



Contents lists available at ScienceDirect

Trends in Food Science & Technology

journal homepage: www.elsevier.com/locate/tifs

The International Malnutrition Task Force: A model for the future?

Alan Jackson^{a,d}, Ann Ashworth^{b,d,*}, Reginald A. Annan^{c,d}^a Human Development and Health, Faculty of Medicine, University of Southampton, Southampton General Hospital, Southampton, SO16 6YD, UK^b Department of Population Health, London School of Hygiene and Tropical Medicine, Keppel Street, London, WC1E 7HT, UK^c Department of Biochemistry and Biotechnology, Kwame Nkrumah University of Science and Technology, Accra Road, Kumasi, Ghana^d International Malnutrition Task Force of the International Union of Nutritional Sciences, 10 Cambridge Court, 210 Shepherds Bush Road, London, W6 7NJ, UK

ARTICLE INFO

Keywords:

Severe acute malnutrition
Child health
International malnutrition task force
WHO guidelines
Obesity
School feeding

ABSTRACT

Background: The International Malnutrition Task Force (IMTF) of the International Union of Nutritional Sciences was set up as an advocacy and capacity-building initiative in 2005 at a time when malnutrition contributed to 60% of deaths among children under-five, and when a reduction in under-five mortality by two-thirds had been set as Millennium Development Goal 4.

Findings and conclusions: By forging partnerships through regional networks of academics, and linking with international agencies and non-governmental organizations, IMTF was able to increase awareness of the urgent need to address the prevention and treatment of child malnutrition. With modest funding, but a common purpose, partners initiated capacity building efforts to reduce high inpatient mortality rates among children admitted with severe malnutrition. In all regions, these initiatives catalysed scaling-up of the WHO 10-step treatment guidelines, resulting in substantial improvements in child survival. Many lessons were learned during this process including the importance of operational research, supervision and teamwork, political commitment, and the potential of eLearning. By establishing alliances between academics, health professionals, policy makers, and national and international paediatric and nutrition societies through a Task Force, we suggest that similar benefits might accrue in other fields, including childhood cancer and school feeding.

1. Introduction

Severe malnutrition during early life is a direct manifestation of how the social problems associated with poverty afflict the most vulnerable. An unhygienic environment predisposes to multiple infections which are exacerbated by an insufficient dietary intake of poor quality. Eradication of malnutrition and its prevention are dependent upon the coordinated and sustained actions of society addressing its wider problems, but this takes many years to put into effect (Keats et al., 2021; UNICEF, 1998). Meanwhile, many children will die and case fatality can be as high as 50% (Schofield & Ashworth, 1996). While acknowledging the important social and environmental determinants, here we focus on the experience of supporting the medical and wider health care system in saving lives, thereby creating opportunities for a better future. The growth and development of children underpins the development of society. Caring adequately for the most vulnerable is fundamental to this ambition.

The first time the International Congress of Nutrition was held in Africa was in Durban in September 2005. A number of delegates from

Africa expressed their concern that at this auspicious event there was insufficient attention being given to the practicalities of dealing with the problems of severe malnutrition in childhood even though it was seen as the most challenging nutritional problem across the continent and contributed to 60% of global deaths of children under-five (Black et al., 2003). The reduction in under-five mortality by two-thirds by 2015 had been set as Millennium Development Goal 4 (<https://www.un.org/millenniumgoals/>). This seemed to be an unrealistic expectation as it was evident that this could not be achieved without addressing the significant role played by malnutrition in child deaths.

In principle, the knowledge of how best to manage these children was available (World Health Organization, 1999). In practical terms there was clear guidance on how to organize the management of severe malnutrition in order to achieve the expectations set within the Millennium Development Goals, but there was a problem as to how this was to be secured at scale within the development context (UNICEF, 1998). WHO/UNICEF had established evidence-informed authoritative guidelines that were widely available, and had provided a detailed practical

Abbreviations: WHO, World Health Organization.

* Corresponding author. Department of Population Health, London School of Hygiene and Tropical Medicine, Keppel Street, London, WC1E 7HT, UK.

E-mail addresses: a.a.jackson@soton.ac.uk (A. Jackson), ann.hill@lshtm.ac.uk (A. Ashworth), reggie@imtf.org (R.A. Annan).

<https://doi.org/10.1016/j.tifs.2022.09.002>

Received 12 July 2022; Received in revised form 1 September 2022; Accepted 3 September 2022

Available online 10 September 2022

0924-2244/© 2022 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

training course (World Health Organization, 2002). However, it was a matter of considerable concern that where the problem was most prevalent, malnutrition was not receiving the attention it deserved (UNICEF, 1998). This lack of attention by practitioners to understand the nature of their responsibilities in addressing the problem as a routine within their everyday activities applied across the board - in health policies, resource allocation, and even in the low level of training provided to all health professionals. Within the spirit of moving towards the reduction in under-five mortality set as Millennium Development Goal 4, in 2005 the newly installed President of the International Union of Nutritional Sciences, Professor Ricardo Uauy, announced the formation of a dedicated task force to consider the problem and to facilitate action, and the International Malnutrition Task Force (IMTF) was launched as an advocacy and capacity-building initiative.

2. Nature of the problem

2.1. Complexity

Over the years a great deal of attention had been given to the problem of severe malnutrition in its different forms by technical people and those engaged in basic research, in clinical practice, and in operational research for public policy. The evidence provided a refined understanding of the biomedical and aetiophysiological characteristics of the problem within widely different contexts. The broader environmental and social factors that provided the context within which the condition was more likely to develop were captured by UNICEF in 1990 in its conceptual model in which causes were attributed to three different levels of organization. In an immediate sense a defining feature was the pathophysiology of the clinical presentation of a sick child. The problem emerged out of a social context that was impoverished in many respects, itself caused by an inadequacy of policy options to improve the situation (Sanders, 1985). The conceptual framework helped to clarify that here was a challenge that defied simple articulation or problem definition. The value and essence of the UNICEF model has provided a way of conceptualising these interlinked relationships and has stood the test of time. In its most recent form it identifies the causes of malnutrition as *immediate*, being determined by diets and care; *underlying*, being determined by food, practices and services available in households and communities; and *enabling considerations*, being determined by political, financial, social, cultural and environmental conditions (UNICEF, 2020).

Historically, severe malnutrition in all its forms has been an unremarkable attendant of war or famine with the different social and medical threads ultimately leading to a common-end point – a severely malnourished child faced with imminent death – and has been repeatedly described but seldom addressed in an agreed or consistent way (UNICEF, 1998). Unfortunately, the focus of any approach that had been adopted to prevention or treatment in any particular context had often been influenced by individual enthusiasms or local experience with limited regard to the holistic approach implied by the UNICEF model (Bhutta et al., 2008; Black et al., 2003). There was the need to move towards harmonization of understanding and effort and, for those engaged but with widely varied experiences, to come together within a single framework of understanding and, by acknowledging the complexities, better enable complementary activity across the piece, in order to match the expectations of all.

2.2. Challenges

The essence of the challenge in determining how best to deal with severe malnutrition required adequate appreciation of the complicated nature of the clinical disorder and recognition that it resulted from a complex interaction of the social and environmental factors faced by impoverished families with limited resources for health care. The application of the understanding obtained from physiological and

metabolic study of the aetiopathology of severe malnutrition in childhood had made better survival possible through the success of a structured approach to clinical care, succinctly captured as the 10 steps (Ashworth, 2007; Ashworth et al., 1996). This successful approach in turn enabled effective care of children in the community thereby preventing the need for difficult and expensive hospitalisation (e.g. Bredow & Jackson, 1994). Screening of children in the community and simple but consistent interventions, made it possible in principle to identify and prevent the disorder in its early stages, with the experience from places such as Thailand showing how this could be achieved at national level (Sanders, 1999; Tontisirin et al., 2001; Valyasevi et al., 1995).

There had been a longstanding debate about how best to deploy limited resources in treating severely malnourished children, with justifiable arguments a) for the use of facility- or hospital-based care for the most sick children and b) for the opportunity provided by community care for reaching the larger numbers of children at lower, but still significant, clinical risk. Further a suitable public health approach to enhance the quality of the environment and ensure adequate availability of food of good quality was a legitimate aspiration. Responsibility for action in each of these aspects usually lay with different bodies and these priorities were often in competition for limited resource. However, as indicated by the UNICEF model, each has an important part to play and the challenge is to provide appropriate support for each as components of an integrated whole, each adding value to the others for maximum benefit: the clinical, the social, and the policy.

Clinical care itself requires interaction amongst different elements for which continuity of care is considered fundamental (Sanders, 1985). The Integrated Management of Childhood Illness (IMCI) includes the special care needed for severely malnourished children (World Health Organization, 2000). Without immediate attention and skilled clinical care malnourished children who are sick with complications are at very high risk of death and need to be admitted to hospital. Providing the best care possible within available resources is a challenge but substantially reduces fatality rates when carried out according to the guidelines. As noted below achieving this at scale remains a big challenge (Kauchali et al., 2022).

Based upon experience gathered from emergency situations such as famine and conflict, community-based management of children without serious complications was shown to be very effective at scale if organized well (Valid International, 2006). Measurements of mid-upper-arm circumference (MUAC) had long been advocated for screening for malnutrition (Jelliffe, 1966; Morley, 1976; Shakir, 1975). However, to justify the adoption of screening at scale and to secure sustainable acceptability it was necessary to have effective treatments for those identified as being severely malnourished. This became possible through a modification of the therapeutic feeds adopted in hospitals, leading to the development of a ready-to-use therapeutic food (RUTF) for use in humanitarian emergencies and, having been found to be effective, could be made widely available. The composition of RUTF meets the particular energy and nutrient needs of malnourished children, supporting rapid rates of weight gain and catch-up growth (Briend et al., 1999; Henry & Xin, 2014). The demonstration of successful treatment in the community enabled the formal adoption of community-based management of acute malnutrition (CMAM) by WHO/UNICEF and committed NGOs and governments (World Health Organization, 2007). The effectiveness of RUTF reinforced and justified the insights developed from the careful clinical studies that had been carried out into the aetiopathology of severe malnutrition. The CMAM approach based on early detection using MUAC to screen children became the basis for active case finding. Screening and treatment with specially formulated food products that are fit-for-purpose, such as RUTF, together are effective in community-based approaches, reducing mortality to low levels. This greatly strengthened an integrated approach with continuity of care across hospitals and communities.

From these experiences the opportunity for earlier detection of *moderately* malnourished children, and intervention to prevent further

deterioration, became a realistic possibility (Ashworth & Ferguson, 2009; Jackson & Ashworth, 2015). By applying the same principles as for CMAM, more children could be identified and managed at an even earlier stage and fewer progressed to severe malnutrition. For children who developed malnutrition, it was important to recognize that the problem was not just the quantity of food that was available but also the quality of the diet, especially where intercurrent infection was a commonplace (Ashworth & Ferguson, 2009). Effective and sustained recovery usually required consideration of the overall balance and availability of energy and nutrients from the diet to meet the unusual demands of higher rates of growth (Golden, 2009). This awareness led to greater emphasis being placed on food and nutrition security at all levels: the household, community and nationally. The implications for the production, availability and accessibility of an adequate supply of food of desirable quality remain a challenge for primary prevention.

The fact that there remain major challenges at all levels identified within the UNICEF model makes evident the complexity of the problem (United Nations, 2015). There are important considerations for food production and availability, social responsibility and cohesion, delivery of health promotion, disease prevention and clinical care (Bhutta et al., 2013). Nutrition is central to the problem and a necessary consideration, but alone it is not sufficient for the solution. Ultimately there is the need for the development of secure, effective and integrated systems for health delivery, social support and food security (Jackson et al., 2014). Notwithstanding this, the rights of the child to life, nutrition and a nurturing caring environment require that the immediate situation of life and death is adequately addressed. The more sick a child, the higher the risk of mortality, and the more difficult and expensive it is to provide care effectively. In the first instance the IMTF had a focus on the most severely sick malnourished children. They are an important clinical problem with case fatalities as high as 50% in some situations. They represent the tip of the iceberg for the community at large, a clear indication that wider problems exist and a call for effective action to be taken (Ashworth et al., 2007).

3. Objectives of the task force

The Task Force set its objectives (Jackson et al., 2006) to:

- raise the profile of malnutrition among health policy makers and donor agencies and advocate for increased recognition of its importance in child survival;
- work with partners to build capacity among pre-service and in-service health professionals to prevent and treat malnutrition, especially in countries with high child mortality;
- advocate for inclusion of malnutrition in medical and nursing curricula and for WHO case-management to be implemented in paediatric wards;
- facilitate the scaling up of effective interventions to reduce malnutrition deaths;
- encourage health workers to undertake operational research to monitor and improve their performance and provide data for advocacy action;
- raise resources, and publish and disseminate findings and experiences.

3.1. Modus operandi

Getting started is always a challenge for new initiatives and we recognised that ‘visibility’ and ‘reach’ would be essential if we were to have influence and impact. Three regional networks and focal points were therefore established to raise the profile of malnutrition and coordinate and develop capacity-building partnerships:

South Asia – International Centre for Diarrhoeal Disease Research, Dhaka, Bangladesh (focal point Dr Tahmeed Ahmed).

Sub-Saharan Africa – School of Public Health, University of the Western Cape, South Africa (focal point Professor David Sanders) and the University Teaching Hospital, Lusaka, Zambia (focal point Dr Beatrice Amadi).

Latin America – Instituto de Investigaciones en Salud y Desarrollo, Universidad Mayor de San Andres, La Paz, Bolivia (focal point Dr Ana Maria Aguilar), and the University of San Carlos, Guatemala City, Guatemala (focal point Professor Michele Monroy Valle).

Non-Governmental-Organizations – Dr Paluku Bahwere (Valid International).

In addition to the regional networks, international partnerships were developed with the International Pediatric Association (IPA), the International Atomic Energy Association (IAEA), WHO, UNICEF, Valid International, Action against Hunger, and the Global Scaling-up-Nutrition (SUN) Civil Society Network. These UN agencies and international non-government organizations were important policy makers and implementers, with extensive outreach.

Addressing a clinical problem that is as complicated as severe malnutrition is challenging. As noted above this is made even more difficult where the complexities require cooperation and coordination across entities with very different responsibilities and priorities. Theoretical models indicate when addressing a challenge of such complexity, that the many components should be assembled at an early stage of the planning process for going to scale (Bulthuis et al., 2020). In reality this was not possible. Although all the aspects would need to be addressed in time, some were recognised from the start but the importance of others emerged with experience. Important lessons from this experience which are considered in detail later were:

- i) data gathering for advocacy and action
- ii) building local capacity/core competencies
- iii) participatory approach and inclusivity
- iv) leadership, supervision and induction to sustain quality of care
- v) keeping messages simple/job aids
- vi) scaling up/eLearning for training at scale
- vii) political commitment.

4. Advocacy activities

To achieve international visibility and advocate for action, we organised symposia and workshops with high profile, influential speakers at regional and international conferences and meetings. These were usually in collaboration with and supported financially by IUNS, WHO and IAEA. For example the IAEA were awarded the Nobel Peace Prize in 2006-7 and in celebration of this part of the award they supported a series of nutrition school seminars across South America, Africa, and Asia. The event in Uganda was particularly remarkable in bringing together colleagues from 22 countries to form a cooperative clinical investigative network to plan research activities, against the background of improved care for severely malnourished children, especially in the context of HIV/AIDS (<https://www.iaea.org/sites/default/files/publications/magazines/bulletin/bull49-1/49105884851.pdf>).

We also used the opportunity at several meetings to bring together young researchers to share ideas on how to have wider capacity building impact and address common problems. Workshops or master-classes were conducted to allow common problems to be discussed, emphasizing the attention to detail required for seemingly simple tasks, and the challenges of applying the concept of reductive adaptation to those aspects of care that appeared counterintuitive to usual practice. This encouragement to contribute developed a strong community, participating with shared experience.

We established a website (www.imtf.org), with ongoing support from a private benefactor. The website is managed by Dr Reginald Annan of Kwame Nkrumah University of Science and Technology, Ghana, who is also the focal point for Engagement with Young Professionals. Since its inception, the website has served as a point for dissemination of new information, progress, research, and resources related to malnutrition and its prevention and treatment. Resources shared through the website include job aids, books and guides, training and policy documents relevant to the area. New project initiatives and research findings are shared through the website. Discussions are held on important topics relevant to the area of malnutrition. The website allows visitors to comment on information posted and for practitioners or researchers with interest in this area of study to ask questions and seek clarifications. Users of the website also send requests through an email provided on the website, and more often, ask for possible collaborations and internships, and on how to solve problems encountered in managing children with malnutrition or nutrition rehabilitation centres.

Advocacy at national level was performed by regional focal points and involved a range of activities. The focal points were well-placed to engage with policy makers and advocate for action especially with regard to implementing the WHO treatment guidelines for severe acute malnutrition. They were also well placed to create research and capacity building partnerships between universities and health systems. These partnerships led to data gathering, particularly regarding case fatality rates (CFRs) of children with severe malnutrition and the extent of adherence, if any, to the 10-step WHO guidelines (Aguilar et al., 2005; Castillo-Carniglia et al., 2010; Karaolis et al., 2007; Puoane et al., 2006, 2008). This operational research led to in-service training to improve survival, capacity building more widely, and advocacy that formed the foundation for scale-up of guideline implementation. Operational research, which provided the evidence that implementation of WHO guidelines reduced case fatality rates substantially, was pivotal in advocating adoption of the WHO guidelines.

5. Prevention and treatment of malnutrition as a core competency

Medical and nursing curricula in countries most affected by malnutrition are often outdated or non-existent, leading to mismanagement of severely malnourished children and high mortality. In preparation for the 26th Congress of the International Pediatric Association (IPA) in Johannesburg, in August 2010, we surveyed national paediatric societies and affiliates in Asia, Africa, Latin America and Europe and found poor awareness among paediatricians of the WHO 10-step treatment guidelines for managing severe malnutrition and absence of the WHO guidelines in most medical/nursing curricula. Most respondents (79%) agreed that the care and treatment of young children with severe malnutrition should be a core competency for paediatricians with responsibility for young children.

Delegates to the IPA Congress later resolved that the identification and treatment of severe malnutrition should be a core competency for paediatricians and related health professionals worldwide (Schofield et al., 2012). Working groups at the Congress also considered how to translate this resolution into action, and recommended at the national level:

- collection of baseline data to underpin the essential activities of advocacy and training;
- advocacy to governments to promote and support implementation of the Resolution, and make it government policy;
- advocacy to Deans of medical/nursing schools to include nutrition/malnutrition in curricula and to engage with evaluation and accreditation processes;
- in-service training for all health workers on prevention and treatment of malnutrition;

- developing effective training teams and communication strategies;
- identifying 'champions' who will motivate others;
- assessing nutritional status at every contact to identify children at risk.

The Johannesburg Resolution, as it became known, was supported by the Royal College of Paediatrics and Child Health, WHO, UNICEF, IAEA and other UN agencies, and a similar Resolution was adopted by nutritionists and other delegates attending the Africa Nutritional Epidemiology Conference in Nairobi in October 2010. A website was developed in support of achieving these ambitions (see above).

6. Building capacity for in-service training

In-service training is usually in small groups and can generate a nucleus of proficient practitioners, but it is rather slow when building capacity from scratch, and especially when there are few knowledgeable and experienced trainers. After many years of slow but steady progress with face-to-face training, IMTF and the University of Southampton developed a three-module eLearning course '*Caring for infants and children with acute malnutrition*'. This is downloadable and free of charge. Each module takes 2–3 h to complete and facilitates self-directed learning, enabling a critical mass to be trained in a short time. Its effectiveness in improving knowledge, skills, and clinical practice was evaluated in a 2-year research project in Ghana, Guatemala, El Salvador and Colombia, funded by the UK Department for International Development (see *Impact* below).

6.1. Impact at scale

Case fatality rates: Diligent implementation of the WHO 10-step treatment guidelines has saved lives. In South Africa and Bolivia, IMTF has been involved in capacity building partnerships to implement the WHO guidelines starting in just one hospital, and implementation has been scaled-up nationwide and has become national policy (Kau-chali et al., 2022). In South Africa, during the period 2009–2021, the national CFR fell from 19.2% to 7.0% as scaling-up progressed. In Bolivia the CFR was around 25% initially and has been 5%–7% from 2012 onwards. In South Asia, IMTF partners have been involved in national training programmes to implement WHO malnutrition guidelines, and reductions in CFRs have ensued.

eLearning: We have shown that the malnutrition eLearning course improves knowledge, understanding, and skills of health professionals in the diagnosis and management of children with severe acute malnutrition (Annan et al., 2020; Choi et al., 2018, 2020). Changes in clinical practice and confidence were reported following completion of the course, and reductions in case fatality rate ensued. Pre-training CFRs ranged from 4.0% to 28.6%. The mean CFR fell significantly from 6.0% pre-training to 2.9% post-training. The findings suggest that high quality, interactive eLearning can be effective in scaling-up capacity building such that health professionals can manage children with severe acute malnutrition more effectively, leading to a reduction in mortality.

6.2. Lessons learned during scaling-up

Participatory approach: From the outset in South Africa and Bolivia, a participatory approach was used in which research skills were shared to enable paediatric ward staff to assess and analyze the situation on their ward (Puoane et al., 2004). This invariably revealed inappropriate treatment and unacceptably high CFRs. These findings motivated and enabled staff to take action and implement the WHO 10-step guidelines: the positive experience also led to a desire to motivate and help train staff in other hospitals, thus expanding workforce capacity for improved quality of care. Taking collective ownership, with a common purpose and resolve, harnessed energies to overcome obstacles and drove forward the process of building workforce competency to reduce deaths.

Even so, given the dearth of skilled and experienced trainers, it took considerable time to build training teams and establish monitoring and mentoring systems for scaling-up (Kauchali et al., 2022).

Data gathering: The reporting of CFRs at ward level proved important for raising awareness at district, provincial, and national levels of the extent of malnutrition deaths, and for advocating guideline adoption and the need to build workforce competencies. Data gathering at national level aided monitoring of progress and problem solving, and hospital managers and district, provincial, and national health personnel were involved from an early stage.

Supervision and leadership: Supportive supervision on the ward, mentoring, and good leadership and teamwork built confidence in case-management and helped sustain improved quality of care. Job satisfaction and morale were boosted by lives saved. Concise instructions, wall charts of the 10-steps, and job aids helped to reduce errors. Induction of incoming doctors and nurses was essential to deal with inadequate pre-service medical and nurse training. Training and supervision of staff involved in triage and emergency care were also essential in avoiding preventable deaths.

Political commitment: For sustainability at scale, regulatory and administrative policies and strategic planning at all levels of the health system required political commitment and budgetary provision. National commitment to the Millennium Development Goals, which included a commitment to reduce child deaths, provided added impetus to addressing child malnutrition. IMTF partners contributed to national policies by direct involvement and/or by providing technical assistance.

Few successful small-scale health interventions ever achieve scale-up but we have been able to show that the WHO guidelines are scalable and that their effectiveness in reducing malnutrition deaths is sustainable at scale in different contexts. We have also been able to provide a real-world account of the process from concept to large-scale implementation, which is rare in low- and middle-income countries (Kauchali et al., 2022).

7. Technical assistance

IMTF has provided advice to WHO/UNICEF on several aspects of the management of moderate and severe malnutrition. Members of the task force have been instrumental in the collection of evidence, and its being formally structured to develop and refine agreed guidelines for prevention and treatment (Ashworth, 2006; Ashworth et al., 2008; Ashworth & Ferguson, 2009). The nature of evidence has evolved over time. The underlying principles of care remain but their application in context to inform practice has matured.

1. WHO first developed guidelines for the treatment of severe malnutrition (protein energy malnutrition) in 1981 at a time when it was shown that case fatality in centres of excellence might be reduced to less than 5% (WHO, 1981). The clinical experience that informed these guidelines was based upon the application of understanding derived from the basic sciences, in physiology, biochemistry, microbiology and metabolism. The need to consider the child as a whole required integration of the information from all studies to show that considering the elements as the components of a system worked well but when the individual elements were taken on their own they could not be shown to confer a beneficial effect. Even though considering the effect of nutrition on metabolism as a whole guided the integration of understanding for more secure clinical judgment, the adoption of these guidelines was very limited.
2. Practitioners from the field needed more accessible advice that could be more readily operationalised. Thus a practical 10-step approach was developed, which formed the basis of a formal review leading to the second WHO guidelines (World Health Organization, 2000) and development of a detailed 5-day training package (World Health Organization, 2002). The success of the WHO 10-steps approach for reducing mortality and accelerating recovery has led to it being

adopted as the “reference standard” for care against which all other approaches can be judged.

3. A technical review of the guidelines in 2004 identified areas of particular challenge where the evidence was insecure, notably how best to manage children with HIV/AIDS (World Health Organization, 2005). This review also differentiated the underlying principles from contextual experience for different locations, making clear that of the outstanding questions that needed to be addressed it would be important to differentiate lack of understanding from poor practice, together with an increasing awareness of the differences imposed by facility compared with community-based care.
4. During this period the use of formal systematic reviews was being increasingly recognised for evidence-informed care. There were clearly defined benefits from its openness and transparency, the need for a complete consideration of the available evidence, recognition of different forms of evidence, and assessment of the quality of all evidence. Being explicit on these aspects of the process enabled more secure interpretation and greater confidence in the judgments made on balance when considering all the available evidence. IMTF was instrumental in enabling an extensive systematic review of the treatment of severe malnutrition (Picot et al., 2012). This was followed by a review of outstanding questions where there was uncertainty or the need to modify the guidance (World Health Organization, 2013).
5. The use of systematic reviews has many benefits and one value is that judgements are informed by the hierarchy of evidence which can be a very powerful tool in providing greater confidence in the conclusions. Randomised controlled trials are at the top of this hierarchy, which by their nature have secure internal validity but may be seriously constrained in their generalisability. This means that they are not strong in allowing for the contextual variability that is important and a common feature of complex nutritional problems. This challenge is under ongoing active consideration but there is not any satisfactory resolution as yet. There are important outstanding questions that need to be addressed but which are not amenable to experimental resolution, but likely require a “systems approach” reflective of the complexity of interactions within and amongst multiple levels of organization from the metabolic to the whole of society.
6. More recently we were commissioned to undertake a scoping review to identify key issues in the identification and treatment of severe wasting and oedema in children aged six months and over to assist guideline development.
7. We have also provided advice to the Department of Health, South Africa, regarding the development of national malnutrition treatment guidelines, and in India and Bangladesh.

8. Wider implications of experience with the preferred approach

The WHO guidelines and 10 steps for inpatient care make clear that we know what to do. Often the appropriate care is counterintuitive for usual paediatric practice, based upon the extent of changes in physiological and metabolic function consequential to the process of reductive adaptation; the frequency of poorly-defined specific nutrient deficiencies that have to be corrected; and the associated immunoparesis and susceptibility to silent infection. Food is a necessary but not sufficient part of treatment and care. The order in which different aspects of treatment are introduced can be of vital importance as the susceptible metabolic state with the reduced loss of resilience readily exposes any error of judgment. Although there are examples of better practice available, these have not been adequately diffused throughout relevant communities for care and public health. Nevertheless, the same general principles inform successful nutritional support of people suffering from primary or secondary malnutrition in all situations as is seen as a frequent problem in all hospitals in all countries (National Institute of Health and Care Excellence (NICE), 2006).

It is remarkable that the principles of care captured within the WHO 10 steps can be applied with success to all forms of undernutrition, different degrees of wasting, stunting, and those with oedema. Hence the WHO guidance and the international collaborative agenda for widening availability through the Scaling-up-Nutrition movement (<https://scalingupnutrition.org/about-sun/the-history-of-the-sun-movement/>) has improved the care of severely malnourished children and adults and made a direct contribution to progress towards the Millennium Development Goals. The prevalence in malnutrition was reduced substantially, even though rates are still high and associated with significant mortality. This same period has been characterised by marked global shifts in many aspects of life and lifestyles which can be attributed directly to an interplay of the demographic, epidemiological, nutritional and social transitions with associated changes in patterns of ill-health and disease. It remains an imperative to effectively address the mortality and morbidity associated with severe malnutrition, but it is also important to maintain awareness of the shifting patterns. Early contributions from the IMTF related to the emerging challenge of the “nutrition paradox” that has come to be known as the “double burden of malnutrition” (Caballero, 2005). This has been characterised by WHO as: “the coexistence of undernutrition along with overweight and obesity, or diet-related noncommunicable diseases, within individuals, households and populations, and across the life-course”. IMTF supported the participants’ statement which formally acknowledged the nature of the problem at the 33rd meeting of the Standing Committee on Nutrition of the United Nations (UNSCN), https://www.unscn.org/upload_s/web/news/The-Double-Burden-of-Malnutrition-A-Challenge-for-cities-Worldwide.pdf). Any particular episode of severe malnutrition is life threatening in its own right and must be treated effectively, but recovery, or more chronic forms of malnutrition can still have significant implications for health and development in the longer term (Childhood Acute Illness and Nutrition (CHAIN) Network, 2022). The WHO 10 steps recognizes the risk, with an emphasis on as complete recovery as possible for physical growth and other aspects of development such as neurocognitive development in order to mitigate adverse long term consequences. From this the importance of three particular considerations has emerged: increasing prevalence of obesity; neurocognitive and social development and the importance of school feeding to maximise lifelong opportunities; health promotion and disease prevention throughout the life course (World Health Organization, 2006).

8.1. Obesity

At the time of the formation of IMTF there was increasing emphasis being placed on the emergence of obesity as a major public health problem. To casual observation this was not obviously a major problem for poorer countries. With increasing success in the effective prevention and treatment of undernutrition, the notable increased prevalence of overnutrition at first appeared as a simple shift to the right of the distribution of weight in relation to height. With more and better data this could only be part of the explanation as for some populations there remained a significant tail of people with relative underweight (NCD Risk Factor Collaboration, 2020). Further, the demonstration in adults of a J- or U-shaped relationship between BMI and mortality during adulthood, emphasised problems related to both overweight and underweight, and the importance of achieving and maintaining a size within the preferred range (Flegal et al., 2007; Aune et al., 2016). Whatever the underlying factors accounting for these patterns, any approach seeking to address the health of the entire population had to consider the factors that caused nutritional ill-health across the entire distribution of relative weight. Approaches that simply sought to move the distribution to the right were inappropriate, but changing the shape of the distribution to ensure that both underweight and overweight are addressed simultaneously represents a significant challenge (NCD Risk Factor Collaboration, 2020, 2021). As the double burden of malnutrition has become more evident with time, and is especially problematic in low- and middle-income countries undergoing rapid development, there is the

need for a better understanding of factors that contribute within and across populations in order to stratify approaches to prevention and treatment appropriately (Gortmaker et al., 2011). Increasing body weight leading to obesity increases the risk of comorbidities of chronic, non-communicable diseases, such as type 2 diabetes, hypertension, heart disease, arthritis. The effect of nutrition on growth and development is recognised as an important risk factor for these conditions giving relevance to nutritional exposures at every stage and age from conception, throughout pregnancy and into childhood (Jackson, 2000; World Health Organization, 2006). The nutritional considerations that determine developmental, structural and functional changes in every organ system and the whole body are complicated. Obesity is but one marker of the outcome of the interplay of these complexities.

8.2. Neurocognitive development and school feeding

The fact that all growth and development is progressive in time means that all later capabilities build on what has been achieved to date. Even when malnourished children are successfully treated they have to return to the same impoverished environments within which the problem developed. It is challenging for children exposed to this kind of environment to achieve their full development potential (Headey & Ruel, 2022). This is one major reason why it is important that the treatment of malnourished children achieves the best outcomes possible. Two of the WHO 10 steps start to address this concern by involving mothers so they may gain practical experience of desirable child care, by improving their skills for food choice and preparation and by showing them how to interact positively with their children to promote age-appropriate skills, understanding, and development. Well-designed trials have shown the benefit to the child which is long lasting leading to better performance in school and enhanced social interactions leading to improved lifetime expectations and performance that are passed on to subsequent generations (Black et al., 2017). To a substantial extent, these interventions were limited to younger children, up to 24 months of age. However, similar benefits on development are found when impoverished children are provided with a meal at school, which encourages attendance and enhances scholarly performance. The importance and value of the provision of a school meal was exaggerated during the financial crisis of 2008 (Bundy et al., 2009), during which school feeding programmes were found to be one of the most important social safety nets for children, with knock-on benefits for their families and their communities (World Food Programme, 2013). One effect of COVID-19 was to limit the extent of these programmes, increasing hardship and nutritional problems in children from vulnerable communities (Headey & Ruel, 2022; World Food Programme, 2020). Building progressively on capabilities that have been acquired is the essence of both physical and functional neurocognitive development. In the longer term one critically important way to achieve and to protect what has been achieved, is to build in a graduated fashion on these achievements to ensure that children have access to schooling that supports their nutritional needs. The World Food Programme together with the World Bank have taken the lead to build an interagency collaboration for this purpose (Bundy et al., 2009, 2018; Drake et al., 2020). Conceptually, by adding support for a further 7000 days to current concern for the first 1000 days, allows completion of care for the 20 years it takes for a person to grow from conception to adulthood and protection for the next generation. The opportunities presented by an agenda for school health and nutrition are of particular value in enhancing attendance for girls, improving interpersonal behaviour, social skills and preparation for the next generation. These benefits will contribute to reducing the risk of malnutrition in the next generation. There remains the need to strengthen the nutrition components for these programmes (Standing Committee on Nutrition of the United Nations (UNSCN), 2017).

8.3. Non-communicable disease, exemplified by cancer

Nutritional factors have been implicated as determining factors for cancer for over forty years. The rates have been rising and cancer now represents a major cause of mortality globally accounting for 10 million deaths in 2020 and it is estimated that it will account for 1 in 2 deaths by 2050 (Sung et al., 2021). This represents much ill health and death across the world, but most particularly in low- and middle-income countries, where the risk factors for cancer have shifted from environmental factors such as cigarette smoking, infections or food related toxins to factors related to diet, nutrition and physical activity. Over the last three decades, there has been increasing recognition of the need to better understand how factors related to diet, nutrition and physical activity can influence the risk of cancer, responses to its treatment, and survival (World Cancer Research Fund/American Institute for Cancer Research, 2018; Clinton et al., 2020). Although much of the increase is attributed to the ageing population and also the double burden of malnutrition, cancer is becoming more evident at younger ages: being attributed to increased rates of obesity caused by poor dietary patterns and physical inactivity. Obesity is identified as a major cause of cancer for thirteen different sites and directly influences the response to treatment and survival. Nutritional exposures during the first 1000 days can influence cancer risk: a healthy pregnancy, secure breast-feeding, early growth and rates of maturation can mitigate the risk. Improved access to quality foods at school also provides an opportunity to screen for obesity, provide education on desirable food and nutrition practices, and instil healthy behaviours that serve for life.

9. Conclusion

The International Malnutrition Task Force has been in operation for sixteen years during which time there have been many changes in the landscape around the problems and care of children with different types and degrees of malnutrition. Progress has been achieved in many areas, but there is still much to do and, as noted above, significant change can be slow and hard to achieve at scale. One important development has been that we advocated successfully for malnutrition to be an identifiable disorder to be included in the ICD classification of disease, E40-E46, enabling more reliable statistics on mortality (<https://www.icd10data.com/ICD10CM/Codes/E00-E89/E40-E46>). General observations might be that there are a common series of nutritional problems across all societies, regardless of their stage of development. A varying balance of exposures might emphasise one form of malnutrition over another, but all forms can be found amongst the socially disadvantaged of all societies. The pace at which the epidemiological, demographic, social and nutritional changes are taking place makes it most important to be clear about the factors that operate and what might be considered to be underlying principles to be shared by all, and differentiated from factors that are more likely to be considered as being context specific.

It will always be important to have a sharp focus on challenges represented by particular issues to enable their successful resolution, but at the same time the extent to which inter-connections and inter-relations exist should always be considered. Thus there is a complex dimension to most problems. This has been readily exemplified by recent focus on the prevention/treatment of stunting, where interventions such as WASH gave results which appeared disappointing. A more detailed consideration of experiences where there appeared to be more successful interventions, identified that it was likely that the correct policy environment was needed for the operational interventions to have the anticipated benefit (Wolf et al., 2022). The analysis related to stunting (Hossain, Choudhury, et al., 2017) is, in principle, similar to that drawn from experiences for effective child care in Africa (Sanders, 1985), or the national experience from Thailand (Valyasevi et al., 1995; Tontisirin et al., 2001) which has been adopted by FAO as its model. Our own report of taking the treatment of severe malnutrition to scale rehearses a similar experience (Kauchali et al., 2022). Recent advice on

interventions for the prevention and management of obesity in childhood also reach similar conclusions. All these experiences dictate that each has to be considered as a complex problem. They are not readily amenable to a linear analysis and the approach that needs to be adopted should integrate multiple threads operating together at different levels of organization (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/820783/Whole_systems_approach_to_obesity_guide.pdf). They have to be considered as the interacting components of a system at any one level and as interacting systems between different levels of organization.

The Director General of the United Nations has emphasised that if we are to be successful in the ambitions espoused in the Sustainable Development Goals then more and better data will be needed: sustainable data for sustainable development. We are used to collecting quality data within the context of carefully planned and constructed research activities, but are perhaps much more casual about the quality of data collected as part of routine activities. Again our experience with scaling up emphasises how important data quality is at an operational level for maintaining standards, identifying problems locally, and facilitating reflective practice and introducing effective improvements. Insufficient emphasis has been placed on establishing such quality assurance as a routine in areas where the need is greatest (Wootton et al., 2014). If we can assure the quality of data collected as a routine, then immediately the opportunity arises for using “big data” approaches for better understanding the nature of the problems. It is also possible to see how to approach the complexities by recognising that each level of organization is organised and acts as a system in its own right and can be analysed as such, as well as being able to determine the inter-relationships amongst different levels of organization. Systems science “refers to a range of methods, composed largely of mathematical or computational modelling and simulation that enable the user to explore complex problems by addressing both interactions between components of a system and the behaviour of the system over time”. The possibility that interactions amongst the different levels of organization are similarly available, and data collected at cellular, metabolic, individual, family or community level can be better interpreted and data collected on food and diet, health and wellbeing can provide a more powerful understanding. The value of all this is dependent upon the skill and commitment of front line staff and the insistence that the collection of data of quality as an integral aspect of everyday care is of considerable importance, necessitating attention to detail and doing simple things well, within a situation that is supportive, organised and well administered.

For severe childhood malnutrition, there remain important clinical problems to resolve which require a deeper understanding of the underlying physiological and metabolic processes that have been deranged (Owino et al., 2019): these include the pathophysiological basis of oedema and its implications for treatment (Gonzales et al., 2022), the different aspects of body composition that are used in screening and treatment and their implications for longer term outcomes (Hossain, Ahmed, et al., 2017; Hossain, Chowdhury, et al., 2017), and how best to manage shock, which is such an important factor contributing to ongoing mortality. Attention is also needed to improve the quality and safety of care within health facilities (English et al., 2022).

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Author contributions

AJ conceptualized the article. AJ and AA wrote the first draft. All authors commented on, contributed to, and approved the final version.

Declaration of competing interest

None.

Data availability

Data will be made available on request.

References

- Aguilar, A. M., Araya, M., Weisstaub, G., et al. (2005). Evaluación del manejo del desnutrido severo menor de cinco años en las redes departamentales de salud de las ciudades de La Paz y El Alto. *Review Society Boletín Pediatría*, 44, 4–10.
- Annan, R. A., Aduku, L. N. E., Kyei-Boateng, S., Yuen, H. M., Pickup, T., Pulman, A., Monroy-Valle, M., Ashworth, A., Jackson, A. A., & Choi, S. (2020). Implementing effective eLearning for scaling up global capacity building: Findings from the Malnutrition eLearning Course evaluation in Ghana. *Global Health Action*, 13, 1. <https://doi.org/10.1080/16549716.2020.1831794>
- Ashworth, A. (2006). Efficacy and effectiveness of community-based treatment of severe malnutrition. *Food and Nutrition Bulletin*, 27(3), S24–S48. supplement.
- Ashworth, A. (2007). The impact of the TMRU on the treatment of severe malnutrition. In T. Forrester, D. Picou, & S. Walker (Eds.), *The Tropical Metabolism Research Unit, the University of the West Indies, Jamaica, 1956-2006. The House that John Built*. Ian Randle Publishers.
- Ashworth, A., & Ferguson, E. (2009). Dietary counseling in the management of moderate malnourishment in children. *Food and Nutrition Bulletin*, 30(3), S406–S433. supplement.
- Ashworth, A., Jackson, A., Khanum, S., & Schofield, C. (1996). Ten steps to recovery. *Child Health Dialogue*, 3–4, 10–12.
- Ashworth, A., Jackson, A., & Uauy, R. (2007). Focusing on malnutrition management to improve child survival in India. *Indian Pediatrics*, 44, 413–416.
- Ashworth, A., Shrimpton, R., & Jamil, K. (2008). Growth monitoring and promotion: Review of evidence of impact. *Maternal and Child Nutrition*, 4(supplement), 86–117.
- Aune, D., Sen, A., Prasad, M., Norat, T., Janszky, I., Tonstad, S., et al. (2016). BMI and all cause mortality: Systematic review and non-linear dose-response meta-analysis of 230 cohort studies with 3.74 million deaths among 30.3 million participants. *British Medical Journal*, 353. i2156–i2156.
- Bhutta, Z. A., Ahmed, T., Black, R. E., Cousens, S., Dewey, K., et al. (2008). What works? Interventions for maternal and child undernutrition and survival. *Lancet*, 371, 417–440.
- Bhutta, Z. A., Das, J. K., Rizvi, A., Gaffey, M. F., Walker, N., Horton, S., et al. (2013). Evidence-based interventions for improvement of maternal and child nutrition: What can be done and at what cost? *Lancet*, 382, 452–477.
- Black, R. E., Morris, S. S., & Bryce, J. (2003). Where and why are 10 million children dying every year? *Lancet*, 361(9376), 2226–2234. [https://doi.org/10.1016/S0140-6736\(03\)13779-8](https://doi.org/10.1016/S0140-6736(03)13779-8). PMID:12842379
- Black, M. M., Walker, F. L. C. H., Andersen, C. T., DiGirolamo, A. M., Lu, C., McCoy, D. C., Fink, G., Shawar, Y. R., Shiffman, J., Devercelli, A. E., Wodon, Q. T., Vargas-Bar, E., & Grantham-McGregor, S., for the Lancet Early Childhood Development Series Steering Committee. (2017). Early childhood development coming of age: Science through the life course. *Lancet*, 389, 77–90. [https://doi.org/10.1016/S0140-6736\(16\)31389-7](https://doi.org/10.1016/S0140-6736(16)31389-7)
- Bredow, M. T., & Jackson, A. A. (1994). Community-based, effective, low cost approach to the treatment of severe malnutrition in rural Jamaica. *Archives of Disease in Childhood*, 71, 297–303.
- Briend, A., Lacsala, R., Prudhon, C., Mounier, B., Grellety, Y., & Golden, M. H. N. (1999). Ready-to-use therapeutic food for treatment of marasmus. *Lancet*, 353, 1767–1768. [https://doi.org/10.1016/S0140-6736\(99\)01078-8](https://doi.org/10.1016/S0140-6736(99)01078-8)
- Bulthuis, S. E., Kok, M. C., Raven, J., & Dieleman, M. A. (2020). Factors influencing the scale-up of public health interventions in low- and middle-income countries: A qualitative systematic literature review. *Health Policy and Planning*, 35, 219–234. <https://doi.org/10.1093/heapol/cz1140>. PMID: 31722382; PMCID: PMC7050685.
- Bundy, D., Burbano, C., Grosh, M. E., Gelli, A., Juke, M., & Lesley, D. (2009). *Rethinking school feeding*. World Bank Publications. <https://doi.org/10.1596/978-0-8213-7974-5>
- Bundy, D. A. P., de Silva, N., Horton, S., Jamison, D. T., & Patton, G. C. (2018). *Optimizing education outcomes: High-return investments in school health for increased participation and learning*. Washington, DC: World Bank. License: Creative Commons Attribution CC BY 3.0 IGO.
- Caballero, B. (2005). A nutrition paradox – underweight and obesity in developing countries. *New England Journal of Medicine*, 352, 1514–1516.
- Castillo-Carniglia, A., Weisstaub, S., Aguirre, P., Aguilar, A. M., & Araya, M. (2010). Identifying cultural representations of families and the health team to improve the management of severe malnutrition in childhood. *Qualitative Health Research*, 20, 524–530. <https://doi.org/10.1177/1049732310361465>
- Childhood Acute Illness and Nutrition (CHAIN) Network. (2022). Childhood mortality during and after acute illness in Africa and South Asia: A prospective cohort study. *Lancet Global Health*, 10, e673–e684.
- Choi, S., Yuen, H. M., Annan, R., Monroy-Valle, M., Pickup, T., Aduku, N. E. L., Pulman, A., Portillo, C. E., Sermeno, C. E. P., Jackson, A. A., & Ashworth, A. (2020). Improved care and survival in severe malnutrition through eLearning. *Archives of Disease in Childhood*, 105, 32–29.
- Choi, S., Yuen, H. M., Annan, R., Pickup, T., Pulman, A., Monroy-Valle, M., Aduku, N. E. L., Kyei-Boateng, S., Monzon, C. I. V., Sermeno, C. E. P., Penn, A., Ashworth, A., & Jackson, A. A. (2018). Effectiveness of the Malnutrition eLearning Course for global capacity building in the management of malnutrition: Cross-country interrupted time-series study. *Journal of Medical Internet Research*, 20, Article e10396. <https://doi.org/10.2196/10396>
- Clinton, S. K., Giovannucci, E. L., & Hursting, S. D. (2020). The world cancer research Fund/American Institute for cancer research third expert report on diet, nutrition, physical activity, and cancer: Impact and future directions. *Journal of Nutrition*, 150, 663–671. <https://doi.org/10.1093/jn/nxz268>
- Drake, L. J., Lazrak, N., Fernandes, M., Chu, K., Singh, S., Ryckembusch, D., Nourozi, S., Bundy, D. A. P., & Burbano, C. (2020). Establishing global school feeding program targets: How many poor children globally should be prioritized, and what would be the cost of implementation? *Frontiers in Public Health*, 8, Article 530176. <https://doi.org/10.3389/fpubh.2020.530176>
- English, M., Nzinga, J., Oliwa, J., et al. (2022). Improving facility-based care: Eliciting tacit knowledge to advance intervention design. *BMJ Global Health*, 7, Article e009410. <https://doi.org/10.1136/bmjgh-2022-009410>
- Flegal, K. M., Graubard, B. I., Williamson, D. F., & Gail, M. H. (2007). Cause-specific excess deaths associated with underweight, overweight, and obesity. *JAMA*, 298, 2028–2037. <https://doi.org/10.1001/jama.298.17.2028>. PMID:17986696
- Golden, M. H. (2009). Proposed recommended nutrient densities for moderately malnourished children. *Food and Nutrition Bulletin*, 30(3), S267–S342. <https://doi.org/10.1177/15648265090303S302>. Suppl.
- Gonzales, G. B., Njunge, J. M., Gichuki, B. M., et al. (2022). The role of albumin and the extracellular matrix on the pathophysiology of oedema formation in severe malnutrition. *EBioMedicine*, 79, Article 103991. <https://doi.org/10.1016/j.ebiom.2022.103991>
- Gortmaker, S. L., Swinburn, B. A., Levy, D., et al. (2011). Changing the future of obesity: Science, policy, and action. *The Lancet*, 378, 838–847.
- Headey, D. D., & Ruel, M. T. (2022). Economic shocks predict increases in child wasting prevalence. *Nature Communications*, 13, 2157. <https://doi.org/10.1038/s41467-022-29755-x>
- Henry, C. J. K., & Xin, J. L. W. (2014). Application of hazard analysis critical control point in the local manufacture of ready-to-use therapeutic foods (RUTFs). *Food and Nutrition Bulletin*, 35(2), S57–S63. Suppl.
- Hossain, M., Choudhury, N., Abdullah, K. A. B., Mondal, P., Jackson, A. A., Watson, J., & Ahmed, T. (2017a). Evidence-based approaches to childhood stunting in low and middle income countries: A systematic review. *Archives of Disease in Childhood*, 102(10), 903–909. <https://doi.org/10.1136/archdischild-2016-311050>. Epub 2017 May 3. PMID: 28468870, PMCID: PMC5739821.
- Hossain, M. I., Ahmed, T., El Arifeen, S., Billah, S. M., Faruque, A., Islam, M. M., & Jackson, A. A. (2017b). Comparison of midupper arm circumference and weight-for-height z score for assessing acute malnutrition in Bangladeshi children aged 6–60 mo: An analytical study. Epub 2017 Oct 4 *The American Journal of Clinical Nutrition*, 106(5), 1232–1237. <https://doi.org/10.3945/ajcn.116.139881>. PMID: 28978541.
- Jackson, A. A. (2000). Nutrients, growth, and the development of programmed metabolic function. *Advances in Experimental Medicine & Biology*, 478, 44–55. https://doi.org/10.1007/0-306-46830-1_4. PMID: 11065059.
- Jackson, A., & Ashworth, A. (2015). Capacity-building in the management of moderate acute malnutrition. *Food Nutrition Bulletin*, 36(1), S47–S52. supplement.
- Jackson, A., Ashworth, A., & Khanum, S. (2006). Improving child survival: Malnutrition Task Force and the paediatrician's responsibility. *Archives of Disease in Childhood*, 91, 706–710.
- Jackson, A., Ashworth, A., Mokhtar, N., & Uauy, R. (2014). Severe malnutrition: Building on the past for a brighter future. *Food and Nutrition Bulletin*, 35(2), S3–S9. supplement.
- Jelliffe, D. B. (1966). *The Assessment of the nutritional status of the community*. World Health Organization. Monograph Series No. 53.
- Karaolis, N., Jackson, D., Ashworth, A., Sanders, D., Sogaula, N., et al. (2007). WHO guidelines for severe malnutrition: Are they feasible in rural african hospitals? *Archives of Disease in Childhood*, 92, 198–204.
- Kauchali, S., Puoane, T., Aguilar, A. M., Kathumba, S., Nkoroi, A., Annan, R., Choi, S., Jackson, A., & Ashworth, A. (2022). Scaling-up improved in-patient treatment of severe malnutrition: Key factors and experiences from South Africa, Bolivia, Malawi and Ghana. *Glob Health Sci Pract*, 10(2), Article e2100411. <https://doi.org/10.9745/GHSP-D-21-00411>
- Keats, E. C., Das, J. K., Salam, R. A., Lassi, Z. S., Imdad, A., Black, R. E., & Bhutta, Z. A. (2021). Effective interventions to address maternal and child malnutrition: An update of the evidence. *Lancet Child Adolesc Health*, 5, 367–384. [https://doi.org/10.1016/S2352-4642\(20\)30274-1](https://doi.org/10.1016/S2352-4642(20)30274-1)
- Morley, D. (1976). Nutritional surveillance of young children in developing countries. *International Journal of Epidemiology*, 5, 51–55.
- National Institute for Health and Care Excellence (NICE). (2006). *Nutrition support for adults: Oral nutrition support, enteral tube feeding and parenteral nutrition*. <https://www.nice.org.uk/Guidance/CG32>. (Accessed 8 July 2022).
- NCD Risk Factor Collaboration. (2020). Height and body-mass index trajectories of school-aged children and adolescents from 1985 to 2019 in 200 countries and territories: A pooled analysis of 2181 population-based studies with 65 million participants. *Lancet*, 396, 1511–1524.
- NCD Risk Factor Collaboration (NCD-RisC). (2021). Heterogeneous contributions of change in population distribution of body mass index to change in obesity and underweight. *Elife*, 10, Article e60060. <https://doi.org/10.7554/eLife.60060>
- Owino, V. O., Murphy-Alford, A. J., Kerac, M., Bahwere, P., Friis, H., Berkley, J. A., & Jackson, A. A. (2019). Measuring growth and medium- and longer-term outcomes in

- malnourished children. *Maternal and Child Nutrition*, 15, Article e12790. <https://doi.org/10.1111/mcn.12790>
- Picot, J., Hartwell, D., Harris, P., Mendes, D., Clegg, A. J., & Takeda, A. (2012). The effectiveness of interventions to treat severe acute malnutrition in young children: A systematic review. *Health Technology Assessment*, 16(19). ISSN 1366-5278.
- Puoane, T., Cuming, K., Sanders, D., & Ashworth, A. (2008). Why do some hospitals achieve better care of severely malnourished children than others? Five-year follow-up of rural hospitals in eastern Cape, South Africa. *Health Policy and Planning*, 23, 428–437.
- Puoane, T., Sanders, D., Ashworth, A., Chopra, M., Strasser, S., & McCoy, D. (2004). Improving the hospital management of malnourished children by participatory research. *International Journal for Quality in Health Care*, 16, 31–40.
- Puoane, T., Sanders, D., Ashworth, A., & Ngumbela, M. (2006). Training nurses to save lives of malnourished children. *Curationis*, 29, 73–78.
- Sanders, D. (1985). *The struggle for health; medicine and the politics of underdevelopment*. MacMillan.
- Sanders, D. (1999). Success factors in community-based nutrition programmes. *Food Nutrition Bulletin*, 20(3), 307–314.
- Schofield, C., & Ashworth, A. (1996). Why have mortality rates for severe malnutrition remained so high? *Bulletin of the World Health Organization*, 72, 223–229.
- Schofield, C., Ashworth, A., Annan, R., & Jackson, A. A. (2012). Malnutrition treatment to become a core competency. *Archives of Disease in Childhood*, 97, 468–469.
- Shakir, A. (1975). Arm circumference in the surveillance of protein-calorie malnutrition in Baghdad. *The American Journal of Clinical Nutrition*, 28, 661–665.
- Standing Committee on Nutrition of the United Nations (UNSCN). (2017). *Schools as a system to improve nutrition: A new statement for school-based food and nutrition. A discussion paper* <https://www.unscn.org/uploads/web/news/document/School-Paper-EN-WEB-nov2017.pdf>.
- Sung, H., Ferlay, J., Siegel, R. L., et al. (2021). Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA: A Cancer Journal for Clinicians*, 71, 209–249. <https://doi.org/10.3322/caac.21660>
- Tontisirin, K., Nantel, G., & Bhattacharjee, L. (2001). Country-wide community participation for nutrition improvement: Lessons learned from Thailand. *Ecology of Food and Nutrition*, 40(6), 685–697. <https://doi.org/10.1080/03670244.2001.9991677>
- UNICEF. (1998). *State of the world's children, 1998* <https://www.unicef.org/media/84766/file/SOWC-1998.pdf>. (Accessed 22 August 2022).
- UNICEF. (2020). Conceptual framework on the determinants of maternal and child nutrition. *A framework for the prevention of malnutrition in all its forms*. <https://www.unicef.org/media/113291/file/UNICEF%20Conceptual%20Framework.pdf>.
- United Nations. (2015). *The Millennium development Goals report, 2015* [https://www.un.org/millenniumgoals/2015_MDG_Report/pdf/MDG%202015%20rev%20\(July%2015\).pdf](https://www.un.org/millenniumgoals/2015_MDG_Report/pdf/MDG%202015%20rev%20(July%2015).pdf). (Accessed 22 August 2022).
- Valid International. (2006). *Community-based therapeutic care (CTC): A field manual*. <https://www.fantaproject.org/sites/default/files/resources/CTC-Field-Manual-Oct2006-508.pdf>.
- Valyasevi, A., Winichagoon, P., & Dhanamitta, S. (1995). Community-based surveillance for action towards health and nutrition: Experience in Thailand. *Food and Nutrition Bulletin*, 16, 1–9. <https://doi.org/10.1177/156482659501600204>
- Wolf, J., Hubbard, S., Brauer, M., et al. (2022). Effectiveness of interventions to improve drinking water, sanitation, and handwashing with soap on risk of diarrhoeal disease in children in low-income and middle-income settings: A systematic review and meta-analysis. *Lancet*, 400, 48–59. [https://doi.org/10.1016/S0140-6736\(22\)00937-0](https://doi.org/10.1016/S0140-6736(22)00937-0)
- Wootton, S., Durkin, K., & Jackson, A. (2014). Quality control issues related to assessment of body composition. *Food and Nutrition Bulletin*, 35(Suppl), S79–S85. <https://doi.org/10.1177/15648265140352S112>. PMID: 25069298.
- World Cancer Research Fund/American Institute for Cancer Research. (2018). *Diet, nutrition, physical activity and cancer: A global perspective*. Continuous Update Project Expert Report <https://www.wcrf.org/wp-content/uploads/2021/02/Summary-of-Third-Expert-Report-2018.pdf>.
- World Food Programme. (2013). State of school feeding worldwide. available at: http://docustore.wfp.org/stellent/groups/public/documents/research/wfp264317.pdf?_ga=2.117872586.2132583508.1657353229-1891379867.1657353229.
- World Food Programme. (2020). State of school feeding worldwide. available at: https://docs.wfp.org/api/documents/WFP-0000123923/download/?_ga=2.103207875.2132583508.1657353229-1891379867.1657353229.
- World Health Organization. (2013). *Guideline: Updates on the management of severe acute malnutrition in infants and children*. World Health Organization.
- World Health Organization. (1981). *The treatment and management of severe protein-energy malnutrition*. World Health Organization.
- World Health Organization. (1999). *Management of severe malnutrition: A manual for physicians and other senior health workers*. World Health Organization. <https://apps.who.int/iris/handle/10665/41999>.
- World Health Organization. (2000). *Management of the child with a serious infection or severe malnutrition. Guidelines for care at the first-referral level in developing countries*. World Health Organization.
- World Health Organization. (2002). *Training course on the management of severe malnutrition*. World Health Organization.
- World Health Organization. (2005). *Severe malnutrition: report of a consultation to review current literature 6-7 September 2004*. World Health Organization.
- World Health Organization. (2006). *Promoting optimal fetal development: Report of a technical consultation towards the development of a strategy for promoting optimal fetal development*, ISBN 92 4 159400 4 (2003 : Geneva, Switzerland).
- World Health Organization. (2007). *A joint statement on community-based management of severe acute malnutrition*. World Health Organization.