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Addressing malnutrition in low- and middle-income countries with double-duty actions

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Multiple forms of malnutrition co-exist (the double burden) in low- and middle-income countries, but most interventions and policies target only one form. Identifying shared drivers of the double burden of malnutrition is a first step towards establishing effective interventions that simultaneously address the double burden of malnutrition (known as double-duty actions). We identified shared drivers for the double burden of malnutrition, to assess which double-duty actions are likely to have the greatest reach in preventing all forms of malnutrition, in the context of the sustainable development goals. We reviewed existing conceptual frameworks of the drivers of undernutrition, obesity and environmental sustainability. Shared drivers affecting all forms of malnutrition and environmental sustainability were captured using a socio-ecological approach. The extent to which drivers were addressed by the five double-duty actions proposed by the WHO was assessed. Overall, eighty-three shared drivers for the double burden of malnutrition were identified. A substantial proportion (75.0%) could be addressed by the five WHO double-duty actions. ‘Regulations on marketing’ and ‘promotion of appropriate early and complementary feeding in infants’ addressed the highest proportion of shared drivers (65.1% and 53.0%, respectively). Twenty-four drivers were likely to be sensitive to environmental sustainability, with ‘regulations on marketing’ and ‘school food programmes and policies’ likely to have the greatest environmental reach. A quarter of the shared drivers remained unaddressed by the five WHO double-duty actions. Substantially more drivers could be addressed with minor modifications to the WHO double-duty actions and the addition of *de novo* actions.

Double-duty: Interventions: Low- and middle-income countries: Malnutrition

The double burden of malnutrition

A third of the global population is affected by one or more forms of malnutrition and 88% of countries face a serious burden of either two or three forms of malnutrition⁽¹⁾ (Fig. 1). These multiple burdens of malnutrition affect both adults and children. Almost two billion adults are overweight or obese, while almost half a billion (462 million)

are underweight and over a quarter of a billion (264 million) of women of reproductive age are anaemic⁽¹⁾. With 52 million children aged under 5 years wasted and 155 million stunted, undernutrition is still the dominant form of malnutrition affecting this age group. However, overweight/obesity is also on the rise, affecting about 41 million children aged under 5 years⁽¹⁾. For older children and adolescents (5–19 years), global figures suggest that obesity prevalence

Abbreviations: EBF, exclusive breast-feeding; LMIC, low-and middle-income countries; NCD, non-communicable disease; SDG, sustainable development goals.

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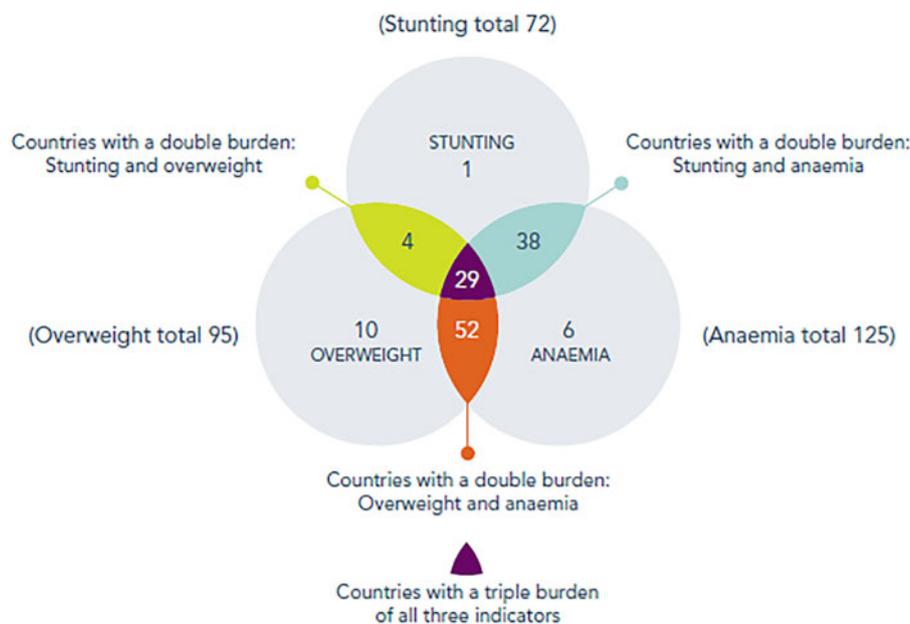


Fig. 1. (Colour online) Number of countries facing burdens of malnutrition.

(124 million) is catching up with that of underweight (192 million)⁽²⁾. The nutrition landscape in low- and middle-income countries (LMIC) has therefore become more complex with worldwide obesity rates doubling since 1980⁽³⁾, while high rates of undernutrition persist⁽¹⁾. This transition to a double burden of malnutrition has been well documented at different scales: from the individual, household, neighbourhood, as well as the national level, therefore representing a pressing public health concern that is increasingly undermining resources allocated to addressing undernutrition.

The need for double-duty actions (interventions and policies)

More recently, there have been calls for double-duty actions that can effectively and simultaneously address multiple goals (i.e. multiple forms of malnutrition)^(4–8). The current lack of integration presents a missed opportunity that hinders optimal utilisation of resources (fiscal, human and time) to tackle multiple forms of malnutrition simultaneously. Global attention has moved from focusing on hunger alone in the millennium development goals, to a broader focus on nutrition and environmental sustainability in the sustainable development goals (SDG), particularly SDG 2 ‘end hunger, achieve food security and improved nutrition and promote sustainable agriculture’, SDG 3 ‘ensure healthy lives and promote wellbeing for all at all ages’, SDG 11 ‘make cities and human settlements inclusive, safe, resilient and sustainable’ and SDG 13 ‘take urgent action to combat climate change and its impact’, thus providing opportunities to link nutrition and environmental sustainability for sustainable development.

The WHO has recently proposed five potential double-duty actions (Table 1): (i) initiatives to promote and protect exclusive breast-feeding (EBF) in the first 6

months, and beyond; (ii) promotion of appropriate early and complementary feeding in infants; (iii) regulations on marketing; (iv) maternal nutrition and antenatal care programmes; and (v) school food policies and programmes⁽⁷⁾. Their proposed mechanisms for their impact on the different forms of malnutrition are described in Table 1. However, the proposed double-duty actions that are likely to have the greatest reach in preventing the double burden of malnutrition remains unknown. This requires identification of shared drivers influencing all forms of malnutrition and prioritising double-duty actions that address the maximum number of drivers with positive impact on both malnutrition and environmental sustainability. Therefore, the aim of the present paper was to identify shared drivers for multiple forms of malnutrition, to assess which double-duty actions are likely to have the greatest reach in preventing and addressing the double burden of malnutrition, in the context of the SDG agenda.

Identifying and categorising the shared drivers of the double burden of malnutrition

Existing conceptual frameworks relating to undernutrition^(9–11) and obesity⁽¹²⁾, and the non-communicable disease (NCD) global monitoring framework⁽¹³⁾ were reviewed (Supplementary Materials 1–5). These conceptual frameworks are internationally recognised and have been used extensively in the field of nutrition. Based on the different conceptual frameworks, drivers of undernutrition and obesity identified in the frameworks were listed separately. Drivers that influence both forms of malnutrition: (i) in the same direction; (ii) through either direct or indirect pathways; and (iii) immediately or later in life were considered as shared. For example, EBF prevents undernutrition (e.g. wasting, stunting and micronutrient deficiency) in early

Table 1. Potential candidates for achieving double duty
Initiatives to promote and protect exclusive breast-feeding in the first 6 months, and beyond

Why the potential for double duty?

- Evidence indicates that providing essential nutrients for growth and development (especially colostrum and breast milk) benefits infant biology and nutritional habits, which reduces the risks for overweight and obesity in later life and protects against stunting and wasting in childhood^(26–28).
- Exclusive breast-feeding helps to regulate maternal weight gain in the postpartum period, which in turn provides added nutrition-related health benefits to the mother, protecting against obesity and some NCD later in life⁽²⁷⁾.

Promotion of appropriate early and complementary feeding in infants

Why the potential for double duty?

- The combination of continued breast-feeding, with appropriate complementary foods containing a wide range of micronutrients, is protective against stunting^(29,30).
- There are indications that the type and timing of complementary feeding may influence future risk of overweight and obesity^(29,31).

Regulations on marketing

Why the potential for double duty?

- Limiting marketing of breast-milk substitutes, in accordance with the International Code of Marketing of Breast-milk Substitutes⁽³⁵⁾, aims to mitigate inappropriate use of substitutes and provide an enabling environment for infant and young child feeding practices, with implications for undernutrition and obesity.
- Food marketing influences children's food preferences and diet-related behaviours and outcomes, with implications for obesity and diet-related NCD⁽³⁶⁾.

Maternal nutrition and antenatal care programmes

Why the potential for double duty?

- Folic acid and iron supplementation as part of a maternal nutrition care plan has been shown to be effective in preventing micronutrient deficiencies in the mother during pregnancy, and to aid in healthy fetal development⁽³²⁾.
- Antenatal nutritional counselling provides adequate and accurate knowledge of which foods, in what quantities, are required for optimal intake. This has the effect of reducing gestational weight gain and subsequently protects against gestational diabetes for the mother, and overweight and obesity later in life for the child^(32,33).

School food policies and programmes

Why the potential for double duty?

- Integrated school-based nutrition programmes can address the double burden of nutrition-related ill health and be used to build on and interconnect ongoing nutrition initiatives. They also represent a potential access point for engaging parents and communities⁽¹⁵⁾.
- School food standards have been found to be effective at increasing the availability and purchase of healthy food and decreasing the purchase of unhealthy food with the potential to impact health⁽³⁴⁾.

NCD, non-communicable disease.
Source: WHO⁽⁷⁾.

infancy⁽¹⁴⁾, but also prevents obesity and nutrition-related NCD in later life^(15,16). Conversely, consumption of energy-dense, nutrient-poor diets in the context of urban LMIC could lead to excessive weight gain while simultaneously contributing to micronutrient deficiencies. Finally, in the context of LMIC, food safety constitutes a shared driver for both forms of malnutrition. For example, consumption of unsafe foods and water contributes to the high diarrhoeal burden in LMIC. Actions taken to avoid such contamination could lead to a preference for soft drinks over water, for highly processed foods over freshly prepared ones, particularly in urban areas where the availability of these products is high. Such shifts in dietary choices can predispose individuals and communities to a dietary pattern associated with increased risk of overweight/obesity and NCD.

Drivers mentioned in only one of the frameworks but where evidence suggested they impact on other forms of malnutrition were included. Additional factors that were absent from the frameworks and for which evidence exist were added (e.g. high-sugar, nutrient-poor foods, ultra-

processed foods^(17–23), food environment^(24,25), supermarket growth⁽²⁶⁾, street vendors, food eaten away from home^(27,28), literacy⁽²⁹⁾, urban residency⁽³⁰⁾, microbiome^(31,32)). The final list of shared drivers was reviewed by the authors and drivers for which consensus was reached that they are shared were maintained, and in some cases, the terminologies were harmonised.

Using the validated DONE framework of determinants of nutrition and eating⁽³³⁾, the identified shared drivers were categorised using a socio-ecological approach into four main levels: individual, interpersonal, environmental and policy⁽³³⁾. A socio-ecological approach is useful for developing future interventions and policies as it accounts for the environments in which people live⁽³⁴⁾. The DONE framework was chosen for categorising the shared drivers because of its rigorous external validation involving a multi-Delphi process by international experts. The DONE framework categorises determinants (drivers) into four main levels (individual, interpersonal, environment and policy), twelve stem categories (biological, demographic, psychological, situational, social, cultural, product,

micro, meso/macro, industry, services/infrastructure, government) and fifty-one leaf categories (e.g. socioeconomic status, cultural behaviours, eating environment). Some adaptations were made to the model to include dietary intake as a relevant stem category.

Assessing the contribution of the shared drivers to environmental sustainability

Existing conceptual frameworks relating to environmental sustainability were reviewed⁽³⁵⁾ (Supplementary Materials 6–7) to select which shared drivers from our pre-defined list proposed in the adapted DONE framework would be sensitive to influencing environmental sustainability. Several other sources of evidence were used to develop the list of environmentally sensitive drivers: food variety, dietary diversity, food availability and access, purchasing power, supermarket growth⁽³⁶⁾; convenience, food away from home, grazing⁽³⁷⁾; street vendors⁽³⁸⁾; medicine use⁽³⁹⁾ and TV watching⁽⁴⁰⁾. When assessing the potential relationship between the shared drivers and environmental sustainability, both direct and indirect pathways (e.g. acting through malnutrition) were considered.

Mapping of recommended interventions and their link with shared drivers

The five double-duty actions proposed by the WHO (Table 1) were linked with the list of identified shared drivers of malnutrition. For each policy action, drivers were extensively reviewed and those that could be addressed by the suggested policies were highlighted. This was based on extensive discussion among the co-authors and review of existing available literature. A list of addressed and unaddressed drivers was then compiled for each policy. Shared drivers that were likely candidates for having an impact on environmental sustainability were also linked to the five double-duty actions, to assess the extent to which the proposed set of double-duty actions could address both malnutrition and environmental sustainability simultaneously.

Identification of unaddressed shared drivers and suggestions for additional *de novo* policy actions

The list of unaddressed drivers was reviewed to propose modifications of current actions or suggestions of new double-duty actions (i.e. *de novo* actions) that could address them. Proven and recommended interventions for overweight/obesity and nutrition-related NCD^(41,42) and undernutrition^(43,44) were considered and chosen actions were grouped into broader policy actions, in line with the SDG.

Review of existing frameworks and identification of shared drivers of the double burden of malnutrition and environmental sustainability

Drivers have been conceptualised differently for the two forms of malnutrition (undernutrition and obesity), using

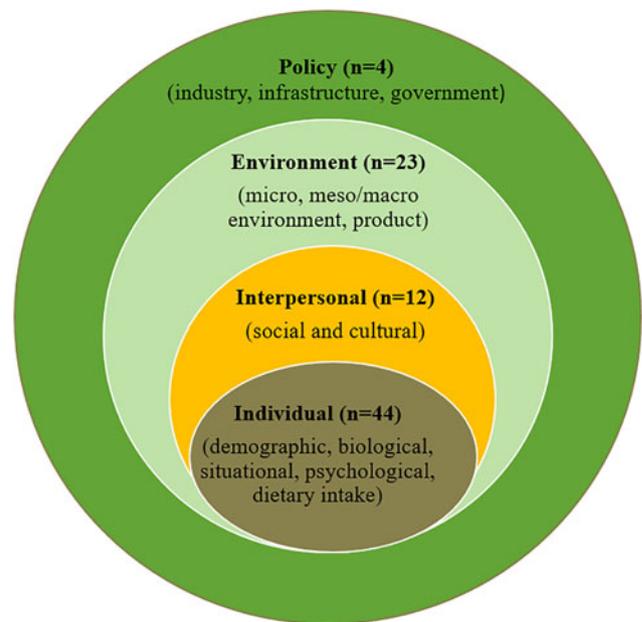


Fig. 2. (Colour online) Summary of the shared drivers of the double burden of malnutrition across socio-ecological levels.

different terminologies and categorisation, which may have previously hindered the development of an integrated conceptual framework guiding efforts to prioritise interventions that address both forms of malnutrition simultaneously. Those specialising in undernutrition have mainly adopted a socio-ecological approach to represent drivers, while those specialising in obesity have used both socio-ecological and systems approaches. A significant proportion of the drivers of obesity and undernutrition are shared (eighty-three of the 207), with forty-four (53.0%), twelve (14.5%), twenty-three (27.7%) and four (4.8%) of these drivers at the individual, interpersonal, environment and policy levels, respectively (Fig. 2).

Most of the shared drivers at the individual level can be classified as biological (e.g. intra-uterine growth restriction, hypertension, preterm birth, diseases, maternal nutrition and appropriateness of child growth). Drivers at the interpersonal level were mostly classified as social (e.g. inadequate child and maternal care, initiation/duration of (exclusive) breast-feeding, inadequate feeding). Most of the shared drivers at the environment level address product-related factors (e.g. energy density of food and drinks, low nutrient-density foods/drinks, high-sugar foods) or meso-/macro-level factors (e.g. environment food availability and accessibility, climate change, lack of marketing regulations); whereas, policy-level drivers mainly relate to services and infrastructure (e.g. medical care, health service access and quality, financial services) and industry (e.g. pressure for growth and profit). A detailed list of the drivers at each level of the socio-ecological model is provided in Fig. 3.

Drivers can have effects on both forms of malnutrition through direct (e.g. inappropriate complementary feeding) or indirect (e.g. maternal time use) pathways. Maternal time use influences caring and feeding practices, which

Stem-categories		Leaf-categories														
Individual	Biological	01. Maternal/adult stature	02. Genetic	03. Epigenetic	04. Satiety	05. Level of available energy	06. Body composition	07. Intra-uterine growth restriction	08. Hypertension	09. Preterm birth	10. Disease	11. Infection	12. Inflammation	13. Maternal nutrition	14. Adolescent pregnancy	
	Demographic	15. Appropriateness of child growth	16. Medicine use †	17. Microbiote	18. Female energy expenditure †	22. Female employment	23. Gender	24. Age	25. Livelihood	26. Level of employment	27. Urban residency †	28. Population density †	29. Women's empowerment	30. Literacy	31. Mental health	32. Purchasing power †
	Psychological	33. Stress	34. Food literacy	35. Appetite control	36. Tendency to graze †	37. Rate of eating										
	Dietary intake	38. Food variety †	39. Low diet diversity †	40. Inadequate intake of ASF †	41. Inadequate complementary feeding											
	Situational	42. De-skilling	43. Time use	44. Demand for convenience †												
Main levels	Social	45. Social support	46. Inadequate child care	47. Non-responsive feeding	48. Inadequate maternal care	49. Inadequate feeding practices	50. TV watching †	51. Household food security †	52. Initiation & duration of EBF/BF							
	Cultural	53. Beliefs	54. Cultural norms	55. Social & cultural valuation of food	56. Birth spacing											
Environment	Product	57. Anti-nutritional factors	58. Fibre content of food & drinks	59. Poor nutritional quality of food & drinks	60. Energy density of food & drinks †	61. Poor food consistency	62. Low energy complementary foods	63. High sugar foods	64. Nutrient-poor foods	65. Palatability	66. Salt in foods	67. Food safety				
	Micro	68. Portion sizes †	69. Poor WASH practices													
	Meso/Macro	70. Cost of ingredients	71. Exposure to food marketing †	72. Lack of marketing regulations †	73. Food eaten away from home †	74. Availability of micronutrient rich foods	75. Supermarket growth †	76. Street vendors †	77. Natural disasters †	78. Climate change †	79. Environment food availability & accessibility †					
	Industry	80. Pressure for growth and profit †														
Policy	Services/infrastructure	81. Medical care †	82. Health service access/quality	83. Financial services												
	Government															

Fig. 3. (Colour online) Shared drivers of the double burden of malnutrition. Source: Adapted from Stock *et al.* (2017). The DONE framework: Creation, evaluation, and updating of an interdisciplinary, dynamic framework 2.0 of determinants of nutrition and eating. PLoS One.12(2):e0171077. ASF, animal source foods; EBF, exclusive breastfeeding; BF, breastfeeding; WASH, water, sanitation and hygiene; †, environmental sensitive drivers.

in turn could lead to one or more forms of malnutrition. Unlike in the afore-mentioned examples, the effects of some drivers, such as intra-uterine growth restriction or preterm birth, may not necessarily be immediate. For instance, intra-uterine growth restriction would impact on growth in the first few years of life (likely to influence stunting levels)⁽⁴⁵⁾, but could also impact on overweight/obesity and nutrition-related NCD in later life^(46,47). A deeper understanding of the different ways that the shared drivers operate would provide a unique opportunity for interventions to address malnutrition across the spectrum more sustainably.

The review of existing environmental sustainability frameworks identified twenty-four of the eighty-three shared drivers (28.9 %) that could be potential candidates for having an impact on environmental sustainability (*n* 10 at the individual level (e.g. demand for convenience, excess intake of animal source foods); *n* 2 at the interpersonal level (food watching and food security); *n* 10 at the environment level (e.g. portion sizes, energy density of foods and drinks, natural disasters, climate change) and *n* 2 at the policy level (pressure for growth and profit and medical care); Fig. 3).

Review of WHO double-duty actions with identified shared drivers of the double burden of malnutrition

The double-duty actions proposed by the WHO addressed a significant number of the drivers, but not all (Table 2).

‘Regulations on marketing’ addressed the highest proportion of shared drivers (65.1 %) followed by ‘promotion of appropriate early and complementary feeding in infants’ (53.0 %), ‘maternal nutrition and antenatal care programmes’ (43.4 %), ‘school food programmes and policies’ (41.0 %) and ‘initiatives to promote and protect EBF in the first 6 months, and beyond’ (28.9 %). The actions addressed mostly individual- and interpersonal-level drivers. Little emphasis was given to women’s empowerment as it was only partly addressed by the policy on ‘maternal nutrition and antenatal care programmes’. Policy-level drivers were seldom targeted by the proposed actions, which focused mainly on the individual level.

About 10 % of the shared drivers: short maternal/adult stature, epigenetic, level of available energy, body composition, disease, infection, inflammation and inadequate feeding practices were addressed by all five policies. However, a quarter of the shared drivers (*n* 12 at the individual level, *n* 4 at the interpersonal level, *n* 3 at the environment level and *n* 2 at the policy level) remained unaddressed. Among the unaddressed drivers, some were non-modifiable (e.g. genetic, age, sex and natural disasters), while others were only modifiable to a lesser extent (e.g. adolescent pregnancy, medicine use, livelihood, urban residency, population density, literacy, mental health, stress, time use, social support, TV watching, beliefs, cultural norms, cost of ingredients, supermarket growth, health service/access quality, financial services).



Table 2. Summary table of the double-duty actions and their likely impact on the double burden of malnutrition and environmental sustainability

WHO double-duty actions	Content and mechanisms	List of drivers addressed by the policy	Number (%) of malnutrition-shared drivers addressed (total n 83)	Number (%) of environmental sustainability-shared drivers addressed (total n 24)	Possible amendments to enhance impact
Initiatives to promote and protect EBF in the first 6 months, and beyond	 (i) EBF reduces risk of overweight in later life and protects against stunting/wasting in childhood; (ii) EBF helps regulate maternal weight gain, protecting against obesity/NCD.	Food security [†] ; short birth spacing; female energy expenditure [†] ; initiation and duration of EBF/BF (continued); satiety; maternal nutrition, appropriateness of child growth; microbiote; personal SES; income; poverty; appetite control; tendency to graze [†] ; inadequate child care; poor WASH practices; climate change [†] ; short maternal/adult stature; epigenetic; level of available energy; body composition; disease; infection; inflammation; inadequate feeding practices.	24 (28.9)	4 (16.7 %)	Ensure paid maternity leave for at least 6 months to allow women to provide appropriate care for themselves and offspring.
Promotion of appropriate early and complementary feeding in infants	 (i) Continued breast-feeding with micronutrient-rich complementary foods protects against stunting; (ii) the type and timing of complementary feeding may influence future risk of overweight.	Non-responsive feeding; poor food consistency; inadequate complementary feeding; food security [†] ; short birth spacing; low-energy complementary feeding; female energy expenditure [†] ; level of employment; education; rate of eating; anti-nutritional factors; fibre content of foods and drinks; palatability; initiation and duration of EBF/BF; satiety; maternal nutrition; appropriateness of child growth; microbiote; personal SES; income; poverty; appetite control; tendency to graze [†] ; food variety [†] ; low dietary diversity [†] ; inadequate/excess of ASF [†] ; inadequate child care; poor nutritional quality of foods and drinks; energy density of foods and drinks [†] ; high-sugar foods; nutrient-poor foods; salt; food safety; portion sizes [†] ; poor WASH practices; climate change [†] ; short maternal/adult stature; epigenetic; level of available energy; body composition; disease; infection; inflammation; inadequate feeding practices.	44 (53.0)	9 (37.5 %)	None
Regulations on marketing	 (i) Limiting breast-milk substitute marketing enables an enabling environment for healthy feeding practices, with implications for undernutrition and obesity; (ii) food marketing influences children's diet-related behaviours, with implications for obesity and diet-related NCD.	Lack of marketing regulations [†] ; purchasing power [†] ; de-skilling; food eaten away from home [†] ; street vendors [†] ; inadequate complementary feeding; intra-uterine growth restriction; hypertension; preterm birth; female employment; inadequate maternal care; social and cultural valuation of food; low-energy complementary foods; exposure to food marketing [†] ; availability of micronutrient-rich foods; pressure for growth and profit [†] ; environment food availability and accessibility [†] ; female energy expenditure [†] ; level of employment; education; rate of eating; fibre content of food and drinks; palatability; initiation and duration of EBF/BF; satiety; maternal nutrition; appropriateness of child growth; microbiote; personal SES; income; poverty; appetite control; tendency to	54 (65.1)	15 (62.5)	Expand the reach to include adolescent girls and WRA; expand marketing regulations to energy-dense nutrient-poor foods; combine marketing regulations with food pricing policies

Tackling the double burden of malnutrition



Table 2. (Cont.)

WHO double-duty actions	Content and mechanisms	List of drivers addressed by the policy	Number (%) of malnutrition-shared drivers addressed (total <i>n</i> 83)	Number (%) of environmental sustainability-shared drivers addressed (total <i>n</i> 24)	Possible amendments to enhance impact
Maternal nutrition and antenatal care programmes	 <p>(i) Folic acid/iron supplements prevent maternal micronutrient deficiencies and healthier fetal development; (ii) counselling on healthy diet reduces maternal weight gain, reducing risk of gestational diabetes and overweight of the child in later life.</p>	<p>graze[†]; food variety[†]; low dietary diversity[†]; inadequate/excess of ASF[†]; inadequate child care; poor nutritional quality of food and drinks; energy density of foods and drinks[†]; high-sugar foods; nutrient-poor foods; salt; food safety; portion sizes[†]; poor WASH practices; climate change[†]; short maternal/adult stature; epigenetic; level of available energy; body composition; disease; infection; inflammation; inadequate feeding practices.</p> <p>Intra-uterine growth restriction; hypertension; preterm birth; female employment; inadequate maternal care; level of employment; education; initiation and duration of EFB/BF; maternal nutrition; personal SES; income; poverty; food variety[†]; low dietary diversity[†]; inadequate/excess of ASF[†]; inadequate child care; poor nutritional quality of foods and drinks; energy density of foods and drinks[†]; high-sugar foods; nutrient-poor foods; salt; food safety; portion sizes[†]; poor WASH practices; short maternal/adult stature; epigenetic; level of available energy; body composition; disease; infection; inflammation; inadequate feeding practices; women's empowerment; food literacy; medical care[†]; anti-nutritional factors.</p>	36 (43.4)	6 (25.0)	Expand ANC programmes to target WRA both in pre- and post-pregnancy periods; widen the focus from nutrition to health and include actions around women's empowerment, reproductive health, mental health, appropriate WASH practices and prevention of substance abuse.
School food programmes and policies	 <p>(i) Access point for engaging communities and parents in school nutrition programmes can prevent undernutrition and overweight; (ii) school food standards increase healthy food availability and purchase with long-term nutritional benefits.</p>	<p>Food variety[†]; low dietary diversity[†]; inadequate/excess of ASF[†]; poor nutritional quality of foods and drinks; energy density of foods and drinks[†]; high-sugar foods; nutrient-poor foods; salt; food safety; portion sizes[†]; short maternal/adult stature; epigenetic; level of available energy; body composition; disease; infection; inflammation; inadequate feeding practices; anti-nutritional factors; social and cultural valuation of food; exposure to food marketing[†]; availability of micronutrient-rich foods; pressure for growth and profit[†]; environment food availability and accessibility[†]; rate of eating; fibre content of foods and drinks; palatability; satiety; appropriateness of child growth; microbiote; appetite control; tendency to graze[†]; climate change[†]; demand for convenience[†].</p>	34 (41.0)	11 (45.8 %)	Acknowledge the importance of safe and nutritious food within and around schools

Source of images: WHO⁽⁷⁾.

EBF, exclusive breastfeeding; NCD, non-communicable diseases; BF, breast-feeding; SES, socio-economic status; WASH, water, sanitation and hygiene; ASF, animal source foods; WRA, women of reproductive age; ANC, antenatal care; [†]environmental-sensitive drivers.



Environmental sustainability of the double-duty actions

Eight of these drivers were targeted by at least three of the double-duty actions (tendency to graze, food variety, low dietary diversity, inadequate/excess of animal source foods, energy density of foods and drinks, portion sizes, climate change and female energy expenditure). Four of these drivers were targeted by two of the double-duty actions (food security, exposure to food marketing, pressure for growth and profit; and environment food availability and accessibility). Twelve of these drivers were targeted by either one double-duty action (lack of marketing regulations, purchasing power, demand for convenience, food eaten away from home, street vendors and medical care) or none (medicine use, urban residency, population density, TV watching, supermarket growth and natural disasters). In their existing forms, the highest number of environmental sustainability sensitive drivers were targeted by 'regulations on marketing' (15/24 environmentally sensitive drivers) and 'school food programmes and policies' (11/24), which suggests that these actions need to be prioritised (Table 2).

Suggestions for modifications of existing WHO double-duty actions

Some of the unaddressed modifiable shared drivers could be addressed by introducing slight modifications to the existing WHO double-duty actions. For example, to effectively implement the policy on 'EBF in the first 6 months, and beyond', it is critical to ensure paid maternity leave for at least 6 months to allow women to have time to provide appropriate care for their offspring and themselves (Table 2). The 'regulations on marketing' policy needs to be expanded to include adolescent girls and women of reproductive age and move away from the sole focus on infants and younger children. In addition to marketing regulation of breastmilk substitutes, other foods such as energy-dense and nutrient-poor foods need to be defined and targeted. Marketing regulations along with food pricing policies (e.g. taxes and subsidies) could be leveraged to make healthier diets (both in terms of safety and nutrition) affordable and accessible. Our synthesis suggests that the policy on 'maternal nutrition and antenatal care programmes' could be expanded to target women of reproductive age both in pre- and post-pregnancy periods and widen the focus from nutrition to overall health. Women's empowerment, reproductive health, mental health, water, sanitation and hygiene practices as well as the prevention of substance abuse should be core actions. The impact of the 'school food programmes and policies' could be maximised by acknowledging the importance of a safe and nutritious food environment within and around schools.

Suggestions for *de novo* policy actions

Two additional double-duty actions are proposed in an attempt to address the remaining unaddressed drivers

that were deemed modifiable (i.e. adolescent pregnancy, livelihood, urban residency, population density, literacy, mental health, stress, time use, social support and health service/access quality). Other drivers were either unmodifiable (i.e. genetic, sex, age and natural disasters) or less easy to modify (i.e. TV watching, medicine use, beliefs, cultural norms, cost of ingredients, supermarket growth and financial services) and were therefore not prioritised when identifying possible *de novo* actions.

The first *de novo* action we propose could focus on improving urban settlements for improved access to safe water, sanitation and hygiene and appropriate living conditions. This has the potential to address drivers such as poor urban residency and high population density. The second action could develop or strengthen social support systems (e.g. social protection schemes) which would, in turn, help to address drivers such as education/literacy, adolescent pregnancy, poor mental health, time use, livelihood, access to health services and stress (Table 2). Some of the previously proposed amendments to the actions on 'EBF in the first 6 months, and beyond' and 'maternal nutrition and antenatal care programmes' would also further tackle drivers such as mental health, adolescent pregnancy, time use and stress. The existing and *de novo* double-duty actions could catalyse the achievement of several SDG including those that are not directly related to nutrition, for example, SDG 2 'end hunger, achieve food security and improved nutrition and promote sustainable agriculture', SDG 3 'ensure healthy lives and promote wellbeing for all at all ages', SDG 11 'make cities and human settlement inclusive, safe, resilient and sustainable' and SDG 13 'take urgent action to combat climate change and its impact'.

Conclusions

The nutrition landscape in LMIC is becoming more complex, with multiple forms of malnutrition (the double burden) co-existing; obesity prevalence has escalated, while all forms of undernutrition persist throughout the life course. However, most interventions and policies address only one form of malnutrition, so there is a need for double-duty actions to address this growing double burden of malnutrition more effectively, since policy-makers have limited resources. Identifying shared drivers of the double burden of malnutrition is a first step towards effective interventions that simultaneously address the double burden of malnutrition (double-duty actions). The present paper identified the shared drivers for multiple forms of malnutrition, to assess which double-duty actions are likely to have the greatest reach in preventing the double burden of malnutrition, in the context of sustainable development. A significant proportion of the drivers of obesity and undernutrition are shared (approximately 40.0%), but the use of different terminologies and concepts to describe them may have previously hindered the development of an integrated conceptual framework guiding efforts to prioritise interventions that address both forms of malnutrition simultaneously. Using a common language is thus critical to

clearly understand actions proposed across areas of activity to ensure sustainable and effective implementation of double-duty actions. Linking the five double-duty actions proposed by the WHO to the shared drivers that we have identified showed that actions with the most benefit for nutrition and environmental sustainability are: regulations on marketing, promotion of appropriate early and complementary feeding in infants and maternal nutrition and antenatal care programmes. These actions therefore need to be prioritised.

Substantially more drivers could be addressed with minor modifications of the WHO double-duty actions and the addition of the two proposed *de novo* double-duty actions: (i) improving settlements for improved access to safe water, sanitation and hygiene and appropriate living conditions; and (ii) developing and strengthening social support systems. Effective implementation of the double-duty actions requires recognition that they are interconnected and that they do not necessarily operate at the same levels (i.e. individual, household, community, societal).

Future research

Prioritisation of the suggested double-duty actions is critical within each country and region, using epidemiological evidence. Data on effectiveness (effect size, cost-benefit analyses) and consideration of trade-offs and tensions between action are needed. Further research on the impact of these actions on environmental sustainability is also required, including empirical data from different LMIC to ensure that evidence is culturally appropriate to the context⁽³⁶⁾.

A paradigm shift in the way research is conducted and financed is needed to catalyse progress in addressing both forms of malnutrition simultaneously. Research should encourage the use of indicators that capture and assess both forms of malnutrition within the same study and evaluate the effectiveness of actions on both forms of malnutrition. To this end, the proposed shared drivers could help integrate the two artificially separated nutrition specialities of undernutrition and obesity.

A single evidence-based and validated conceptual framework integrating shared drivers of both forms of malnutrition is needed to guide programmes, actions and policies. This evaluation is one step to developing such a framework so that integrated efforts can be developed to leverage the increased attention given to nutrition. The validation process should use rigorous methods, such as the best fit framework approach⁽⁴⁸⁾ and consult with an interdisciplinary panel of experts. Failure to tackle both forms of malnutrition will compromise the achievement of the SDG given that nutrition is both an input and output of many of the SDG.

Supplementary material

The supplementary material for this article can be found at <https://doi.org/10.1017/S0029665118002616>

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Conflict of Interest

None.

Authorship

The authors had joint responsibility for all aspects of preparation of this paper.

References

1. Development Initiatives (2017) Global Nutrition Report 2017: Nourishing the SDGs. Bristol, UK: Development initiatives. Available at <http://globalnutritionreport.org/the-report/> (Accessed April 2018).
2. NCD Risk Factor Collaboration (2017) Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128.9 million children, adolescents, and adults. *Lancet* **390**, 2627–2642.
3. Kelly T, Yang W, Chen C-S *et al.* (2008) Global burden of obesity in 2005 and projections to 2030. *Int J Obes* **32**, 1431.
4. Hawkes C, Demaio AR & Branca F (2017) Double-duty actions for ending malnutrition within a decade. *Lancet Glob Health* **5**, e745–e766.
5. Dietz WH (2017) Double-duty solutions for the double burden of malnutrition. *Lancet* **390**, 2607–2608.
6. WHO (2017) *The Double Burden of Malnutrition*. Policy brief. Geneva: World Health Organization. Available at <http://www.who.int/nutrition/publications/doubleburdenmalnutrition-policybrief/en/> (Accessed April 2018).
7. WHO (2017) *Double-duty Actions*. Policy brief. Geneva: World Health Organization. Available at <http://www.who.int/nutrition/publications/double-duty-actions-nutrition-policybrief/en/> (Accessed April 2018).
8. Demaio AR & Branca F (2018) Decade of action on nutrition: our window to act on the double burden of malnutrition. *BMJ Glob Health* **3**, e000492.
9. UNICEF (2013) Improving child nutrition: the achievable imperative for global progress. Available at https://www.unicef.org/gambia/Improving_Child_Nutrition_-_the_achievable_imperative_for_global_progress.pdf (Accessed April 2018).
10. Stewart CP, Iannotti L, Dewey KG *et al.* (2013) Contextualising complementary feeding in a broader framework for stunting prevention. *Matern Child Nutr* **9**, 27–45.
11. Herforth A & Harris J (2014) Understanding and Applying Primary Pathways and Principles. Brief #1. Improving Nutrition through Agriculture Technical Brief Series. Arlington, VA: USAID/Strengthening Partnerships, Results, and Innovations in Nutrition Globally (SPRING) Project. Available at https://www.spring-nutrition.org/sites/default/files/publications/briefs/spring_understandingpathways_brief_1.pdf (Accessed May 2018).
12. Tackling Obesities: Future Choices – Building the Obesity System Map (2007) The Obesity System Map. Available at



- https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/296290/obesity-map-full-hi-res.pdf (Accessed April 2018).
13. WHO (2013) NCD Global Monitoring Framework. Ensuring progress on noncommunicable diseases in countries. Available at http://www.who.int/nmh/global_monitoring_framework/en/ (Accessed April 2018).
 14. Rollins NC, Bhandari N, Hajeebhoy N *et al.* (2016) Why invest, and what it will take to improve breastfeeding practices? *Lancet* **387**, 491–504.
 15. Victora CG, Bahl R, Barros AJ *et al.* (2016) Breastfeeding in the 21st century: epidemiology, mechanisms, and life-long effect. *Lancet* **387**, 475–490.
 16. WHO (2014) Exclusive breastfeeding to reduce the risk of childhood overweight and obesity. Biological, behavioural and contextual rationale. Available at http://www.who.int/elena/bbc/breastfeeding_childhood_obesity/en/ (Accessed August 2018).
 17. Kant AK (2000) Consumption of energy-dense, nutrient-poor foods by adult Americans: nutritional and health implications. The third National Health and Nutrition Examination Survey, 1988–1994. *Am J Clin Nutr* **72**, 929–936.
 18. Singh GM, Micha R, Khatibzadeh S *et al.* (2015) Estimated global, regional, and national disease burdens related to sugar-sweetened beverage consumption in 2010. *Circulation* **132**, 639–666.
 19. WHO (2003) Guiding principles for complementary feeding of the breastfed child. Available at http://www.who.int/nutrition/publications/guiding_principles_compfeeding_breastfed.pdf (Accessed August 2018).
 20. Dewey KG (2016) Reducing stunting by improving maternal, infant and young child nutrition in regions such as South Asia: evidence, challenges and opportunities. *Matern Child Nutr* **12**, 27–38.
 21. Rauber F, da Costa Louzada ML, Steele EM *et al.* (2018) Ultra-processed food consumption and chronic non-communicable diseases-related dietary nutrient profile in the UK (2008–2014). *Nutrients* **10**, 587.
 22. Costa CS, Del-Ponte B, Assunção MCF *et al.* (2018) Consumption of ultra-processed foods and body fat during childhood and adolescence: a systematic review. *Public Health Nutr* **21**, 148–159.
 23. Silva FM, Giatti L, de Figueiredo RC *et al.* (2018) Consumption of ultra-processed food and obesity: cross sectional results from the Brazilian Longitudinal Study of Adult Health (ELSA-Brasil) cohort (2008–2010). *Public Health Nutr* **21**, 2271–2279.
 24. Herforth A & Ahmed S (2015) The food environment, its effects on dietary consumption, and potential for measurement within agriculture-nutrition interventions. *Food Secur* **7**, 505–520.
 25. Cobb LK, Appel LJ, Franco M *et al.* (2015) The relationship of the local food environment with obesity: a systematic review of methods, study quality, and results. *Obesity* **23**, 1331–1344.
 26. Demmler KM, Ecker O & Qaim M (2018) Supermarket shopping and nutritional outcomes: a panel data analysis for urban Kenya. *World Dev* **102**, 292–303.
 27. Cunha DB, Bezerra IN, Pereira RA *et al.* (2018) At-home and away-from-home dietary patterns and BMI z-scores in Brazilian adolescents. *Appetite* **120**, 374–380.
 28. Popkin B & Reardon T (2018) Obesity and the food system transformation in Latin America. *Obes Rev* **19**, 1028–1064.
 29. Madjdian DS, Azupogo F, Osendarp SJ *et al.* (2018) Socio-cultural and economic determinants and consequences of adolescent undernutrition and micronutrient deficiencies in LLMICs: a systematic narrative review. *Ann NY Acad Sci* **1416**, 117–139.
 30. Hawkes C, Harris J & Gillespie S (2017) Changing diets: Urbanization and the nutrition transition. In 2017 Global Food Policy Report. Chapter 4. Pp 34–41. Washington, DC: International Food Policy Research Institute (IFPRI). Available at https://doi.org/10.2499/9780896292529_04 (Accessed August 2018).
 31. Hartstra AV, Bouter KE, Bäckhed F *et al.* (2015) Insights into the role of the microbiome in obesity and type 2 diabetes. *Diabetes Care* **38**, 159–165.
 32. Million M, Diallo A & Raoult D (2017) Gut microbiota and malnutrition. *Microb Pathog* **106**, 127–138.
 33. Stok FM, Hoffmann S, Volkert D *et al.* (2017) The DONE framework: creation, evaluation, and updating of an interdisciplinary, dynamic framework 2.0 of determinants of nutrition and eating. *PLoS ONE* **12**, e0171077.
 34. Story M, Kaphingst KM, Robinson-O'Brien R *et al.* (2008) Creating healthy food and eating environments: policy and environmental approaches. *Annu Rev Public Health* **29**, 253–272.
 35. Holdsworth M & Brics N (2016) Impact of climate change on food consumption and nutrition. In *Climate Change and Agriculture Worldwide*. Springer, pp. 227–238 [E Torquebiau, editor. Versailles-Dordrecht: Springer Quae].
 36. Jones AD, Hoey L, Blesh J *et al.* (2016) A systematic review of the measurement of sustainable diets. *Adv Nutr* **7**, 641–664.
 37. Jackson P & Viehoff V (2016) Reframing convenience food. *Appetite* **98**, 1–11.
 38. Ekanem EO (1998) The street food trade in Africa: safety and socio-environmental issues. *Food Control* **9**, 211–215.
 39. Thomas F & Depledge M (2015) Medicine ‘misuse’: implications for health and environmental sustainability. *Soc Sci Med* **143**, 81–87.
 40. Michaelowa A & Dransfeld B (2008) Greenhouse gas benefits of fighting obesity. *Ecol Econ* **66**, 298–308.
 41. WHO (2013) Global action plan for the prevention and control of noncommunicable diseases 2013–2020. Available at http://www.who.int/nmh/events/ncd_action_plan/en/ (Accessed May 2018).
 42. Swinburn B, Vandevijvere S, Kraak V *et al.* (2013) Monitoring and benchmarking government policies and actions to improve the healthiness of food environments: a proposed Government Healthy Food Environment Policy Index. *Obes Rev* **14**, 24–37.
 43. Bhutta ZA, Das JK, Rizvi A *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.
 44. Ruel MT, Alderman H, Maternal *et al.* (2013) Nutrition-sensitive interventions and programmes: how can they help to accelerate progress in improving maternal and child nutrition? *Lancet* **382**, 536–551.
 45. Christian P, Lee SE, Donahue Angel M *et al.* (2013) Risk of childhood undernutrition related to small-for-gestational age and preterm birth in low-and middle-income countries. *Int J Epidemiol* **42**, 1340–1355.
 46. Oken E & Gillman MW (2003) Fetal origins of obesity. *Obes Res* **11**, 496–506.
 47. Crume TL, Scherzinger A, Stamm E *et al.* (2014) The long-term impact of intrauterine growth restriction in a diverse US cohort of children: The EPOCH study. *Obesity* **22**, 608–615.
 48. Booth A & Carroll C (2015) How to build up the actionable knowledge base: the role of ‘best fit’ framework synthesis for studies of improvement in healthcare. *BMJ Qual Saf* **24**, 700–708.