



Synthesis of evidence to date, key gaps and opportunities for adolescent nutrition

Prepared for the Adolescent Interest Group
Meeting, held on 12th December 2017

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Abbreviations

AA-HA!	Global Accelerated Action for the Health of Adolescents	MMN	Multiple micronutrient
BMD	Bone mineral density	NCD	Non-communicable disease
BMI	Body mass index	NICE	National Institute for Health and Care Excellence
CDC	Center for Disease Control	PAHO	Pan American Health Organization
DALY	Disability-adjusted life year	SDG	Sustainable Development Goals
ENN	Emergency Nutrition Network	SPRING	Strengthening partnerships, results and innovations in nutrition globally
FANTA	Food and nutrition technical assistance	SUN	Scaling Up Nutrition
GBoDP	Global Burden of Disease Paediatrics Collaboration	TSH	Thyroid-stimulating hormone
HIC	High-income country	UNDESA	United Nations Department of Economic and Social Affairs
IDA	Iron-deficiency anaemia	UNICEF	United Nations Children's Fund
IFA	Iron-folic acid	USAID	United States Agency for International Development
LBW	Low birth weight	VAD	Vitamin A deficiency
LMIC	Low and middle-income country	WHO	World Health Organization
LSHTM	London School of Hygiene & Tropical Medicine	WRA	Women of reproductive age
MENA	Middle East and North Africa		

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Executive summary

This synthesis paper was prepared specifically as a background document for the Adolescent Interest Group meeting organised by Emergency Nutrition Network (ENN), London School of Hygiene & Tropical Medicine (LSHTM) and Save the Children which took place 12 December 2017. It is intended to give an overview of the ‘state of play’ and highlight key recent initiatives in the field of adolescent nutrition that set the scene for discussions during the day. As such, it is not a comprehensive review of all work in this area.

Adolescence is a time not only of sexual maturation but also rapid growth, second only to the first year of life. It is a unique period in the human life cycle in that it is biologically, socially and culturally sensitive. Adolescents face a high burden of morbidity and mortality, yet are

often overlooked in policies, programmes and guidelines. More recently, adolescents have been the focus of increased attention through global initiatives including The Lancet Commission on Adolescent Health and Wellbeing and inclusion in the Global Strategy for Women’s, Children’s and Adolescents’ Health (2016-2030) and Sustainable Development Goal (SDG) targets.

Nutrition is important to the health and wellbeing of adolescents now, in their adult lives and for the next generation, not only biologically but also socially and culturally. Despite this, relatively limited information is available on trends in adolescent nutritional status, effective interventions and delivery platforms, or age group and gender-specific guidelines.

Recent data shows that the global prevalence of moderate and severe underweight decreased from 1975

to 2016 in children and adolescents aged 5 to 19 years, although in certain regions (south Asia, southeast Asia and central, east and west Africa) absolute numbers are increasing due to population growth. At the same time, worldwide prevalence of obesity in this age group is increasing in every country and every region. If current trends continue, child and adolescent obesity is expected to overtake moderate and severe underweight by 2022.

Iron-deficiency anaemia (IDA) is the most common micronutrient deficiency among adolescents and was ranked as the leading cause of adolescent disability-adjusted life years (DALYs) lost in 2015. The next-highest burden in adolescents is iodine deficiency, followed by vitamin A deficiency. Data for other micronutrients is more limited.

Draft review findings suggest the diets of adolescent girls in low and middle-income countries (LMICs) are generally of poor quality, while increasing consumption of processed and calorie-rich foods is contributing to the rise in overweight and obesity. Fifty per cent of adolescent girls in LMICs do not eat three meals a day, with most not eating breakfast.

There is a paucity of available evidence in terms of nutrition interventions. Most robust evidence is in relation to micronutrient supplementation. Iron supplementation significantly improves haemoglobin concentration and potentially reduces anaemia; periconceptional folic acid supplementation can reduce neural tube defects; and high-dose (≥ 1 g daily) calcium intake among pregnant women at risk of low calcium intake reduces the risk of pre-eclampsia, preterm birth and neonatal high-care admissions. Specific studies among adolescent women indicate that zinc supplementation among adolescents is associated with improvements in serum zinc and haemoglobin concentration, and supplementation among pregnant adolescents significantly reduces preterm birth rates and low birth weight. Limited evidence is available on protein-energy supplementation in adolescents. Studies of interventions to address adolescent overweight/obesity are mainly from high-income countries and have shown limited, non-significant effects. Obesity-prevention programmes remain an important approach.

Non-nutrition interventions – particularly those that improve education, increase empowerment and delay early marriage and pregnancy – may have as great or greater effect on adolescent nutrition and birth outcomes than nutrition interventions.

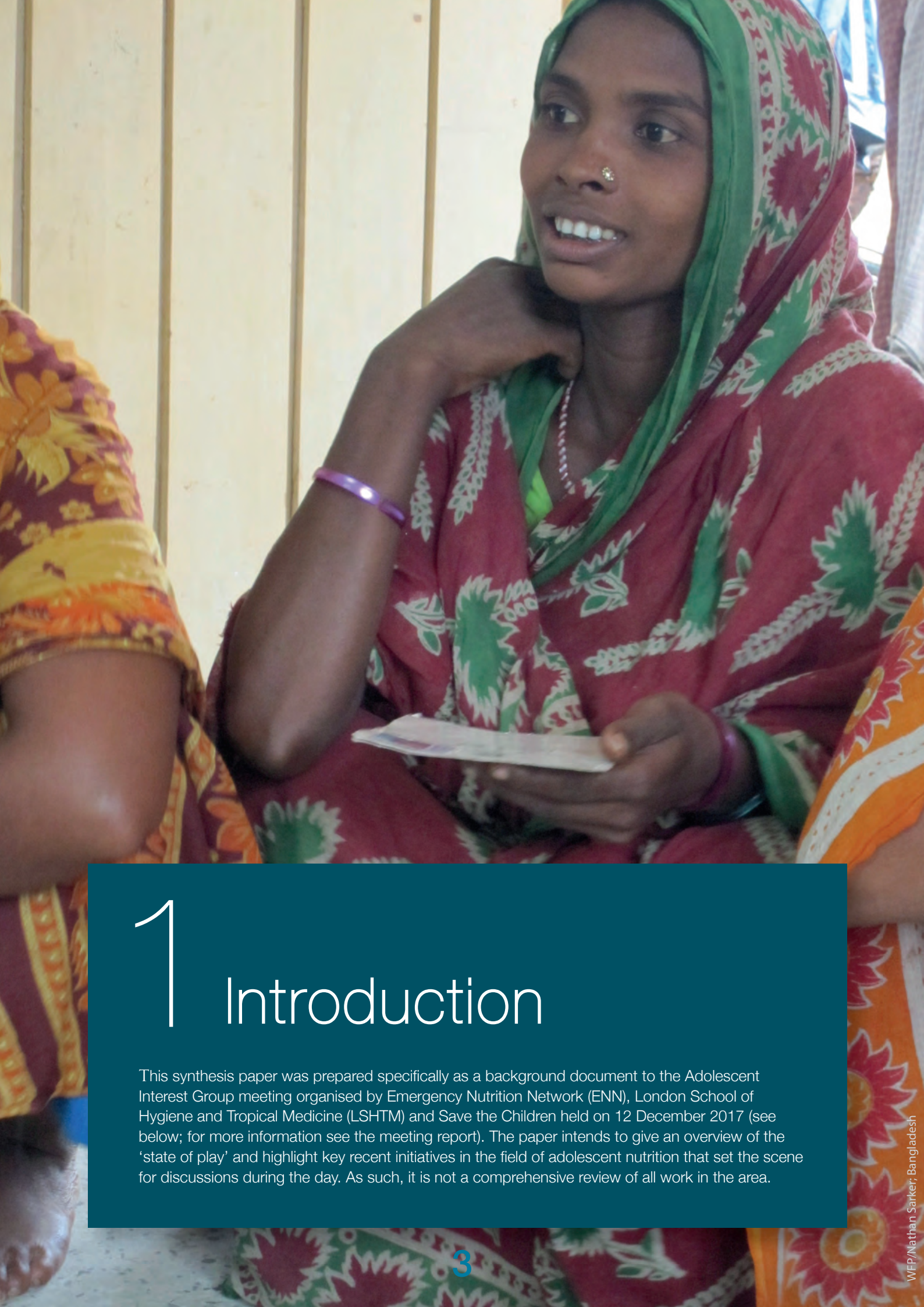
A growing body of international evidence suggests that

'catch-up' growth in adolescence is possible. This is mediated through a delay to maturation and/or an extended pubertal growth phase. Further research is needed to understand this potential better.

There is limited documentation of practical experience of what works in terms of programmatic approaches to meeting adolescents' needs. For nutrition interventions, useful approaches identified include the use of community models such as women's groups, mother's clubs, teen clubs, health extension workers and community volunteers, who provide services in the community and in the home. In health, the adaptation of services to be user-friendly and appealing has proven effective in increasing uptake by adolescents.

Participatory approaches show promise with positive examples from the education sector. In health, peer education is the most-evaluated strategy for increasing youth engagement, while youth-led participatory action research is an increasingly popular approach to engaging adolescents in the design and implementation of interventions. However, cultural, generational, bureaucratic and financial barriers may limit the sustainability of meaningful youth engagement, particularly for adolescent girls. As adolescence is a period of openness to new ideas and adolescents are often the first to adopt new technologies; the use of digital technology and social media provide potential opportunities for youth engagement, although there is a lack of rigorous evaluations or consensus on the most effective strategies for adolescents to date.

A review of recent global initiatives shows a broad consensus on the gaps, opportunities and recommendations on priorities for moving forward. There is an overriding call for greater global attention to, and investment in, adolescents; a need for disaggregated data by age group and gender; and more robust evidence, particularly from LMICs, to inform effective, targeted interventions and approaches and for the formulation of adolescent-specific guidelines. The key gaps, opportunities and recommendations from recent initiatives relating to adolescent nutrition are summarised in table 6.



1 Introduction

This synthesis paper was prepared specifically as a background document to the Adolescent Interest Group meeting organised by Emergency Nutrition Network (ENN), London School of Hygiene and Tropical Medicine (LSHTM) and Save the Children held on 12 December 2017 (see below; for more information see the meeting report). The paper intends to give an overview of the 'state of play' and highlight key recent initiatives in the field of adolescent nutrition that set the scene for discussions during the day. As such, it is not a comprehensive review of all work in the area.

2 Background

Adolescence is not only a time of sexual maturation but also of rapid growth, second only to the first year after birth.

Definitions of 'adolescence'

World Health Organization (WHO) – the period between the ages of 10 and 19 years.

The Lancet Commission on Adolescents (2016) – the period between the ages of 10 and 24 years. This was to cover the groups defined by the:

United Nations Department of Economic and Social Affairs (UNDESA)

- adolescents (aged 10-19 years),
- youths (aged 15-24 years), and
- young people (aged 10-24 years)

Adolescence is a unique point in the human life cycle because it is:

- A *biologically* sensitive period of rapid growth, driven hormonally but needing adequate nutrition (quantity and quality) for optimal growth/development.
- A *socially* sensitive period: attitudes and behaviours determining future health and non-communicable disease (NCD) risk are formed and reinforced, with lifelong consequences.
- A *culturally* sensitive period: the 'in limbo' phase when adolescents are moving from childhood to adulthood can impact access to food at household level and beyond, as well as access to services.

Yet adolescents are often overlooked in policies and interventions. Following limited focus in global initiatives, more interest has emerged recently, in particular through The Lancet Commission on Adolescent Health and Wellbeing (2016) which outlines the opportunities and challenges for investment in adolescents at country and global levels. Furthermore, the recent pledges on Sustainable Development Goals (SDGs) have provided a renewed agenda to improve the health of adolescents and young people by strengthening the delivery mechanisms of healthcare interventions. Adolescent health and development was made an integral part of the Global Strategy for Women's, Children's and Adolescents' Health (2016-2030). Adequate nutrition in adolescence is important for both current and future

health. This period is perhaps one of the few opportunities for the catch-up nutrition needed to prevent the vicious intergenerational effect of malnutrition whereby small babies grow into smaller, disadvantaged mothers, who in turn are more likely to give birth to small, underweight babies. These infants, already nutritionally impaired at birth, often become stunted children, more at risk of cognitive delays, poor school performance and worse health and education outcomes in the future.

The Interest Group meeting aimed to capitalise on this upsurge of interest in adolescents and provide a platform to identify emerging research and operational experiences; disseminate existing data with potential for analysis from an adolescent nutrition perspective; and help 'bridge' the disciplines of health and nutrition by facilitating discussion and learning. It focused on the three interwoven areas of populations, interventions and outcomes. (For more information, refer to the meeting report).



3 Evidence to date

The *Lancet* series on Maternal and Child Nutrition 2013 identified adolescents as a key priority, placing them at the centre of nutrition interventions, together with women of reproductive age (WRA) and mothers. More

recent evidence on global trends in adolescent nutrition, effective interventions, potential for catch-up growth and available nutrition guidelines is described below.

3.1 Evidence on global trends in adolescent nutrition

The current worldwide population of adolescents (aged 10 to 24 years) is 1.8 billion; 89 per cent of them live in low and middle-income countries (LMICs), where adolescents make up one third of the population. As more children are surviving beyond their fifth birthday, the population of adolescents is increasing (Lassi et al, 2015). Around 16 million girls aged 15 to 19 years and one million girls under 15 years old give birth annually. Pregnancy during adolescence is associated with a 50 per cent increased risk of stillbirth and neonatal death and greater risk of preterm birth, low birthweight (LBW) and small-for-gestational age (SGA) compared to older mothers (Bhutta et al, 2013).

Findings from the 2016 report on global burden of diseases and injuries among children and adolescents suggest that protein-energy malnutrition¹ is among the top ten causes of death among children and adolescents, accounting for 225,906 deaths in 2013. Globally, around 34 deaths per 100,000 children and adolescents are attributed to malnutrition. This number varies significantly between developing (38.5 per 100,000) and developed countries (0.2 per 100,000) (Collaboration GBoDP, 2016).

Few studies have assessed global and regional trends in the nutrition of adolescents. There is an overall lack of data and there are large gaps in the data that is available. For **stunting** among adolescent females, data is particularly limited, but it has been estimated that in some countries as many as half of all adolescents are stunted, indicating chronic exposure to undernutrition from an early age and resulting in poor physical and cognitive outcomes (Save the Children, 2015).

The extent and severity of **wasting** among adolescents is less clear compared with the effects in children under five years of age, primarily due to limitations in data collection and standard thresholds for adolescent populations (UNICEF, 2013).

Trends in underweight, overweight and obesity in adolescents presented here are from two main pieces of work:

- 1) Recent analysis published in *The Lancet* by the NCD Risk Factor Collaboration group (2017) on worldwide trends in body mass index (BMI), underweight,

¹ Protein-energy malnutrition is the term used by Global Burden of Disease for undernutrition.

overweight and obesity from 1975 to 2016; a pooled analysis of 2,416 population-based measurement studies in 128.9 million children, adolescents and adults, and

- 2) Analysis published by Akseer et al in 2017 of nutrition levels, trends and patterns among young people between 10 and 24 years of age, focused on current best estimates (from 2009 onwards) or trends from 1990 to 2015, where available.

Overweight and obesity

Overweight and obesity affect one in every three adolescents worldwide and are of particular concern among girls (WHO, 2014). In 2011 an estimated 43 million (seven per cent) of children under five years old were overweight globally, marking a 54 per cent increase from an estimated 28 million in 1990. Most of these overweight children (32 million) lived in LMICs. The regional and country-level prevalence of overweight/obesity among females under 20 years old (irrespective of pregnancy status) is shown in figure 1.

As shown in figure 1, among all females younger than 20 years old, the median prevalence of overweight and obesity (defined as children and youth $> +1$ SD and $+2$

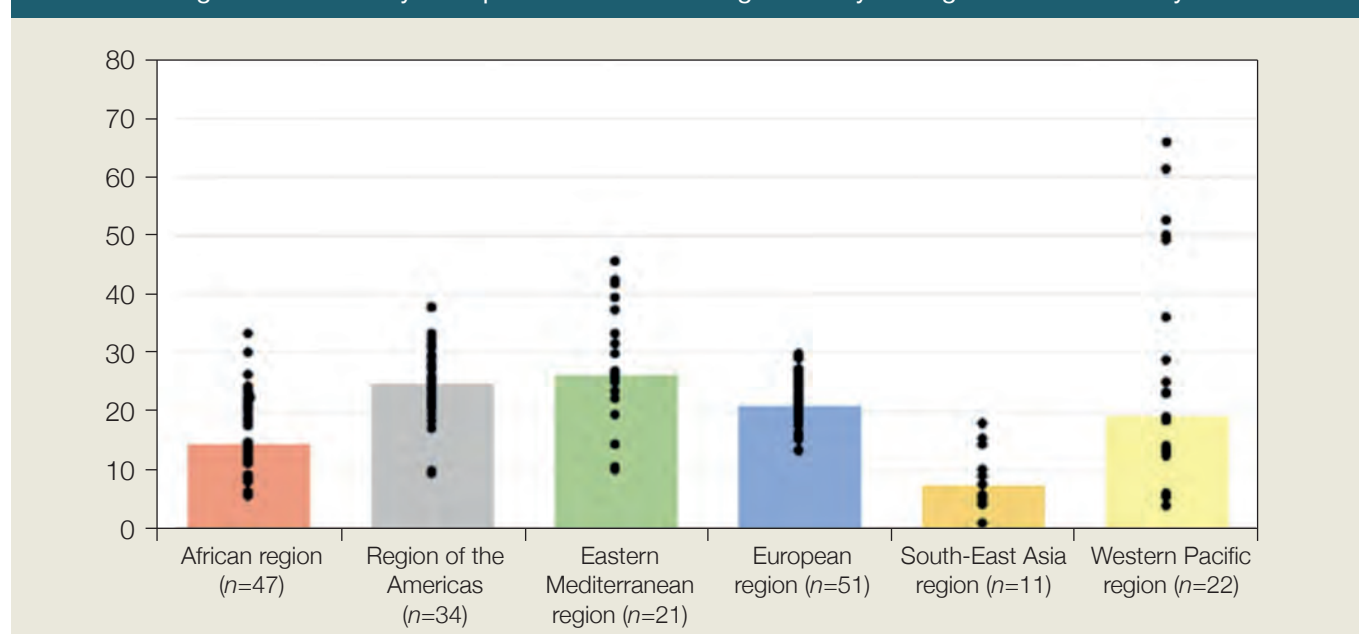
SD from age- and sex-specific population reference BMI) is highest in the eastern Mediterranean region (28%), followed by the western Pacific (25%), the Americas (25%), and Europe (21%). Around 15 per cent of African and nine per cent of south Asian female children and youths are also overweight/obese. In 11 countries, the proportion of overweight and obese girls was found to be almost 40 per cent or more. These are shown in table 1.

TABLE 1 Countries with almost 40 per cent or more overweight and obese girls

Country	Percentage of overweight and obese girls
Saudi Arabia	37%
Costa Rica	38%
Uruguay	40%
Libya	42%
Oman	42%
Kuwait	46%
Solomon Islands	49%
Tonga	53%
Micronesia	61%
Kiribati	66%

Source: Akseer et al, 2017

FIGURE 1 Regional and country-level prevalence of overweight/obesity among females under 20 years old



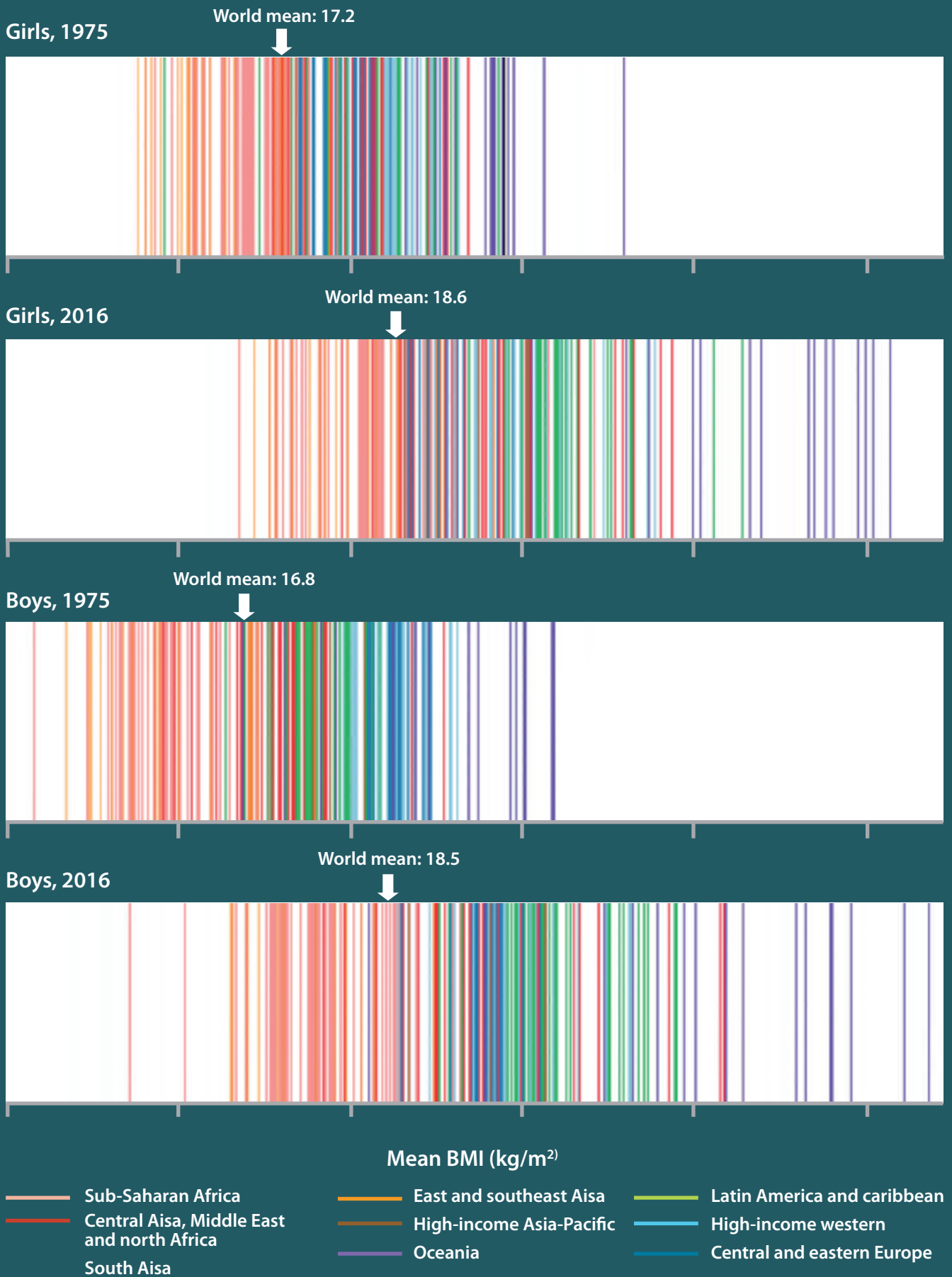
Source: Akseer et al, 2017

Table 2 Increase in global age-standardised prevalence of obesity and mean BMI between 1975 and 2016 in children and adolescents age 5-19 years, by gender

	Global age-standardised prevalence of obesity		Global age-standardised mean BMI (kg/m ²)	
	1975	2016	1975	2016
Girls	0.7% (0.4 – 1.2)	5.6% (4.8 – 6.5)	17.2 (16.8 – 17.6)	18.6 (18.4 – 18.7)
Boys	0.9% (0.5 – 1.3)	7.8% (6.7 – 9.1)	16.8 (16.3 – 17.2)	18.5 (18.3 – 18.7)

Source: NCD Risk Factor Collaboration, 2017

FIGURE 2 Age-standardised mean BMI in children and adolescents in 1975 and 2016
(Each line shows one country)



Source: NCD Risk Factor Collaboration, 2017

More recent analysis shows worldwide increases from 1975 to 2016 in mean BMI and (especially) in the prevalence of obesity in children and adolescents aged 5-19 years old, with increases in every region and every country (NCD Risk Factor Collaboration, 2017). Increases according to gender are shown in table 2. Analysis shows that the trend in children’s and adolescents’ mean BMI has plateaued, albeit at high levels, in many high-income countries (HICs) since around 2000, but has increased in east, south and southeast Asia, as illustrated in figure 2. Figure 3 shows the dramatic increase in numbers of obese children and adolescents between 1975 and 2016, particularly in east Asia, the Middle East and north Africa.

Underweight

The prevalence of underweightⁱⁱ among adolescent females aged 13 to 17 years across the five regions of the world and about 60 countries is generally less than five per cent. However, in some LMICs in Africa and Asia, almost ten per cent or more of younger adolescent girls (13 to 15 years) are too thin for their age and height (Akseer et al, 2017). These are shown in Table 3.

More recent analysis by the NCD Risk Factor Collaboration (2017) showed that the prevalence of moderate and severe underweight decreased from 1975 to 2016 in children and adolescents aged 5 to 19 years, as shown in Table 4. In 2016 the prevalence of moderate and severe underweight was highest in India, at 22.7 per cent (95% CI, 16.7–29.6%) among girls and 30.7% (95% CI, 23.5–38.0%) among boys.

The lowest mean child and adolescent BMIs in 2016 were still those in south Asia and east Africa, with age-

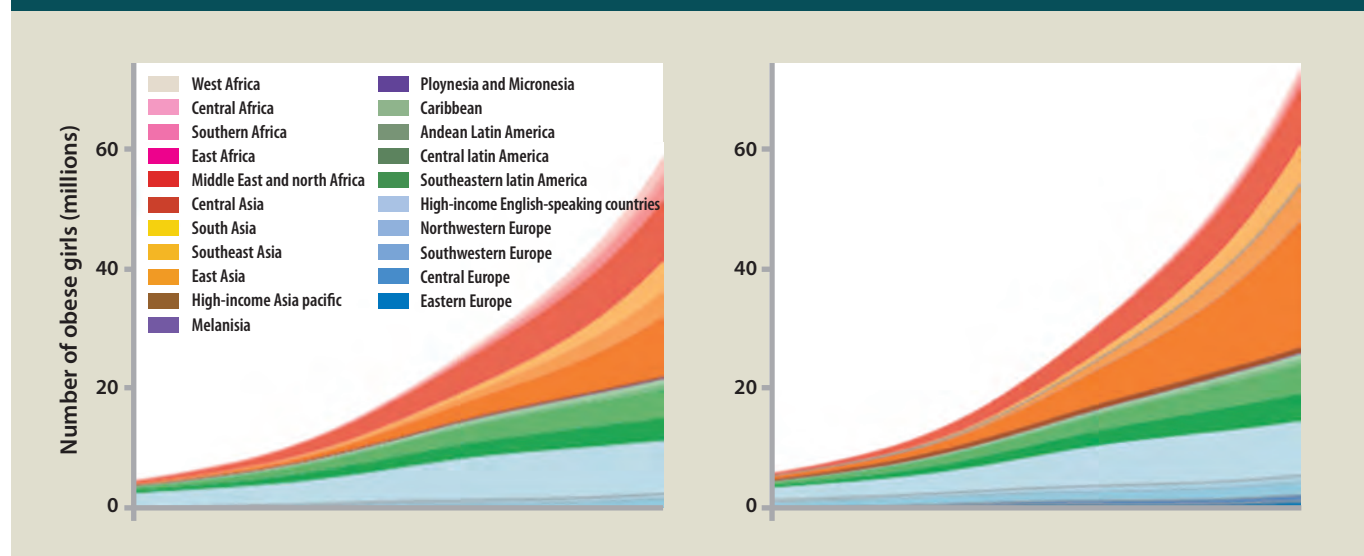
standardised mean BMIs between 16.9 and 17.9 kg/m² for girls and boys. Ethiopia had the lowest age-standardised mean BMI for both sexes; 16.8 kg/m² (95% CI 15.6–17.9) for girls and 15.5 kg/m² (14.4–16.6) for boys. Other countries with low BMI in both sexes in 2016 were Niger, Senegal, India, Bangladesh, Myanmar and Cambodia (NCD Risk Factor Collaboration, 2017).

In most regions the absolute number of moderately and severely underweight children and adolescents decreased since 2000, despite population growth (see figure 4). The exceptions were south Asia; southeast Asia; and central, east and west Africa, where population growth led to an increase in the burden of underweight in terms of absolute numbers, despite declining prevalence. In 2016, 47.5 million (63 per cent) of 75 million moderately and severely underweight girls and 73.6 million (63 per cent) of 117 million underweight boys in the world lived in south Asia, considerably higher than its 27 per cent share of the global child and adolescent population (NCD Risk Factor Collaboration, 2017).

Despite the rise in prevalence of obesity, there are currently more children and adolescents worldwide who are moderately or severely underweight than obese. However, if post-2000 trends continue, child and adolescent obesity is expected to overtake moderate and severe underweight by 2022. In most regions the increase in the prevalence of overweight and obesity was larger than the decline in the prevalence of underweight.

ⁱⁱ Defined as proportion of youth < -2 SD from the age and sex-specific population median BMI

FIGURE 3 Trends in the number of children and adolescents aged 5 to 19 years old with obesity between 1975 and 2016



Source: NCD Risk Factor Collaboration, 2017

TABLE 3 Countries with almost 10 per cent or more underweight girls aged 13 to 15 years

Country	Percentage of underweight girls
Maldives	18%
Vietnam	16%
Sudan	14%
Cambodia	13%
Mauritius	11%
Bangladesh	11%
Namibia	10%
Fiji	10%
Pakistan	9%
The Philippines	9%

Source: Akseer et al, 2017

As the authors have highlighted, the finding that the number of children and adolescents aged 5-19 years globally who are moderately or severely underweight remains larger than those who are obese and underscores the continued need for policies and programmes to improve food security in low-income countries and households, especially in south Asia (NCD Risk Factor Collaboration, 2017). However, the experiences of east Asia, Latin America and the Caribbean show that the transition from underweight to overweight and obesity can be rapid. In an unhealthy transition an increase in nutrient-poor, energy-dense foods can lead to stunted growth alongside weight gain in children, adolescents and adults. The consequences of this are higher BMI and worse health outcomes throughout the life course.

TABLE 4 Decreases in global age-standardised prevalence of moderate and severe underweight between 1975 and 2016 in children and adolescents age 5-19 years, by gender

	Global age-standardised prevalence of moderate and severe underweight	
	1975	2016
Girls	9.2% (6.0–12.9%)	8.4% (6.8–10.1%)
Boys	14.8% (10.4–19.5%)	12.4% (10.3–14.5%)

Source: NCD Risk Factor Collaboration, 2017

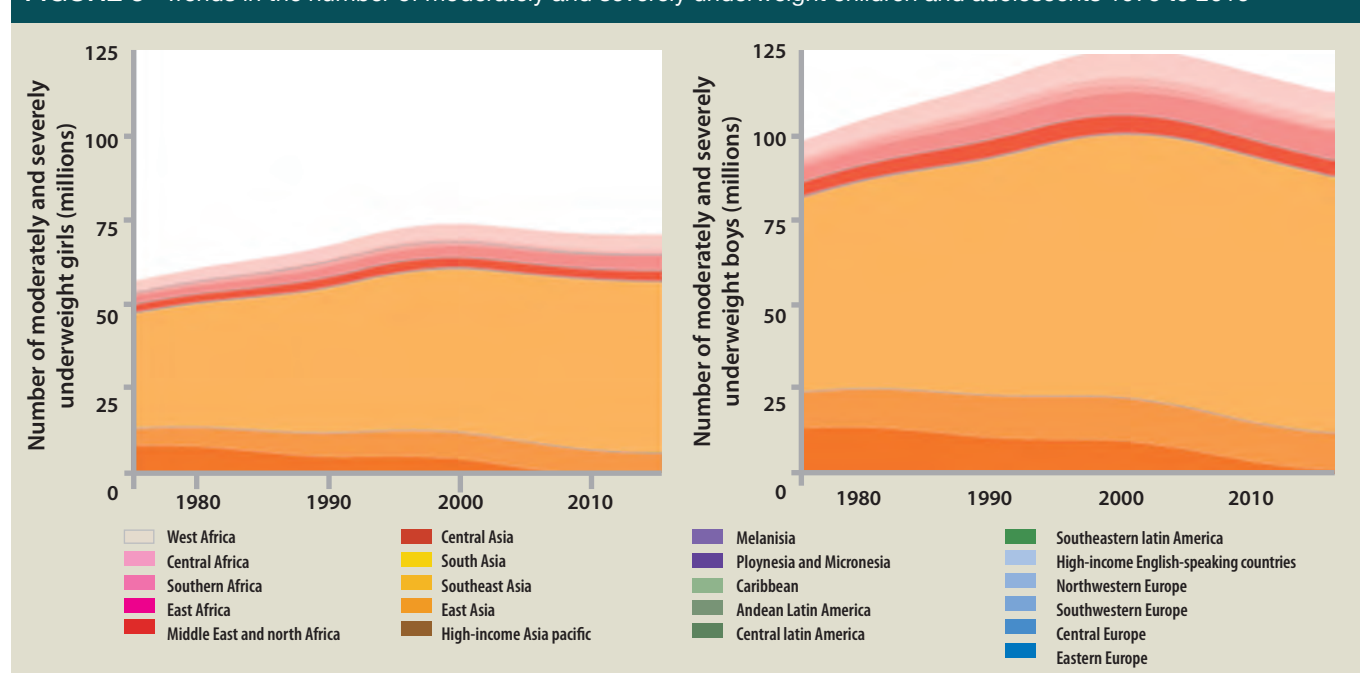
Micronutrient deficiencies

The information presented in this section on micronutrient deficiencies is sourced from Akseer et al, 2017.

Iron deficiency anaemia

Iron is one of the most common micronutrient deficiencies among adolescents. Iron deficiency anaemia (IDA) ranked as the leading cause of adolescent disability-adjusted life years (DALYs) lost in 2015. Except in older male adolescents (20 to 24 years old), it was the leading cause of DALYs lost in both sexes and age groups, contributing to more than 2,500 DALYs per 100,000 adolescents among females in some regions. The number of DALYs due to IDA in girls by age group is shown in Table 5.

The highest regional burden of iron deficiency and associated anaemia is seen in south Asia, followed by sub-Saharan Africa, across all age groups and both genders. The lowest burden is seen in central Europe, eastern Europe and central Asia region.

FIGURE 3 Trends in the number of moderately and severely underweight children and adolescents 1975 to 2016


Source: NCD Risk Factor Collaboration, 2017

Iodine deficiency

The available micronutrient data indicates that, for adolescents, the next highest burden is from iodine deficiency. Among all males and 10 to 14-year old females, DALYs due to deficiencies in iodine ranged between about 20 to 140 per 100,000 people among global regions in 1990, with the highest levels found in south Asia, sub-Saharan Africa and the Middle East and North Africa (MENA) region. From 1990 to 2015 these levels decreased moderately to range between 20 and 100 per 100,000 people. Regional distribution remained about the same. Among the older age groups (aged 15 to 19 and 20 to 24 years), DALY rates are generally higher and greater variation is observed between regions. Females tend to have a higher burden than males across all age group.

Vitamin A deficiency (VAD)

According to available DALY data, VAD appears to be less of a concern among adolescents, relative to iron and iodine. From 1990 to 2015 DALYs ranged from about 0 to 9 per 100,000 people across age groups, sexes and geographic regions. South Asia, sub-Saharan Africa and the MENA region have the highest rates globally, while disability from VAD is lowest in Europe. Similar trends exist across each of the age groups and for both sexes.

Other micronutrient deficiencies

Rates of DALYs from a combined group of other nutritional deficiencies, including those in vitamins B, C, D, calcium, zinc, folic acid and selenium, range from two to 75 per 100,000 people. South Asia has the highest burden (two to three times higher than the next-highest burden region) and also experienced the most decline from 1990 to 2015. Trends are similar across all adolescent ages. Females generally have greater disability from deficiencies in these nutrients than males.

TABLE 5 Number of DALYs due to IDA in adolescent girls by age group, 2015

	Age group		
	10-14 years	15-19 years	20-24 years
Number of DALYs due to IDA per 100,000 girls	700 – 1,200	300 – 900	300 – 1100

Adolescence is the second-fastest growth period following infancy, characterised by high energy and nutrient requirements. Zinc, calcium and vitamin D are key micronutrients in this critical developmental phase, making adolescents vulnerable to deficiencies in them, although limited data is currently available to substantiate this.

Adolescents' diets

Evidence from an as-yet-unpublished systematic review on the diet and eating practices of adolescent girls was presented during the meeting (Keats et al, 2017; in press). In brief, the review found that the diet quality of adolescent girls in LMICs is generally poor. Increasing consumption of processed and calorie-rich foods is contributing to the rise in overweight and obesity, especially among younger adolescent girls (aged 10-14 years). In South Asia and Africa protein intake is inadequate and fat intake is low; findings that may contribute to the prevalence of underweight in these regions. Overall, breakfast skipping and snacking are highly prevalent among adolescent girls of all ages. Fifty per cent of adolescent girls in LMICs do not eat three meals per day, with most not eating breakfast. Disparity is high among adolescents from lower socioeconomic profiles compared with their wealthier counterparts (Lassi et al, 2017; in press).

FIGURE 5 Summary table of evidence on dietary intake of adolescents

Study	Findings
Marshall, Burrows and Collins, 2014	Most school-age children in LMICs eat plant-based foods; fewer than 50 percent consume dairy; breakfast is the most-skipped meal; consumption of processed foods is increasing.
Doku and others, 2013; Ochola and Masibo, 2014	In Ghana 31 percent of those aged 12-18 years ate breakfast fewer than four days a week; 56 percent rarely ate fruits; 48 per cent rarely ate vegetables; boys were more physically active than girls.
Barugahara, Kikafunda and Gakenia, 2013	In Uganda girls aged 11-14 years achieved WHO daily requirements in the following proportions: 30 percent for protein; 61 percent for vitamin A; 89 percent for vitamin C; 92 percent for fibre.
Kawade, 2012	In India school-going girls (aged 10-16 years) were deficient in zinc, with 50 percent having cognitive impairments.
Nago and others, 2010	In Benin adolescents (aged 13-19) years received 40 percent of their daily diet from food prepared outside the home, accounting for 75 percent of their daily energy intake.
Alam and others, 2010	In Bangladesh consumption of non-stable, good-quality food items within the last week were less frequent and correlated positively with the household asset quintile.

Source: Lassi et al, Nutrition in Middle Childhood and Adolescence, 2017 (in press)

3.2 Evidence on effective interventions

The most recent review of effective interventions was published by Lassi et al (2017(a)) and was also summarised in the same series of papers by Bhutta et al (2017). This comprehensively reviewed all published systematic reviews that targeted interventions related to nutrition (through October 2016) on adolescents (10-19 years) and WRA, including pregnant women. To help conceptualise nutrition interventions and outcomes for adolescents, a framework was presented by Lassi et al (2017a) (see figure 3 below).

The 2017 review supersedes one from 2016, which was limited to micronutrient supplementation, nutrition interventions for pregnant adolescents and interventions to prevent obesity (Salam et al, 2016). The paper by Lassi et al 2017(a) reviews the current evidence for nutritional and related interventions from studies focused on adolescents only or as part of different population groups. These interventions include micronutrient supplementation, food/protein energy supplementation and obesity prevention and management. A total of 35 systematic reviews (five on adolescents only) and 107 primary studies on adolescents were identified. Findings from the review are summarised in figure 4.

A major limitation of the review was the paucity of trials on adolescent populations. Trials on WRA (including pregnant women) did not include disaggregated data for adolescents. Most studies are of low-to-moderate quality due to small sample size, lack of rigorous study

design and lack of blinding (as most included behaviour-change educational activities this would have been very difficult to achieve in practice). Many would require longer duration to achieve impact, therefore actual impact was not captured. There is very limited evidence from LMICs on interventions for undernutrition and very few studies on nutrition-sensitive interventions for adolescents.

The evidence presented below on nutrition interventions is sourced from the systematic review by Lassi et al 2017(a), unless otherwise indicated.

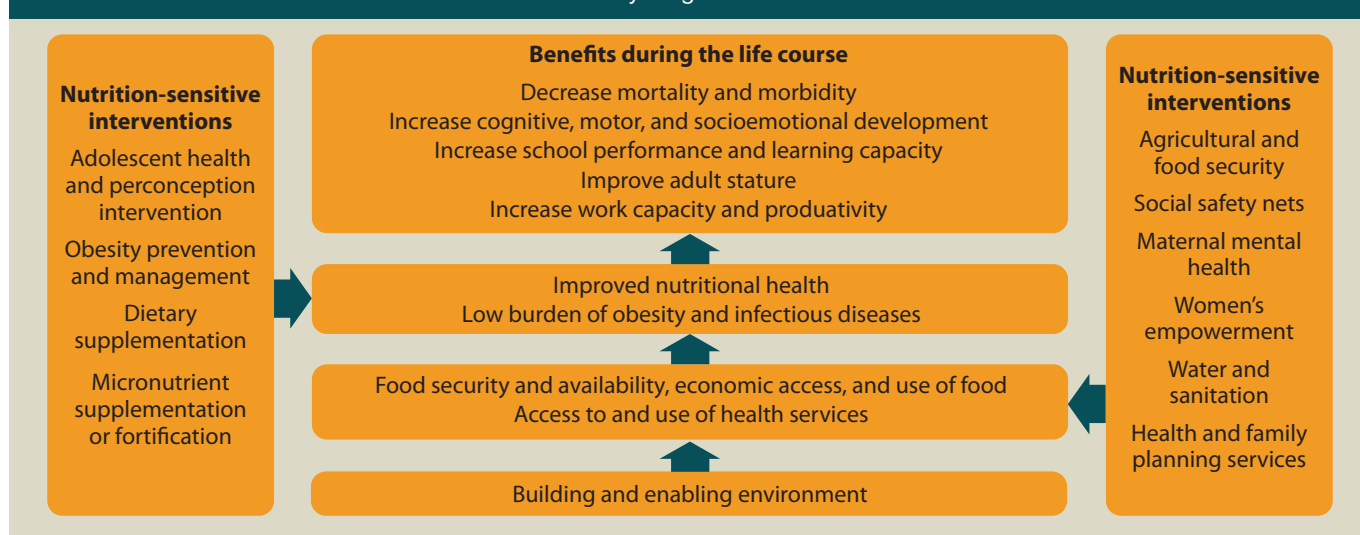
Iron supplementation

Iron supplementation significantly improves haemoglobin concentration and potentially reduces anaemia; periconceptional folic acid supplementation can reduce neural tube defects; and high-dose (≥ 1 g daily) calcium intake among pregnant women at risk of low calcium intake reduces the risk of pre-eclampsia, preterm birth and neonatal high-care admissions.

Zinc supplementation

Specific studies among adolescent women indicate that zinc supplementation among adolescents is associated with improvements in serum zinc and in haemoglobin concentration, and supplementation among pregnant adolescents significantly reduced preterm birth rates and LBW.

FIGURE 6 Framework for nutrition in adolescents and young women



Source: Lassi et al. 2017a

A paucity of trials on calcium, vitamin D, vitamin A and iodine supplementation were found. The review also found limited available evidence on food/protein energy supplementation in adolescents. The potential risk of protein-energy supplementation in younger adolescent girls inducing earlier puberty, with associated negative consequences of early pregnancy, needs further investigation.

Overweight and obesity

Studies that targeted interventions to address overweight and obesity among adolescents show some non-significant benefits in reducing BMI, but the evidence is limited and studies are mainly from high-income settings and therefore have limited generalisability to LMICs. However, obesity prevention programmes are an important approach in school/community settings and in urban populations, where physical activity among young girls may be limited for sociocultural reasons, lifestyle behaviours or lack of adequate facilities, or where the consumption of healthy diets is limited due to access and availability issues. Nutrition counselling, the promotion of physical activity and behaviour change can help prevent obesity, but more research is needed to improve the effectiveness of these interventions across all platforms and in the

context of wider socioeconomic, political and commercial issues. Since micronutrient deficiencies can coexist with overweight and obesity across all age groups, this subject also needs consideration.

Non-nutrition interventions

Beyond specific nutrition interventions, interventions by other sectors may have as much if not more effect on adolescent nutrition and birth outcomes than nutrition interventions themselves. For example, among adolescents in LMICs, higher education levels are associated with reduced teenage births and older age at marriage. Modelling the effect of trends in education on adolescent fertility from 1990 to 2012 showed each additional year of education decreased adolescent birth rates annually by 8.5 births per 1,000 girls per year across all countries, when adjusted for growth in national wealth (Patton et al, 2016). A Cochrane review found that incentive-based interventions that focus on keeping young people, especially girls, in secondary school may reduce adolescent pregnancy, but further high-quality trials are needed to confirm this (Mason-Jones et al, 2016). Interventions for the prevention of infection are also key. School-based malaria prevention interventions have been shown to significantly reduce anaemia and increase sustained attention in school children (Clarke et al, 2017).

FIGURE 7 Adolescent nutrition interventions: Impacts and delivery platforms

Delivery platforms utilized	Interventions	Outcomes	Impact estimates RR/SMD (95% CI)		
			Mostly from HICs	From both HICs and LMICs	Mostly from LMICs
Community school Online media	Obesity prevention	BMI	SMD -0.05 (-0.11, 0.01)		
	Obesity management	BMI at 6 months	SMD -0.24 (-0.36, 0.13)		
Community school	Daily iron versus placebo	Anemia			RR
	Daily IFA versus placebo	Anemia Serum hemoglobin			
	Weekly IFA versus placebo	Anemia Serum hemoglobin			
	Vitamin A versus placebo	Anemia			
	Calcium versus placebo	BMD change of spine Serum calcium		SMD -0.03 (-0.26, 0.20) SMD 0.17 (-0.32, 0.67)	
	Vitamin D versus placebo	Serum 25(OH)D levels at 3 years		MD 8.8 (-2.68, 20.28)	
	Zinc versus placebo	Hemoglobin Serum zinc Preterm birth (pregnant adolescents)		SMD 4.81 (0.47-8.66) SMD 4.28 (2.49-6.06) RR 0.57 (0.46-0.69)	
	Iodine versus placebo	TSH Cretinism (pregnant adolescents)		MD 0.30 (-0.06, 0.66) RR 0.27 (0.12-0.60)	
	MMN versus placebo	Serum hemoglobin			SMD 1.83 (0.59-3.08)
	MMN versus IFA	Anemia			RR 1.1 (0.5-2.2)

3.3 Evidence on potential for catch-up growth

A growing body of international evidence suggests that 'catch-up' growth in adolescence is possible. This is mediated through a delay to maturation and/or an extended pubertal growth phase. Longitudinal data from the Young Lives Study (Fink and Rockers, 2014) shows that 36 per cent of stunted children aged eight years managed to catch up with their peers by age 15. Furthermore, results from the Young Lives Study show that children who caught up in height by age fifteen had smaller deficits in cognitive function than children who remained stunted (Fink and Rockers 2014).

Two other key findings from later Young Lives work (Benny et al, 2017) are summarised as follows:

1. Being born to a stunted adolescent mother increases the chance the infant will be stunted by 15 percentage points. While identifying this intergenerational link is not new, showing that this stunting may persist into the child's adolescent years is. Most of this effect is linked to the mother being

- chronically malnourished before and during pregnancy, rather than the age of giving birth.
2. In a second (older) group of girls studied, the extent of physical recovery during adolescence showed more change than expected. For girls who were shorter than the WHO expected norm at age 12, on average 40 per cent of the height deficit was recovered by the age of 19. In addition, although not conclusive, findings seem to suggest that the largest share of catch-up growth occurred in early adolescence, between the ages of 12 and 15, suggesting early adolescence may be a particularly promising period for intervention.

The authors conclude:

"An important implication of these findings is that interventions that aim to delay childbearing and promote catch-up growth among adolescent girls, particularly in early adolescence, may be effective in breaking the intergenerational cycle of stunting in LMICs."

3.4 Guidelines for nutrition interventions for adolescents

Lassi et al 2017(b) reviewed the evidence from existing guidelines on various aspects of nutrition interventions for adolescents and young women. They report on 18 bodies who have formulated guidelines focused on nutrition for adolescents and women and identify 29 guidelines pertinent to adolescents and women before pregnancy and 84 for women during pregnancy. Very few of these guidelines specifically addressed adolescents; those that did mainly focused on overweight and obesity. Guidelines pertinent to women before and during pregnancy were derived from general guidelines for WRA that included adolescents and young women.

The authors extract and synthesise specific directives for nutrition in adolescents, macro- and micronutrient supplementation, exercise, obesity and nutrition during preconception, pregnancy and the post-conception period. These are summarised below:

- *Eating healthily* – most guidelines recommend a balanced diet, food from five groups, discourage high-fat, high-sugar foods, reduced sodium intake.
- *Micronutrient supplementation* – guidelines do exist for folic acid, iron and folic acid and vitamin A, but no specific guidelines for adolescents were identified.

Specific recommendations for iodine, calcium and vitamin D for adolescents do exist.

- *Food/protein-energy supplementation* – although none of the guideline development agencies have yet finalised guidelines for balanced protein-energy supplementation for malnourished girls and women, WHO is in the process of developing guidelines for balanced protein-energy supplementation during pregnancy.
- *Nutrition education and counselling for pregnant adolescents* – no guidelines exist specific to adolescents.
- *Obesity prevention and management* – some specific recommendations for adolescents within guidelines from WHO, Center for Disease Control (CDC) and the National Institute for Health and Care Excellence (NICE).

The authors conclude that there is a general lack of comprehensive guidelines targeting adolescents, despite the high burden of morbidity and mortality this age group faces, and recommend all relevant stakeholders come together to formulate evidence-based guidelines on nutrition and healthy behaviours for adolescents.



4 Lesson learning on effective approaches to adolescent programming

As previously highlighted, there is relatively limited empirical evidence on adolescent nutrition; this includes documented practical experience on what works in terms of programmatic approaches to meeting adolescents' needs.

Specifically for nutrition, the information presented below is summarised from a review of programmatic responses by Duffy et al (2015). This review found that, out of a total of 53 programmes identified through literature and internet searches, only ten targeted adolescent girls specifically. Overall the focus of these ten programmes was the promotion of consumption of a diverse diet and IFA supplementation. The most common programmatic approaches among this group included community-based platforms for nutrition education and promotion, the direct distribution of micronutrients, food, and/or cash, as well as capacity-building of health workers (or other service delivery agents).

Within these programmes, activities unique to adolescent girls included sensitisation of government and religious leaders surrounding the risks associated with early marriage and the benefits associated with delaying pregnancy until early adulthood. The use of the interpersonal communication/nutrition education approach within schools among adolescent girls was common. Most often teachers and education professionals were trained to provide nutrition education and/or direct supplementation to adolescent girls attending school. An alternative approach to reach out-of-school girls involved using a cascade approach, training girls in school who were receiving a nutrition

education/IFA intervention to provide similar services to their out-of-school female counterparts (Kotecha et al, 2009).

Other approaches involved mass media campaigns, targeting adolescents to improve their general nutritional intake, intake of IFA supplements and delay of early marriage and pregnancy. Media campaigns took place during national 'Adolescent Health Weeks' in which adolescents were encouraged to attend health services. National/regional government strengthening approaches included mentoring of government officials surrounding adaptation of clinics so that they were able to provide adolescent-friendly services.

The main lesson learning was identified from IFA programmes, which formed around one third of the programmes reviewed and generally had more developed approaches. Useful approaches that can be extended to other programmes included the use of community models such as women's groups, mother's clubs, teen clubs, health extension workers and community volunteers who provide services in the community and in the home. These platforms, which currently are most often used for IFA programmes, may also be used to provide education surrounding food diversification via household gardens/seed programmes, general eating practices to improve household nutrition, including cooking classes, and community sensitisation surrounding fortified foods.

Some lesson learning from the health sector has shown evidence that making health services more adolescent-

friendly does work. Of all age groups, adolescents have the poorest levels of universal health coverage (Tylee et al, 2007). Despite having clear needs, adolescents often fail to access health services. This trend is illustrated well by data on unmet sexual healthcare needs. In most African countries, for example, the proportion of adolescent girls with unmet contraceptive need is at least 25 per cent and over 60 per cent in some countries. In Asia the same proportion ranges from 25 per cent to as high as 94 per cent (Woog et al, 2015).

In 2006 WHO published a systematic review of the effectiveness of interventions to improve the use of health services by adolescents in developing countries (WHO, 2006). This review identified 12 initiatives, including one

randomised controlled trial (Nigeria); six quasi-experimental studies (Bangladesh, China, Madagascar, Mongolia, Uganda and Zimbabwe); two national programmes (Mozambique and South Africa); and three projects (Ghana, Rwanda and Zimbabwe). This review demonstrated that actions to make health services user-friendly and appealing had led to increases – sometimes considerable – in the use of health services by adolescents. Other reviews show similar results (Tylee et al, 2007). Adolescents are a heterogeneous group but have two key common characteristics that have been identified across the globe: they want to be treated with respect and to be sure their confidentiality is protected, in particular with respect to their parents and families (WHO, 2002). Given that many nutrition interventions are delivered through health systems, the way and extent to which adolescents access health services is highly relevant.

In other sectors such as education, participatory approaches have been demonstrated to be usefulⁱⁱⁱ. In health, although the rationale for youth engagement is strong, to date there have been few syntheses of the evidence on the effectiveness of more participatory approaches (Patton et al, 2016). Peer education is the predominant strategy evaluated, while youth-led participatory action research is an increasingly popular approach to advancing adolescent engagement and empowerment that aims to promote social change and improve community conditions for healthy development (UNICEF, 2017)^{iv}. There are cultural, generational, bureaucratic and financial barriers to the sustainability of meaningful youth engagement. In many contexts, adolescent girls and young women in particular face inequitable systems and structures which limit their participation (Patton et al, 2016).

Adolescence is a period of openness to new ideas and adolescents are often the first to adopt new technologies, especially via the internet. This creates opportunities for innovative delivery platforms; such as through social media rather than traditional service delivery. Use of social media, information technology, cash transfers, social protection and microfinance initiatives are potential approaches, although there is a lack of rigorous evaluations or consensus on most effective strategies for adolescents to date (Patton et al, 2016). For social media in particular, potential harmful effects must be considered; for example, in relation to online security.



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ⁱⁱⁱ www.schoolsandhealth.org/

^{iv} An example of engaging adolescent girls in action research can be found here: www.sddirect.org.uk/our-work/projects/dfid-la-p%C3%A9pini%C3%A8re-drc-s-programme-for-adolescent-girls/



5

Summary of gaps, opportunities and recommendations coming out of recent publications, meetings, initiatives

Since The Lancet Commission on Maternal and Child Undernutrition in 2013 identified adolescents as a key priority area there have been several key meetings, commissions, global gatherings and publications with a focus on adolescent nutrition. Some of these are illustrated in figure 8 and are summarised below (in chronological order).

Technical meeting on diet and eating practices of adolescents and WRA co-hosted by PAHO/WHO,

USAID and the two USAID global nutrition projects (Strengthening Partnerships, Results and Innovations in Nutrition Globally (SPRING) and the Food and Nutrition Technical Assistance III Project (FANTA)), March 2015

More than 40 global leaders in the field of adolescent and women’s nutrition, including academic and programme experts representing a variety of government, non-government, research and donor institutions participated in the meeting. Objectives were to:

FIGURE 8 Some recent initiatives on adolescents



- Review insights and lessons from the two discussion papers on the nutrition of adolescent girls and WRA;
- Identify characteristics and issues related to key diet and eating practices for strengthening policies and programmes; and
- Propose next steps in the development of a set of recommendations for key diet and eating practices. Subsequent to this meeting, a webinar was held and a further stakeholders' consultation meeting was held in October 2017. A summary of this was presented at the Adolescent Interest Group meeting on 12 December and is included in the meeting report.

Adolescent Nutrition – Policy and Programming in SUN+ Countries (Save the Children, 2015)

A review commissioned by Save the Children in 2015 to collate the experience of existing approaches for supporting adolescent nutrition in different contexts, with a focus on Scaling Up Nutrition (SUN) countries and India. It aims to assess the extent to which adolescent nutrition is currently being addressed.

International Summit on the Nutrition of Adolescent Girls and Young Women held in Portland, Oregon, USA in 2015 (Krebs et al, 2017)

This event brought together 67 delegates from 17 countries who agreed a series of recommendations that would make progress on improving the nutritional status of girls and young women in countries where their access to nutrition is compromised. Delegates represented leading scientific institutions, international aid agencies and government organisations.

Recommendations were agreed at the summit to address:

- Major gaps in knowledge of the biology of nutrition and pregnancy as related to adolescent girls, women, and their offspring; and
- Major systemic, policy, cultural and environmental barriers to the achievement of improved nutritional health for adolescent girls and women and their offspring.

WHO Technical Consultation on Adolescent Health Research Priorities October 2015 (WHO, 2015)

The aim of the technical consultation was to contribute to defining global adolescent health research priorities and the role that WHO might play in these. The consultation had a particular focus on the health of adolescents, young people and youth in low and middle-income countries. One hundred and forty-two experts participated in the research prioritisation exercise for eight areas of adolescent health, including nutrition. The exercise identified the following specific research priorities:

1. What are the causes of anaemia among adolescent girls and how does this vary by region?
2. What are the relationships between early pregnancy and stunting, anaemia and NCD risk (overweight, diabetes, hypertension)?
3. What social and behaviour-change communication platforms are the most effective to reach adolescents to help them to improve their diet?
4. How does the burden of disease from nutritional causes for adolescent boys and girls vary by country and within countries and by socioeconomic status?
5. What is the prevalence of adolescent undernutrition and overnutrition by risk/protective factors such as gender, urban/rural residence, schooling, access to green spaces, access to food and socioeconomic strata in different world regions?

The Lancet Commission on Adolescent health and wellbeing 2016 (Patton et al, 2016)

This Commission, which involved a network of academics, policy-makers, practitioners and young health advocates, outlined the opportunities and challenges for investment in adolescents at country and global levels. The Commission identified the following key messages:

- Investments in adolescent health and wellbeing bring a triple dividend of benefits now, in future adult life and for the next generation of children.
- Adolescents are biologically, emotionally and developmentally primed for engagement beyond their families. We must create the opportunities to meaningfully engage with them in all aspects of their lives.
- Inequities, including those linked to poverty and gender, shape all aspects of adolescent health and wellbeing: strong multi-sector actions are needed to grow the resources for health and wellbeing and offer second chances to the most disadvantaged.
- Adolescents and young adults face unprecedented social, economic and cultural change. We must transform our health, education, family support and legal systems to keep pace with these changes.

Young Lives 2016 Conference on Adolescence, Youth and Gender, Oxford, UK (Young Lives, 2016)

This conference brought together more than 170 researchers, policy-makers and practitioners for two days of debate, dialogue and presentation of new research on adolescence, youth and gender. The focus was on knowledge for change: change which makes a positive difference to children and young people's lives. Themes ranged from education, aspirations, social norms, sexual and reproductive health, marriage and

parenthood, migration, nutrition, boys and masculinity, deprivation, economic empowerment and social protection, labour markets, time use, adolescent transitions, violence, programming and measurement.

Series of peer-reviewed papers in Annals of New York Academy of Sciences 2017, including paper on delivering an action agenda for nutrition interventions addressing adolescent girls and young women: priorities for implementation and research (Bhutta et al, 2017)

This series recognises the limitations of the paucity of available information concerning this age group, especially from well-designed randomised controlled trials in LMICs, but argues that a range of interventions is feasible to address outcomes, although some need to start earlier in childhood. Packages of preventive care and management are proposed, encompassing both nutrition-specific and nutrition-sensitive interventions to address adolescent undernutrition, overnutrition and micronutrient deficiencies. Potential delivery platforms and strategies relevant to LMICs are discussed.

WHO Global Accelerated Action for the Health of Adolescents (AA-HA!) guidance to support country implementation 2017 (WHO, 2017)

The Global AA-HA! guidance is intended as a reference document for national-level policy-makers and programme managers to assist them in the planning, implementing, monitoring and evaluation of adolescent health programmes. Nutrition is considered throughout the guidance and is integral to the systematic approach taken. The guidance focuses on seven aspects: approach, prevention, priority-setting, government leadership, benefits across generations, inclusivity and adolescent participation. It also draws particular attention to the disproportionate risks adolescents face in humanitarian and fragile settings, including poor physical and mental health, harassment, assault and rape.

There is a broad consensus on gaps, opportunities and recommendations on ways forward among these collaborative initiatives, summarised in table 6 below.

FIGURE 6 Summary of key gaps, opportunities and recommendations from recent initiatives relating to adolescent nutrition

	SPRING Technical meeting 2015	Adolescent Nutrition – SUN+ countries 2015	International Summit – Oregon 2015	WHO Health research priorities 2015	Lancet Commission 2016	Young Lives Conference 2016	Series - Annals of New York Academy of Sciences 2017	WHO AA-HA! Guidance 2017
Gaps								
Disaggregated data	✓	✓	✓		✓	✓	✓	✓
Robust evidence, especially LICs	✓	✓	✓		✓	✓	✓	✓
Documented lesson learning	✓	✓	✓		✓	✓	✓	✓
Understanding on critical windows or specific populations (gender, age)		✓	✓		✓	✓	✓	✓
Appropriate outcomes & indicators	✓	✓	✓		✓	✓	✓	
Opportunities								
Digital technology, social media		✓	✓		✓	✓	✓	✓
Adolescents themselves		✓	✓		✓	✓	✓	✓
Potential for catch-up growth		✓	✓		✓	✓	✓	
Recommendations								
Greater prioritisation in global and national policies, systems, guidelines		✓	✓		✓	✓	✓	✓
Increased investment		✓	✓		✓	✓	✓	✓
Disaggregated data by age and gender		✓	✓	✓	✓	✓	✓	
Adolescent-friendly health & other services		✓		✓	✓	✓	✓	✓
Meaningful engagement of adolescents in design and implementation		✓	✓		✓	✓	✓	✓
Multi-sectoral, multi-component, multi-level interventions		✓	✓		✓	✓	✓	✓
More rigorous research into effective interventions: platforms, timing, duration, gender, potential for catch-up growth, especially in LMICs		✓	✓	✓	✓	✓	✓	✓

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