# Current evidence on anaemia and micronutrient supplementation strategies in school-age children and adolescents

By Elena Hemler, Wafaie Fawzi and Stephanie Wrottesley

**Elena Hemler** is senior project coordinator for the Nutrition and Global Health Program in the Department of Global Health and Population at the Harvard School of Public Health. Elena has over five years of experience in project management and research related to nutrition and global health.

**Wafaie Fawzi** is professor of population sciences, nutrition, epidemiology and global health and former Chair of the Department of Global Health and Population at Harvard School of Public Health. Over the past 25 years, Wafaie has led the design and implementation of large number of randomised controlled trials in health and nutrition.

**Stephanie Wrottesley** is a nutritionist with ENN.

## Background

Globally, one in four adolescents is affected by anaemia (Azzopardi et al, 2019). Asia contributes the highest number of cases, with approximately 194 million anaemic adolescents living in India and China (Wang et al, 2020). While the aetiology of anaemia in low-and middle-income countries (LMICs) is multi-faceted, including infection and chronic illness, the predominant causes during adolescence are iron and other micronutrient deficiencies. Iron deficiency and iron deficiency anaemia (IDA) contribute the majority of disability-adjusted life years (DALYs) associated with micronutrient deficiencies globally, with IDA being the leading cause of years lived with disability among children and adolescents (Das et al, 2018). Age-disaggregated data for school-aged children 5-9 years of age, younger adolescents (10-14 years of age) and older adolescents (15-19 years of age) is scarce. However, combined data for children and adolescents (0-19 years of age) shows that the prevalence of IDA is highest in Afghanistan (41%), followed by Yemen (39.8%) and Senegal (38.5%) (Global Burden of Disease Pediatrics Collaboration, 2016).

Children and adolescents are vulnerable to anaemia due to increased requirements for iron to support growth and development, particularly as they enter puberty. The risk of anaemia and/or iron deficiency is higher in adolescent girls than boys, particularly between 12-15 years of age, due to the elevated requirements for menstruation (Patton et al, 2016). Anaemia during childhood and adolescence increases the risk of infection and has adverse effects on growth and development, which may reduce school achievement and work productivity in later life (Shaban et al, 2020). As girls and young women reach childbearing age, anaemia poses a threat to maternal and infant health, contributing to higher risks of morbidity and mortality, with potential long-term implications on the health and wellbeing of mothers and infants (Patton et al, 2016).

In addition to iron, deficiencies in other micronutrients often coexist in LMICs, although data on the burden of specific deficiencies in school-aged children and adolescents is sparse (Christian & Smith, 2018). Data that is available indicates that iodine deficiency affects 3% of girls 10-14 years of age and 5% of girls 15-19 years of age in countries with lower socio-demographic index (Christian & Smith, 2018). Vitamin A deficiency is estimated to affect 20% of girls 10-14 years of age and 18% of girls 15-19 years of age in low socio-demographic index countries (Christian & Smith, 2018).

## Current guidelines and recommendations

To date, research, policy and programming efforts for anaemia have focused on women of reproductive age (15-49 years), with an emphasis on reducing the prevalence of anaemia during pregnancy. However, the need to address anaemia earlier in the life-course (i.e., during the early adolescent years) has gained momentum. Current World Health Organization (WHO) guidelines (WHO, 2018) recommend weekly iron and folic acid (IFA) supplementation for all menstruating adolescent girls and adult women living in settings with an anaemia prevalence of 20% or higher, to improve their haemoglobin concentrations and iron status and reduce their risk of anaemia. For girls and women who live in settings where anaemia prevalence is 40% or higher, daily iron supplementation is recommended. However, these recommendations have not been enacted at a large scale in most LMICs and there is an urgent need to advance the implementation of micronutrient interventions among adolescents, with rigorous evaluation and deliberate plans for national scale-up. In addition, very few micronutrient intervention studies have been conducted on adolescent boys, hindering the development of evidence-based recommendations for this group.

The available evidence suggests that IFA supplementation is a crucial tool for anaemia prevention and treatment among adolescents and additional benefits may be noted with multiple micronutrient supplements (MMS). The recent Lancet Series on Maternal and Child Undernutrition Progress highlighted the strong evidence supporting MMS rather than IFA supplementation during the antenatal period and suggested a potential benefit of extending this to adolescent girls (Heidkamp et al, 2021). Alongside their current guidelines on IFA, the WHO calls for additional research to clarify the best formulation to provide multiple micronutrients on an intermittent basis to adolescents and women of reproductive age (WHO, 2011). However, very few studies have examined MMS among adolescents. The WHO recommends that countries have a national strategy for prevention and control of micronutrient malnutrition and the choice of intervention should include consideration of costs, cost-effectiveness, feasibility and acceptability (WHO, 2016). However, in most LMICs sufficient information does not exist to allow governments to develop evidence-based national strategies to address multiple micronutrient deficiencies in adolescents.

Specific recommendations on anaemia prevention and supplementation for pre-adolescent school-aged children 5-9 years of age have not been established, since this age group is commonly categorised together with younger children in research and programming efforts, if at all. For example, for children 2-12 years of age, point-of-use fortification of foods with iron-containing micronutrient powders is recommended by the WHO in settings where childhood anaemia prevalence is 20% or higher. However, in practice, the anaemia prevalence in older children is often not known and the burden of anaemia is commonly estimated using prevalence figures for children under five years of age. Given these gaps in available data and recommendations, further research presented in this article will focus on adolescents 10-19 years of age, with the acknowledgement that greater attention on younger children is urgently needed.

## Evidence comparing IFA and MMS in adolescents

As mentioned, IFA supplementation has been identified as a promising intervention to improve the health of adolescents in LMICs. Intermittent supplementation one, two or three times a week with IFA can reduce anaemia by approximately 35% in menstruating adolescent girls (Fernández-Gaxiola & De-Regil, 2019). Providing MMS, which include other vitamins and minerals in addition to IFA, may have additional benefits compared to IFA alone. A review of 5 trials found that MMS among non-pregnant and pregnant adolescents resulted in a significant improvement in serum haemoglobin concentration (Lassi et al, 2017). In anaemic girls in Bangladesh, long-term twice-weekly MMS with a doubled UNIMMAP (UNICEF et al, 1999), led to greater improvements in haemoglobin concentration and in the status of vitamins A, B2 and C, when compared with IFA (Ahmed et al, 2010). In non-anaemic girls, twice weekly MMS was equivalent to IFA in improving haemoglobin levels and preventing iron deficiency, but had additional benefits in improving vitamins A, B2 and C status (Ahmed et al, 2012).

In many LMICs, there is a lack of systematic evidence to support rollout of national micronutrient interventions and no information on the most effective combination of micronutrients to provide to adolescents. Trials in LMICs comparing effects of MMS with IFA on health and education outcomes in adolescents are needed to clarify an optimal supplementation strategy, including the combination of micronutrients and dosage required. These studies are also needed to provide a basis for scale up of national micronutrient supplementation programmes and to provide governments with information on cost, feasibility, acceptability and best practices for implementing these programmes.

## Examples of large-scale programmes

In a few LMICs, IFA supplementation programmes are being implemented to improve adolescent health. These programmes may be cost-effective given the economic losses due to IDA (Shekar et al, 2017). However, there is a need for additional studies to evaluate programmes and provide governments with guidance on how to implement programmes and maximize adherence. These programmes need to cater to adolescents who are in-school, as well as a substantial proportion of adolescents who are not enrolled in school.

A recent evaluation of the Girls' Iron-Folate Tablet Supplementation (GIFTS) Programme in Ghana found that school-based weekly IFA supplementation improved haemoglobin and reduced anaemia prevalence among girls 10-19 years of age in Ghana, although adherence was a challenge (Gosdin et al, 2021). The GIFTS programme also provides supplementation to out-of-school adolescent girls through community health workers, but evaluations of this programme are limited (Yidana et al, 2020). A study of the GIFTS programme implementation in Karaga District, Ghana found that most IFA tablets were distributed in schools, with only 3% of pills distributed by health workers. The Indonesian government has also implemented a weekly school-based IFA supplementation programme for adolescent girls, yet coverage and adherence to this programme has been low. In the East Java and East Nusa Tenggara regions, only 10% and 31% of girls respectively reported receiving at least one tablet in the past six months and only 9% and 18% respectively reported consuming at least one of the received tablets (Alfiah et al, 2020). In 2012, the India Federal Ministry of Health and Family Welfare launched a national weekly IFA supplementation programme for in-school adolescent boys and girls and out-of-school adolescent girls. However, in a recent population-based survey in West Bengal, the majority of adolescents enrolled in the programme reported not receiving any tablets in the past month (62% of in-school girls, 73% of in-school boys and 97% of out-of-school girls). Only 9% of in-school girls, 7% of in-school boys and 2% of out-of-school girls reporting consuming four IFA tablets during the last month as intended by the programme (Sudfeld et al, 2020). Experiences from these existing programmes underscore the need for further research to guide programme implementation and improve coverage and adherence.

## Next steps

In LMICs, national programmes to provide adolescents with micronutrients are crucial to set a trajectory for wellbeing throughout the life course. To inform these programmes, additional studies are urgently needed to clarify the optimal supplementation composition and delivery strategies, to address challenges with coverage and adherence and to guide programme implementation to maximize effectiveness. One example is the ongoing School-Based Assessment of Micronutrient Interventions in Adolescents (SAMIA) study, which is comparing weekly IFA with daily MMS on anaemia status, school performance/attendance and development outcomes among adolescents enrolled in secondary schools in Burkina Faso and Zanzibar, Tanzania. Findings from this study will clarify the optimal supplementation strategy (IFA alone vs. together with other essential nutrients) and provide evidence on feasibility, adherence and best practices to support scale up of national micronutrient supplementation programmes. These programmes are critical to improve nutrition among adolescents, which can lead to improvements in health and school performance, with lifelong and intergenerational implications. Similar efforts are needed for school-aged children 5-9 years of age, starting with addressing the need for data on anaemia prevalence in this age group in order to inform specific recommendations on anaemia prevention and management, including the effectiveness of supplementation and other appropriate interventions for school-aged children.

For more information, please contact Wafaie Fawzi at **mina@hsph.harvard.edu**

## References


Ahmed F, Khan M R, Akhtaruzzaman M, Karim R, Williams G, Banu C P, et al (2012) Effect of long-term intermittent supplementation with multiple micronutrients compared with iron-and-folic acid supplementation on Hb and micronutrient status of non-anaemic adolescent schoolgirls in rural Bangladesh. *Br J Nutr*, *108*(8), 1484-1493. https://doi.org/10.1017/s0007114511006908

Ahmed F, Khan M R, Akhtaruzzaman M, Karim R, Williams G, Torlesse H, et al (2010) Long-term intermittent multiple micronutrient supplementation enhances hemoglobin and micronutrient status more than iron + folic acid supplementation in Bangladeshi rural adolescent girls with nutritional anemia. *J Nutr, 140*(10), 1879-1886. https://doi.org/10.3945/jn.109.119123

Alfiah E, Briawan D, Khomsan A, Dewi M, Ekayanti I, Mardewi et al (2020) Coverage and adherence of weekly iron folic acid supplementation among school going adolescent girls in Indonesia. *J Nutr Sci Vitaminol (Tokyo), 66*(Supplement), S118-s121. https://doi.org/10.3177/jnsv.66.S118

Azzopardi P S, Hearps S J C, Francis K L, Kennedy E C, Mokdad A H, Kassebaum N J, et al (2019) Progress in adolescent health and wellbeing: tracking 12 headline indicators for 195 countries and territories, 1990-2016. *Lancet (London, England)*, 393(10176), 1101-1118.

Christian P, and Smith E R (2018) Adolescent undernutrition: global burden, physiology, and nutritional risks. *Ann Nutr Metab*, *72*(4), 316-328. https://doi.org/10.1159/000488865

Das J K, Lassi Z S, Hoodbhoy Z, and Salam R A (2018) Nutrition for the next generation: older children and adolescents. *Annals of Nutrition and Metabolism, 72(suppl 3)*(3), 56-64. https://doi.org/10.1159/000487385

Fernández-Gaxiola A C, and De-Regil L M (2019) Intermittent iron supplementation for reducing anaemia and its associated impairments in adolescent and adult menstruating women. *Cochrane Database Syst Rev, 1*(1), Cd009218. https://doi.org/10.1002/14651858.CD009218.pub3

Global Burden of Disease Pediatrics Collaboration (2016) Global and national burden of diseases and injuries among children and adolescents between 1990 and 2013: findings from the Blobal Burden of Disease 2013 study. *JAMA pediatrics, 170*(3), 267-287. https://doi.org/10.1001/jamapediatrics.2015.4276

Gosdin L, Sharma A J, Tripp K, Amoaful E F, Mahama A B, Selenje L, et al (2021) A school-based weekly iron and folic acid supplementation program effectively reduces anemia in a prospective cohort of Ghanaian adolescent girls. *J Nutr*, 151(6), 1646-1655. https://doi.org/10.1093/jn/nxab024

Heidkamp R A, Piwoz E, Gillespie S, Keats E C, D'Alimonte M R, Menon P, et al (2021) Mobilising evidence, data, and resources to achieve global maternal and child undernutrition targets and the Sustainable Development Goals: an agenda for action. *The Lancet*, 397(10282), 1400-1418.

Lassi Z S, Moin A, Das J K, Salam R A, and Bhutta Z A (2017) Systematic review on evidence-based adolescent nutrition interventions. *Annals of the New York Academy of Sciences, 1393*(1), 34-50. https://doi.org/10.1111/nyas.13335

Patton G C, Sawyer S M, Santelli J S, Ross D A, Afifi R, Allen N B, et al (2016) Our future: a Lancet commission on adolescent health and wellbeing. *Lancet (London, England), 387*(10036), 2423-2478. https://doi.org/10.1016/s0140-6736(16)00579-1

Shaban L, Al-Taiar A, Rahman A, Al-Sabah R., and Mojiminiyi O (2020) Anemia and its associated factors among adolescents in Kuwait. Scientific Reports, 10(1), 5857. https://doi.org/10.1038/s41598-020-60816-7

Shekar M, Kakietek J, Eberwein J D, and Walters D (2017) *An investment framework for nutrition: reaching the global targets for stunting, anemia, breastfeeding, and wasting*. W. Bank.

Sudfeld C R, Rai R K, Barik A, Valadez J J, and Fawzi W W (2020) Population-level effective coverage of adolescent weekly iron and folic acid supplementation is low in rural West Bengal, India. *Public Health Nutr*, 23(15), 2819-2823. https://doi.org/10.1017/s1368980020000932

UNICEF, WHO, and UNU (1999) *Composition of a multi-micronutrient supplement to be used in pilot programmes among pregnant women in developing countries: report of a United Nations Children's Fund (UNICEF), World Health Organization (WHO) and United Nations University workshop*. UNICEF. https://apps.who.int/iris/handle/10665/75358

Wang J-Y, Hu P-J, Luo D-M, Dong B, Ma Y, Dai J, et al (2020) Reducing anemia among school-aged children in China by eliminating the geographic disparity and ameliorating stunting: evidence from a national survey [Original Research]. *Frontiers in Pediatrics*, 8(193). https://doi.org/10.3389/fped.2020.00193

WHO (2011) *Guideline: intermittent iron and folic acid supplementation in menstruating women* World Health Organization

WHO (2016) *Guideline: use of multiple micronutrient powders for point-of-use fortification of foods consumed by infants and young children aged 6–23 months and children aged 2–12 years*. World Health Organization. https://www.who.int/publications/i/item/9789241549943

WHO (2018) *Weekly iron and folic acid supplementation as an anaemia-prevention strategy in women and adolescent girls: lessons learnt from implementation of programmes among non-pregnant women of reproductive age*. World Health Organization. https://apps.who.int/iris/handle/10665/274581

Yidana, A., Azongo, T. B., & Mohammed, A. (2020). Iron and folic acid supplementation compliance among adolescent girls in Karaga District, Ghana. *Public Health Research*, 10(5), 133-142.