suppression that permits the development of other infections which may themselves cause malnutrition.
4. **RESPIRATORY INFECTIONS:** Respiratory infections have been reported to cause growth faltering (Rowland *et al.*, 1977).
5. **INTESTINAL PARASITES:** Close associations between intestinal parasites e.g., *Schistosoma*, *Giardia* and *Ascaris*, and malnutrition have been reported (Tomkins and Watson, 1989). They have been found to cause growth faltering, a reduction of food intake, malabsorption, endogenous nutrient loss and anaemia.
6. **AIDS:** Diarrhoea and weight loss are almost universally associated with the full clinical picture of AIDS. The various immunological dysfunctions in AIDS may be due to multiple pathogen-induced alterations in the gastrointestinal tract which results in malabsorption and malnutrition. A variety of micronutrient deficiency syndromes have been observed in AIDS patients and special dietary therapy may be necessary.

## MALNUTRITION AND RISK OF INFECTION

Pathogens have to overcome a variety of host defense mechanisms if they are to colonise, invade a tissue and multiply sufficiently to cause disease. If the defense mechanisms (the immune system) of a person are weak, due to malnutrition or other reasons, the risk and severity of infection will be higher.

## DIETARY MANAGEMENT AND DIETARY PREVENTION OF INFECTION

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Dietary management aims at modifying the course and outcome of infection by the improvement of food intake during disease and recovery. Formal and non-formal education can play a key role in this respect. Some possible actions which suit specific common diseases include:

- Continuation of breastfeeding during infections.
- Maintenance of diet during infection, especially persistent diarrhoea, including both active and recovery phases
- Administration of vitamin A in the management of measles, acute respiratory infections, etc.,
- Use of oral rehydration therapy in treatment of acute diarrhoea,
- Dietary support in chronic infections,
- Oral administration of iron during the treatment of malaria,
- Parasite control programmes in areas where parasite infestation is prevalent.

On the other hand, dietary prevention of infection seeks to reduce the frequency and severity of infection by ensuring a safe and nutritionally adequate diet and limiting energy expenditure to protect nutritional status. Good nutritional status prevents infection by a number of mechanisms, notably through the immune system and maintaining the integrity of epithelial tissues. Dietary prevention of infection includes promoting or ensuring the following:

- Exclusive breastfeeding for four to six months,
- Continued breastfeeding into the second year of life,
- Satisfactory quality and intake of complementary foods,



- Vitamin A status in relation to measles and respiratory tract infections,
- Prevention of low birth weight.

## CONCLUSIONS

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The operational implications of nutrition and infection interactions apply to health programmes specifically, and to the fact that interventions to improve nutrition will often be an effective way of preventing ill health. Some of the latter may be outside the health sector itself. Nutrition interventions as part of health programmes will help prevent infection and are an important feature of effective management of disease. Adequate protein-energy status seems particularly important in the prevention and management of many diseases, eg. diarrhoea, measles and respiratory infections. Measures to improve the nutritional status of the population will have important beneficial effects on health. This means that meeting the objective of improving health requires actions to alleviate poverty and to bring an adequate diet within the reach of everyone. The health sector must advocate such actions, some of which are the direct responsibilities of others. Nutrition programmes, whether or not operated through health services, will benefit health. Similarly access to adequate health services improves nutrition, e.g., measles immunisation reduces severe protein-energy and vitamin A deficiencies.

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