

Review Article

Potential interventions targeting adolescent nutrition in Indonesia: a literature review

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Abstract

Objective: The present study aimed to take stock of nutrition interventions that warrant consideration as a minimum package of interventions in Indonesia to improve four key nutrition indicators for adolescents: stunting, thinness, overweight and anaemia.

Design: We conducted a review of the peer-reviewed literature published between 1995 and 2017 on nutrition-specific and nutrition-sensitive interventions that target adolescents in Indonesia. The search to identify studies was conducted in PubMed, Google Scholar and EMBASE, using key search terms. We also explored programmatic and policy documents from the grey literature as they related to adolescents and/or Indonesia. Our search yielded thirty-five peer-reviewed articles and programmatic documents.

Setting: Indonesia.

Subjects: Adolescent girls and boys.

Results: There is very limited evidence on the impact of interventions specifically among adolescents in Indonesia. Nevertheless, findings from our review suggest the minimum package of interventions in Indonesia could include the following nutrition-specific interventions: (i) iron–folic acid supplements, paired with anti-helminths delivered at scale via school-based platforms and through health centres; and (ii) diet counselling and nutrition education provided through school-based platforms, adolescent youth centres/peer education and technology-based platforms. The minimum package could also include the following nutrition-sensitive interventions: (i) improving access to reproductive health services; and (ii) increasing the coverage of interventions designed to increase school attendance.

Conclusions: Programmes and policies targeting adolescent nutrition are relatively new and coverage is low. To improve the nutritional status of this vulnerable population, additional evaluations of adolescent programming and surveillance data on adolescents are needed.

Keywords

Adolescents

Adolescent nutrition

Nutritional interventions

Indonesia

Low- and middle-income countries

Data from 2016 indicate that there are approximately 45 million adolescents in Indonesia, which represents 18% of the total population⁽¹⁾. Despite the global consensus that adolescence is a nutritionally vulnerable life stage, very few actions have been taken to improve adolescent nutrition. In particular, there is a dearth of interventions that address the double burden of malnutrition at scale, despite the fact that the prevalence of overweight/obesity among adolescents is increasing, while undernutrition persists^(2,3).

Adolescence is a critical period for the acquisition of healthy eating and physical activity behaviours, which can

track throughout the life course^(4,5). Additionally, many girls in low- and middle-income countries (LMIC) will become pregnant during adolescence, which can have adverse implications for their own nutritional status as well as for their offspring⁽⁶⁾. It is well documented that pre-pregnancy maternal undernutrition puts infants at increased risk for being born preterm (earlier than 37 weeks' gestation), with low birth weight (less than 2500 g at birth) or small-for-gestational-age, and subsequently increases the risk of stunting during early childhood^(3,7). Alternatively, pre-pregnancy maternal overweight puts infants at increased

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risk of being born large-for-gestational-age and then overweight during childhood^(8–10).

The 2013 National Basic Health Research Survey in Indonesia (RISKESDAS), a household survey carried out in thirty-three provinces and 497 districts/cities between May and June 2013, indicates that 35% of adolescents aged 13–15 years and 31% of adolescents aged 16–18 years are stunted (height-for-age Z-score < -2)⁽¹¹⁾. Thinness (BMI-for-age Z-score < -2) affects approximately 11% and 9% of adolescents aged 13–15 and 16–18 years, respectively. Importantly, 11% of adolescents aged 13–15 years and 7·3% of adolescents aged 16–18 years in Indonesia are overweight/obese (BMI-for-age Z-score > 1), demonstrating a typical example of the dual burden of malnutrition at the country level. In addition, anaemia affects 12% of boys and 23% of girls aged 13–18 years (Hb < 13·0 g/dl for boys; Hb < 12·0 g/dl for non-pregnant girls). Longitudinal data are not available to compare trends over time. Data that would allow for direct comparisons of the prevalence of thinness and/or overweight/obesity among adolescents in Indonesia with the global or regional prevalence of thinness and/or overweight/obesity among adolescents are also not available. However, cross-sectional data from the Demographic and Health Surveys and the Indonesian Family Life Survey, which included only adolescent girls, suggest that the prevalence of underweight and overweight/obesity among adolescents in Indonesia is higher than the prevalence of underweight and overweight/obesity among adolescents in East Asia and the Pacific region, more broadly⁽¹²⁾. Cautiously comparing 2013 RISKESDAS⁽¹¹⁾ and data from UNICEF's 2017⁽¹³⁾ survey, that was conducted in two districts in Indonesia, suggests that the prevalence of overweight/obesity among adolescents has increased over time.

Several ‘calls to action’ have emphasized the importance of reaching adolescents with nutrition interventions because this is a rapidly growing segment of the population and pre-conception interventions have the potential to break the intergenerational cycle of malnutrition^(2,14–16). In particular, Christian and Smith outlined the nutrition vulnerability of adolescents and provided a framework for conceptualizing adolescent health that considers both the life course and social determinants of health⁽²⁾. In addition, Salam *et al.* assessed the effectiveness of nutrition-specific interventions to promote optimal nutrition among adolescents⁽¹⁷⁾. Their review comprised evidence on micronutrient supplementation, nutrition interventions for pregnant adolescents and interventions to prevent obesity. Similarly, Lassi *et al.* summarized the literature on micronutrient supplementation, nutrition education for pregnant adolescents, and obesity prevention and management, as it relates to adolescents⁽¹⁸⁾. We aim to complement these reviews in several ways. First, we take stock of the evidence on nutrition-specific and nutrition-sensitive interventions that are ongoing in or relevant for Indonesia, specifically. Second, we aim to consider and summarize

the platforms for intervention delivery that are most feasible in Indonesia, given the existing infrastructure and culture. Third, we incorporate programmatic evidence from Indonesia, as appropriate. Thus, the objective of the present study was to review and qualitatively synthesize the evidence on nutrition interventions that warrant consideration as a potential minimum package of interventions in Indonesia, aimed at improving four key nutrition indicators for adolescents: stunting, thinness, overweight and anaemia.

Methods

We reviewed English-language, peer-reviewed articles and programmatic literature that focused on nutrition-specific and nutrition-sensitive interventions targeting adolescents from 1995 to 2017. First, we searched for existing review articles. If a review article was not identified for a particular intervention approach, then we conducted a new review for original articles that detailed interventions that targeted stunting, thinness, overweight and/or anaemia, guided by the Lancet Framework for actions to achieve optimal nutrition⁽³⁾. The literature search to identify review and original articles was conducted in PubMed, Google Scholar and EMBASE using the following search terms: ‘adolescents’, ‘adolescence’, ‘teen’, ‘youth’, ‘nutrition’, ‘stunting’, ‘thinness’, ‘anaemia’, ‘overweight’, ‘obesity’, ‘Indonesia’, ‘programming’, as well as ‘agriculture’, ‘social safety-nets’, ‘women’s empowerment’, ‘child protection’, ‘education’, ‘water and sanitation’ and reproductive health’. Additionally, we obtained programmatic documents from UNICEF colleagues, which were examined for relevance.

The titles and abstracts were screened by one reviewer for relevance and were excluded if they: (i) did not focus on nutrition-specific or nutrition-sensitive interventions that targeted stunting, thinness, anaemia or overweight; and (ii) were not specific to adolescents, young adults or women of reproductive age, as many programmes can be tailored to address adolescent-specific social and behavioural risks. Initially, we intended to exclude evidence on nutrition-specific and nutrition-sensitive interventions targeting stunting, thinness, overweight and/or anaemia among adolescents that was not from Indonesia or from South-East Asia. However, our initial review revealed a paucity of evidence specific to adolescents in Indonesia or South-East Asia; thus, we expanded our search to include evidence from other world regions and high-income countries, as necessary. The impact of the intervention (i.e. whether it was positive, negative or null) was not a criterion for exclusion. Examples of research excluded were those articles that focused on severe acute malnutrition, specific micronutrient deficiencies (e.g. vitamin A), children under 5 years old, or eating disorders. After the retrieval of the full texts of review studies and

studies detailing original research, data from each study were abstracted and entered into a standardized form to qualitatively synthesize each study based on study design, methods, outcome measures and results. If there were several articles with experimental study designs for a given intervention (e.g. iron–folic acid (IFA) supplementation), then the evidence was classified as ‘moderate’. If there was only one article with an experimental study design for a given intervention, and/or the studies identified largely employed observational designs, then the evidence was classified as ‘limited’.

Results

Our search yielded thirty-five peer-reviewed and grey literature articles. Few programmes specifically targeted adolescent girls and/or boys. Nevertheless, findings from our review were categorized as nutrition-specific or nutrition-sensitive and synthesized into the following categories to facilitate application in a programmatic context: (i) improving micronutrient status; (ii) improving dietary intake; (iii) health interventions; (iv) social safety-nets; (v) education; and (vi) child protection (see Table 1).

Nutrition-specific

Micronutrient supplementation

Iron and folic acid supplementation. Moderate-quality evidence, largely based on small-scale programmes in LMIC, suggests that weekly IFA supplementation (60 mg Fe/d with 400 µg folic acid/d) among adolescents leads to a significant reduction in anaemia among both girls and boys^(17–26). In particular, recent evidence pooling data from twenty-three trials among adolescents in low-, middle- and high-income countries showed that IFA significantly reduced anaemia and improved serum Hb levels⁽¹⁸⁾. Most of the evidence focuses on adolescent girls, including both pregnant and non-pregnant girls, and uses schools as the delivery platform.

In Indonesia, the national guideline for IFA supplementation was published in 2016, but to date IFA tablets are being distributed only to adolescent girls at senior and junior high schools, and coverage is minimal⁽²⁷⁾. An additional small-scale effort in selected areas of Indonesia (e.g. Sidoarjo) includes promoting the direct purchase of commercial iron or multivitamin supplements⁽²⁸⁾. In Indonesia, one in nine girls is married before age 18 years⁽²⁹⁾ and approximately 3·6 million adolescents aged 16–18 years are not attending school⁽¹⁾. These programmes are not targeting vulnerable groups of adolescents, including those who are out of school, married, pregnant or in the workforce. Notably, data from the 2012 Demographic and Health Survey indicate the 66% of pregnant adolescent girls (15–19 years old) had four or more antenatal care visits and IFA was distributed through

the primary health centre and by government-paid and private-practice midwives. However, compliance remains problematic, likely in part due to adverse side-effects, as has been previously documented⁽²¹⁾.

Multiple-micronutrient supplementation. There is moderate-quality evidence that supplements that contain multiple micronutrients (MMN) can lead to a reduction in anaemia among adolescents. Two randomized trials from Kenya indicated that daily MMN supplementation paired with multi-helminth chemotherapy is associated with increased serum retinol⁽³⁰⁾ and Hb levels⁽³¹⁾ among adolescent boys and girls via school-based delivery. A meta-analysis from Lassi *et al.* also suggested that MMN supplementation significantly improved serum Hb concentrations, both among non-pregnant and pregnant adolescent girls⁽¹⁸⁾.

Although limited in number, experimental evidence from Indonesia found similar results. A 1997 randomized controlled trial, with approximately 250 adolescent girls, showed that weekly MMN supplementation (iron, vitamin C, folic acid, vitamin C) significantly improved Hb and retinol concentrations⁽³²⁾. A recent randomized controlled trial in Tangerang found that twice-weekly multiple-micronutrient powder (MNP) given for 16 weeks to 150 anaemic adolescent girls (aged 14–18 years) in schools effectively increased Hb concentrations and iron stores⁽³³⁾. However, the largest impact was found with the lowest dose of iron (20 mg Fe as ferrous fumarate), which suggests that compliance may have been lower with larger doses. The majority of countries implementing MNP in South-East Asia have just recently done so and coverage is minimal.

Improving dietary intake

Nutrition education and diet counselling. There is limited evidence on providing diet counselling to adolescents. Nutrition education and/or diet counselling in LMIC largely focuses on complementary feeding practices for infants and young children or pregnant women^(17,34). A qualitative study, conducted with ten key informants working in public health in Indonesia, did not identify any existing nutrition education programmes targeting adolescent girls in Indonesia⁽³⁵⁾. We only identified one relevant ongoing intervention from Indonesia (R Menon and EK Sari, personal communication, 2017). However, we can draw on one review of US-based studies that found that individualized education and counselling effectively improved pregnant adolescents’ dietary choices and resulted in appropriate gestational weight gain⁽³⁶⁾, which could be altered to target adolescents more specifically. Another US-based study randomized adolescents to a health clinic-based behavioural nutrition intervention which emphasized a diet high in fruits, vegetables and low-fat dairy; this intervention increased adolescents’ intakes of fruits, potassium and magnesium significantly, and decreased total fat consumption⁽³⁷⁾. Additionally,

Table 1 Summary of nutrition interventions for adolescents identified in the current review of peer-reviewed literature and programmatic and policy documents from the grey literature, published between 1995 and 2017 18

Intervention	Indicator of nutritional status	Advantages	Disadvantages	Status in Indonesia	Quality of the evidence	Peer-reviewed or programmatic literature cited
Iron–folic acid supplementation	Stunting* Anaemia†	<ul style="list-style-type: none"> • Feasible via several delivery platforms • Potentially targets intergenerational cycle of undernutrition if given pre-conception 	<ul style="list-style-type: none"> • Compliance remains problematic due to side-effects 	<ul style="list-style-type: none"> • National guidelines published in 2016 • Currently, being distributed only to adolescent girls in high schools 	<ul style="list-style-type: none"> • Moderate quality evidence of increasing iron stores, specifically among adolescents 	Agustina and Praifiantini ⁽²⁷⁾ ; Bansal <i>et al.</i> ⁽²⁵⁾ ; Beasley <i>et al.</i> ⁽²²⁾ ; Februhartany <i>et al.</i> ⁽¹⁹⁾ ; Htet <i>et al.</i> ⁽²⁰⁾ ; Jus'at <i>et al.</i> ⁽²⁸⁾ ; Lassi <i>et al.</i> ⁽²³⁾ ; Lassi <i>et al.</i> ⁽¹⁸⁾ ; Salam <i>et al.</i> ⁽¹⁷⁾ ; Soekarjo <i>et al.</i> ⁽²¹⁾ ; WHO ⁽²⁴⁾ ; Vir <i>et al.</i> ⁽²⁶⁾
Multiple-micronutrient supplementation	Thinness* Anaemia†	<ul style="list-style-type: none"> • Feasible via several delivery platforms • Potentially addresses concurrent micronutrient deficiencies • Potentially targets intergenerational cycle of undernutrition 	<ul style="list-style-type: none"> • Compliance may be problematic • Not universally recommended by WHO 	<ul style="list-style-type: none"> • No ongoing programmes specifically targeting adolescents 	<ul style="list-style-type: none"> • Moderate quality evidence of effectiveness at reducing anaemia among adolescents 	Angeles-Agdeppa <i>et al.</i> ⁽³²⁾ ; Friis <i>et al.</i> ⁽³¹⁾ ; Lassi <i>et al.</i> ⁽¹⁸⁾ ; Mwaniki <i>et al.</i> ⁽³⁰⁾ ; Sitompul <i>et al.</i> ⁽³³⁾
Nutrition education/diet counselling	Stunting* Thinness* Overweight* Anaemia†	<ul style="list-style-type: none"> • Appropriate approach to target the dual burden of malnutrition • Feasible via several delivery platforms 	<ul style="list-style-type: none"> • Likely needs to be combined with other approaches 	<ul style="list-style-type: none"> • No programmes specifically targeting adolescents 	<ul style="list-style-type: none"> • Limited evidence on providing diet counselling that targets non-pregnant adolescents 	Couch <i>et al.</i> ⁽³⁷⁾ ; Menon and Sari (personal communication, 2017); Nielsen <i>et al.</i> ⁽³⁶⁾
Food fortification	Anaemia and other micronutrient deficiencies (e.g. vitamin A)	<ul style="list-style-type: none"> • Cost-effective • Reaches large segments of populations • Highly feasible at scale if infrastructure in place • Potentially targets intergenerational cycle of undernutrition 	<ul style="list-style-type: none"> • Difficult to target adolescents directly • Need to identify feasible food for fortification that is also widely consumed • Unintended consequences are possible if fortifying energy-dense foods (e.g. oil) • Unintended consequences are possible: need to exercise caution given growing burden of obesity 	<ul style="list-style-type: none"> • Mandated fortification of salt with iodine in 2013 • Mandated fortification of flour with iron, zinc, thiamin, riboflavin and folic acid • Voluntary fortification of vegetable oil with vitamin A • No programmes specifically targeting adolescents 	<ul style="list-style-type: none"> • Very limited evidence on the effectiveness of food fortification specifically among adolescents 	Berner <i>et al.</i> ⁽⁴²⁾ ; Horton <i>et al.</i> ⁽⁴¹⁾ ; Ifrad <i>et al.</i> ⁽⁴³⁾
Balanced energy and protein	Stunting* Thinness*	<ul style="list-style-type: none"> • Potentially targets intergenerational cycle of undernutrition • Feasible via several delivery platforms 	<ul style="list-style-type: none"> • Unintended consequences are possible: need to exercise caution given growing burden of obesity 	<ul style="list-style-type: none"> • No evidence of impact on nutrition indicators specifically among adolescents 	<ul style="list-style-type: none"> • No evidence of impact on nutrition indicators specifically among adolescents 	India Ministry of Law and Justice ⁽⁴⁵⁾
Energy balance to prevent overweight	Overweight*	<ul style="list-style-type: none"> • Potentially feasible if delivered in schools 	<ul style="list-style-type: none"> • Somewhat difficult to implement outside school-based settings • Needs to be combined with other approaches to meaningfully effect obesity 	<ul style="list-style-type: none"> • No programmes specifically targeting adolescents 	<ul style="list-style-type: none"> • Limited evidence of reducing BMI among adolescents 	Salam <i>et al.</i> ⁽¹⁷⁾ ; Waters <i>et al.</i> ⁽⁴⁶⁾
Reproductive health	Stunting* Thinness* Anaemia†	<ul style="list-style-type: none"> • Contributes to delaying age at first pregnancy 	<ul style="list-style-type: none"> • Cultural norms around contraception use may limit uptake 	<ul style="list-style-type: none"> • Pelayanan Kesehatan Peduli Remaja's programming provides reproductive health through health centres 	<ul style="list-style-type: none"> • No evidence among adolescents 	Mepham ⁽⁵¹⁾

Table 1 *Continued*

Intervention	Indicator of nutritional status	Advantages	Disadvantages	Status in Indonesia	Quality of the evidence	Peer-reviewed or programmatic literature cited
Social safety-nets	Stunting* Thinness* Anaemia†	<ul style="list-style-type: none"> • Can reach large segments of the population • Can reach adolescents who do not participate in school and/or health systems 	<ul style="list-style-type: none"> • Typically, do not specifically target adolescents • Evidence is based mostly on conditional cash transfers and comes mostly from Latin America • Some potential for unintended consequences 	<ul style="list-style-type: none"> • In January 2014, Indonesia established a universal national health insurance system, Jaminan Kesehatan Nasional • Indonesia has a national conditional cash transfer programme, Program Keluarga Harapan, targeting low-income households 	<ul style="list-style-type: none"> • Some demonstrated evidence on nutritional status, but not among adolescents specifically 	Ayuku <i>et al.</i> ⁽⁵⁶⁾ ; Baird <i>et al.</i> ^(57,58)
Education	Stunting* Thinness* Overweight* Anaemia†	<ul style="list-style-type: none"> • Can reach large segments of the adolescent population and specifically target adolescents • Can affect nutrition in the long term (via individual earnings and national economic development) • Potentially targets intergenerational cycle of undernutrition 	<ul style="list-style-type: none"> • None identified 	<ul style="list-style-type: none"> • UNICEF has launched a pilot programme designed to improve menstruation hygiene management, to increase adolescent girls' participation in school 	<ul style="list-style-type: none"> • Demonstrated evidence between education and future income potential • No evidence of impact on nutritional status among adolescents 	Sammon <i>et al.</i> ⁽⁶²⁾ ; Burnet Institute <i>et al.</i> ⁽⁶³⁾ ; Madjian <i>et al.</i> ⁽⁵⁹⁾
Child protection	Stunting* Thinness*	<ul style="list-style-type: none"> • Can reach large segments of the population • Potential to affect nutrition in the long term as it likely reduces school dropouts • Potentially targets intergenerational cycle of undernutrition 	<ul style="list-style-type: none"> • Difficult to implement and see effects over a short period of time 	<ul style="list-style-type: none"> • UNICEF recently piloted the Roots Program in South Sulawesi and Central Java, which aims to reduce school bullying • Indonesia has implemented several programmes to reduce child labour, including the Roadmap Toward a Child Labour-Free Indonesia in 2022 	<ul style="list-style-type: none"> • No evidence of impact on nutritional status among adolescents 	Baird <i>et al.</i> ^(57,58) ; Paluck <i>et al.</i> ⁽⁶⁷⁾ ; Malhotra <i>et al.</i> ⁽⁶⁶⁾ ; International Labour Organization ⁽⁷¹⁾

*Based on the 2007 WHO reference for children 5–19 years of age, stunting is defined as height-for-age Z-score < -2; thinness is defined as BMI-for-age Z-score < -2; and overweight/obesity is defined as BMI-for-age Z-score > 1.

†Anaemia is defined as defined as Hb < 12.0 g/dl for non-pregnant girls, Hb < 11.0 g/dl for pregnant girls and Hb < 13.0 g/dl for boys.

using technology-based platforms, such as social media, to deliver nutrition-based messages is a promising strategy in LMIC given the widespread use of smartphones⁽³⁸⁾. Prior studies indicated that technology-based platforms would be a feasible and effective way to reach both younger and older adolescent girls and boys^(35,39,40). The Global Alliance for Improved Nutrition (GAIN) recently began piloting a social media campaign to target urban girls aged 16–19 years in Indonesia. During the 3-month pilot phase, more than 80 000 users logged on to view nutrition-related content and were particularly interested in content related to fat, sugar and salt consumption (R Menon and EK Sari, personal communication, 2017). The social media campaign has not yet been evaluated for its impacts on diet or nutritional indicators.

Fortified foods. We did not identify evidence on the effectiveness of food fortification on adolescents' nutritional status in Indonesia. But fortification is one the most cost-effective strategies to reach large segments of the population, which does include adolescents⁽⁴¹⁾. Furthermore, data from the USA indicate that fortified foods are a major contributor to micronutrient intake in children and adolescents⁽⁴²⁾. In Indonesia, salt is fortified with iodine, and in 2003 the Ministry of Trade mandated the fortification of flour with iron, zinc, thiamin, riboflavin and folic acid. However, flour is not a staple food and thus fortification of flour with iron remains less effective at reducing anaemia. In 2015, Indonesia adopted mandatory fortification of vegetable oil with vitamin A, which was shown to effectively improve vitamin A status in a pilot study⁽⁴³⁾.

Energy balance supplementation. Balanced energy and protein (BEP) has not been implemented at scale and there is no evidence that BEP at the time of puberty affects linear growth⁽⁴⁴⁾. But the potential benefits of increasing energy and protein intakes via BEP include weight gain among thin adolescents, particularly married adolescent girls for whom becoming pregnant is likely, and improved micronutrient status. We did not find peer-reviewed or programmatic evidence on BEP targeting adolescents in Indonesia. However, in India, adolescent girls are provided BEP supplementation using micronutrient-fortified grains or flour as a midday meal in school under the National Food Security Act. Out-of-school adolescent girls are also eligible to receive daily supplementary foods through alternative programming in India⁽⁴⁵⁾. This programme is not implemented at scale in India and, to our knowledge, has not been evaluated for its impacts on thinness.

Energy balance to prevent overweight. There is limited evidence on the effectiveness of interventions that are designed to prevent overweight among adolescents. One systematic review, which contained studies from low-, middle- and high-income countries, reported that among adolescents 11–19 years old, BMI marginally decreased when interventions included both diet (e.g. integrating nutrition messaging into the current curriculum, parent- and peer-led nutrition education) and physical activity

(e.g. encouraging additional sport and play activities outside school, integrating short activity breaks into the classroom)^(17,46). Physical activity or diet alone did not have a significant effect on BMI reduction and school-based delivery strategies were more effective than interventions in non-educational settings^(17,46). Currently, there are no programmes in Indonesia that focus on energy balance to mitigate unhealthful weight gain among adolescents.

Nutrition-sensitive

The Lancet Framework outlines a number of nutrition-sensitive actions designed to achieve optimal nutrition⁽³⁾. Moreover, Christian and Smith highlight the fact that structural determinants, such as cultural norms, education and income, influence adolescent health⁽²⁾. Several nutrition-sensitive programmes have been implemented in Indonesia; however, none have been evaluated in relation to nutrition outcomes.

Health interventions

Reproductive health and HIV. As outlined in the 2013 Lancet Framework⁽³⁾, health and family planning services are important nutrition-sensitive interventions to promote optimal nutrition, as adolescent pregnancy holds implications for the nutritional status, health and education of both the adolescent girl herself and her offspring. For example, adolescents who become pregnant have hindered growth and are at higher risk for under-nutrition⁽⁴⁷⁾ and infants born to mothers living with HIV have poorer growth and higher morbidity and mortality than children who are born to mothers not infected with HIV⁽⁴⁸⁾. Additionally, adolescents with HIV/AIDS are at increased risk of malnutrition⁽⁴⁹⁾. Yet, in Indonesia, knowledge is limited, as only 4% of adolescent girls and 9% of adolescent boys aged 15–19 years have comprehensive knowledge of HIV⁽⁵⁰⁾. Furthermore, data from Demographic and Health Surveys suggest that only 50% of adolescents aged 15–19 years report using contraception.

Access to reproductive health education and contraception is limited among non-married adolescents in Indonesia due to cultural norms. In Jakarta, there are several non-governmental organizations that provide education and information services that aim to meet adolescent reproductive health needs; however, historically many of these programmes solely promote abstinence⁽⁵¹⁾. Pelayanan Kesehatan Peduli Remaja (Adolescent Health Care Services) provides reproductive health education through the health centres. Initiated in 2003, this programme aims to increase the knowledge and skills of adolescents related to reproductive health and healthy lifestyles, in addition to providing quality health care. Services are additionally provided at schools, in the community and through peer counsellors to ensure optimal coverage. Pelayanan

Kesehatan Peduli Remaja has not been evaluated in relation to nutrition outcomes.

Social safety-nets

Prior observational studies have documented associations between economic resources and indicators of nutritional status among adolescents in Indonesia⁽⁵²⁾. Social safety-nets, such as universal health coverage, cash transfers and microfinance initiatives, are designed to increase economic resources among vulnerable populations. In January 2014, Indonesia launched Jaminan Kesehatan Nasional (National Health Insurance), a universal national health insurance system that will provide basic care to all by 2019 (which should reduce out-of-pocket expenses). Although not specifically targeting adolescents, presumably more adolescents will be covered under Jaminan Kesehatan Nasional. Therefore, reaching adolescents through health centres is likely to become a very feasible mechanism for improving adolescents' reproductive health and nutritional status.

Cash transfer and microfinance interventions often target women as the main beneficiary as a way of alleviating poverty and improving the nutritional status of the household^(53–55). A study of unconditional cash transfers to parents of children and adolescents in Kenya observed positive effects on children's and adolescents' school attendance, compared with non-participating households⁽⁵⁶⁾. Similarly, in Malawi, school-aged adolescent girls (aged 13–22 years) who received either conditional or unconditional cash transfers in the amount of \$5–15 per month, as well as coverage of secondary school fees, had 43% lower school dropout rates^(57,58). Results also suggested that the unconditional cash transfer delayed early marriage among adolescent girls. Additional evidence of cash transfers or microfinance schemes explicitly targeting adolescents was not found, nor was there evidence that cash transfers affect indicators of nutritional status among adolescents.

Education

A recent review of economic and sociocultural determinants of adolescent nutrition suggested that at the community level, the consequences of adolescent undernutrition were largely related to education and cognition⁽⁵⁹⁾. Increasing the educational attainment of adolescent girls and boys beyond primary school is critical for at least two reasons: (i) education reduces wealth inequality, which is linked to improved longer-term health and nutrition⁽⁶⁰⁾; and (ii) quality education is one strategy to delay the age at which adolescents get married and begin bearing children. Although not formally tested, several pathways of this association have been suggested for women, but are broadly applicable to adolescents, including: schooling may transmit information about health and nutrition directly and schooling may expose individuals to more prosocial nutrition ideas⁽⁶⁰⁾.

There has been rapid growth in primary and junior secondary education enrolment in Indonesia. In 2015–2016 there were 3·4 million new entrants enrolled in junior secondary school, and 1·64 million girls and 1·62 million boys graduating from junior secondary school⁽⁶¹⁾. In senior secondary school, there were 3·1 million new entrants and 1·60 million boys (56%) and 1·25 million girls (44%) graduating⁽⁶¹⁾. However, low-income families in Indonesia cannot always keep their children in school due to the high costs. Fee waivers and Universal Child Grants have been suggested as one way to increase adolescents' educational attainment. Additionally, the One Roof School Programme, implemented in Indonesia in 2005, combines primary and junior secondary education in one location, aiming to increase access for students in remote rural areas. Studies in 2011 and 2013 demonstrated modest evidence of secondary education retention, but neither study evaluated the programme's impact on nutritional indicators⁽⁶²⁾.

Among adolescent girls, inadequate water, sanitation and hygiene facilities to appropriately manage menstruation reduce their participation in school further and can lead girls to drop out of school all together. One in six adolescent girls in Indonesia has missed one or more days of school during their last menstruation⁽⁶³⁾. As a way to promote school retention, UNICEF Indonesia has initiated a pilot to promote menstruation hygiene management (MHM) using an interactive comic book for adolescents in selected districts. Data suggest that the programme has increased MHM knowledge among adolescent girls and boys, but the programme has not been evaluated for health impacts⁽⁶³⁾.

Vocational training and employment

A number of employment initiatives have emerged with the aim of enhancing adolescents' economic opportunities to improve health and alleviate poverty in LMIC (e.g. World Bank Adolescent Girls Initiative). Interest in increasing vocational training of both girls and boys is also on the rise in Indonesia. Approximately 7·5% of students in Indonesia are enrolled in vocational school and the Government of Indonesia has demonstrated a commitment to improving the quality of vocational education. The Vocational Education Strengthening Project (INVEST) aims to expand access to quality vocational education and improve its relevance to changing labour market demand. INVEST model schools have integrated girls and boys equally in all training activities and female participation has increased over the project period⁽⁶⁴⁾.

Child protection

Postponing marriage

Approximately 12% of girls in Indonesia are married before 18 years of age^(1,65). Postponing age at marriage is important because pregnancy mostly occurs in a marital relationship in Indonesia⁽³⁵⁾. Programmes that (i) empower

girls with information, skills and support, (ii) educate and mobilize parents and community members, (iii) enhance the accessibility and quality of formal schooling for girls, (iv) offer economic support and incentives for girls and their families, and/or (v) foster an enabling legal and policy framework, have shown potential in delaying age of marriage⁽⁶⁶⁾. Interventions to postpone marriage in Indonesia were not identified; but a cash transfer linked with education was associated with a lower prevalence of early marriage among adolescents in sub-Saharan Africa^(57,58).

School bullying

The recent Global School Based Student Health Survey in Indonesia reported that 21% of students aged 13–17 years are bullied. Bullying may adversely impact the health and welfare of adolescents and, if persistent, reduce school attendance and subsequently impact health. UNICEF recently adapted and piloted the Roots Program in South Sulawesi and Central Java, where students were tasked with spreading positive social norms throughout their social networks by demonstrating positive behaviour and rewarding positive behaviour of others⁽⁶⁷⁾. Roots has been implemented globally and demonstrated results in reducing school violence at a low cost, which would be expected to increase retention⁽⁶⁷⁾. However, the effect of the programme on nutritional status has not been tested.

Child labour

Agriculture-based labour is disruptive to the schooling of adolescents and evidence among women of reproductive age suggests that formalized employment is associated with weight in LMIC⁽⁶⁸⁾. Data from the 2013 Indonesian Child Profile indicated that there are 3·6 million working children aged 10 to 17 years⁽⁶⁹⁾. Child labour is found predominantly in rural areas, where 12·5% of adolescents are working compared with 5·9% in urban areas⁽⁶⁹⁾. A majority of working adolescents are engaged in agriculture-based labour, which is somewhat driven by the booming demand for palm oil worldwide⁽⁷⁰⁾.

Indonesia has made moderate advancements in efforts to eliminate child labour via the implementation of several social safety-nets that provide additional income to disincentivize youth from becoming employed (e.g. Program Keluarga Harapan (conditional cash transfer programme)). Additionally, policy-level approaches have also been implemented. One recent example includes the Roadmap Toward a Child Labour-Free Indonesia in 2022 (2014–2022), which aims to establish child labour-free zones⁽⁷¹⁾.

Discussion

Limited evidence is available on successful adolescent-specific intervention approaches that target stunting, thinness, overweight and/or anaemia, and relatively little

is known about the nutrition promotion needs of adolescents⁽³⁵⁾. Although the current review was comprehensive, and we aimed to triangulate findings by examining multiple data sources, findings should be interpreted while bearing in mind some of the limitations of our analysis. First, our review of the literature was not systematic; as such, the summary findings are subject to bias. There is virtually no evidence on the effectiveness of nutrition-sensitive interventions on adolescent nutrition. The articles included in the review were reviewed by only one author (V.M.O.). Programme documentation is often not available after implementation ends; therefore, our review may not capture all insights from some ongoing programmes. Finally, the review may have limited generalizability beyond Indonesia. Nevertheless, several of the aforementioned interventions discussed represent promising mechanisms for improving adolescents' nutritional status in Indonesia. Enhanced nutritional status of adolescent girls and boys in Indonesia will require effective nutrition-specific interventions paired with large-scale nutrition-sensitive programmes that address key underlying determinants of nutritional status.

Nutrition-specific

Our review of ongoing programmatic work globally suggests that IFA would likely be both an effective and a feasible means of reducing iron-deficiency anaemia among both school-going and out-of-school girls and boys in Indonesia. Key advantages of this approach include having scientific evidence specifically among adolescents and the delivery is feasible using various platforms. To scale up IFA supplementation in Indonesia it will be important to combine the distribution of supplements with nutrition education about micronutrient deficiencies and healthy eating behaviours, as adolescents' knowledge around nutrition is likely to be limited in Indonesia. For example, WHO reports that Indonesian adolescents associate 'good nutrition' with 'quantity of food'⁽⁷²⁾ and in a recent study conducted in West Java, adolescent girls cited that green leafy vegetables could prevent anaemia, but few knew that animal-source foods were also important in preventing anaemia⁽²⁷⁾. Combining the benefits of IFA supplementation with counselling has been shown to improve compliance rates in India, a similar setting, where IFA was distributed largely through the school system for school-going girls and through India's Integrated Child Development Services for out-of-school girls⁽²⁶⁾.

Moreover, coupling IFA with deworming programmes, which decrease parasitic load and improve Hb levels, has also been implemented in several LMIC⁽²⁶⁾ and should be considered. Additionally, our review suggests IFA distribution as part of routine antenatal care is an existing delivery mechanism that could be further utilized, as data from the Indonesia Demographic and Health Survey indicate that 66% of pregnant girls aged 15–19 years had

some antenatal care. IFA as part of routine antenatal care to pregnant adolescent girls should be paired with providing nutrition education to increase compliance. To reach married, non-pregnant adolescents and adolescents not attending school, particularly boys, it will be important to consider additional mechanisms for the distribution of IFA supplements.

Given the micronutrient-poor (trending on energy-dense) diet among adolescents in Indonesia, it is critical to consider interventions that focus on improving the diet of adolescents, in addition to interventions that provide micronutrient supplementation. While there is limited evidence on diet counselling among adolescents, it is the only intervention strategy identified that targets the dual burden of malnutrition and some evidence suggests that there is a 'readiness' to deliver nutrition education/diet counselling in Indonesia. For example, a recent qualitative study suggested that incorporating nutrition education, particularly practical skills, as a subject in the national curriculum or integrating nutrition education into extracurricular activities could be feasible in Indonesia⁽³⁵⁾, and school-based nutrition education is a promising mechanism of delivery given increased school enrolment in Indonesia. It may also be feasible to consider implementing nutrition standards to all food outlets and meals (e.g. restricting the sale of sugary beverages) and nutrition education be provided to staff. Such an approach has been implemented in Malaysia and Singapore. For example, in Singapore, the Healthy Meals in Schools Program organizes culinary and nutrition training for canteen vendors as well as culinary skills training to help staff prepare healthier meals. Concurrently, promoting the integration of physical education into the existing school structure or integrating short activity breaks into the classroom has been implemented both in high-income countries (e.g. Japan, Finland, Australia) and LMIC (e.g. Brazil, Mexico, Malaysia, Vietnam) and is a recommended approach, along with diet counselling/nutrition education outlined by the NOURISHING framework to promote healthy diets and reduce obesity^(17,46,73). All of these intervention strategies can draw on the existing Balanced Nutrition Guidelines (Pedoman Gizi Simbang)⁽⁷⁴⁾, which promote a diverse diet, as well as physical activity and personal hygiene.

It will also be important to consider additional approaches to improve the diet of out-of-school adolescents. In Indonesia, it would be feasible to deliver diet counselling via youth centres, if done so by peers⁽⁷⁵⁾. Providing nutrition education that is integrated within existing facilities, such health centres, should also be considered as a way to reach the out-of-school population, particularly in light of the recent implementation of universal health care. For example, screening BMI measurement, combined with a referral system for treatment, has been implemented in some East Asian contexts (e.g. Singapore's Trim and Fit Program). Policy-level approaches to improve diet and reduce overweight could also reach out-of-school

adolescents. Such approaches could include sugary beverage taxes, which have shown promise in LMIC⁽⁷⁶⁾. Finally, given the successful engagement of many adolescents during the pilot phase of a GAIN-led trial designed to improve the diet of urban adolescent girls (16–19 years old), using social media to provide diet counselling to adolescents in and out of school in Indonesia has potential for further trial.

While IFA and diet counselling are the most promising interventions identified, MMN supplementation and fortification could also be tailored to adolescents. Currently, there are no existing programmes in Indonesia distributing MMN supplements to adolescents, but as noted above, two studies from Kenya indicated that daily MMN supplementation paired with multi-helminth therapy is a promising approach to reducing anaemia among adolescents^(30,31). MMN supplementation in Indonesia may also be feasible via school-, health centre- and youth centre-based delivery platforms and its potential to address concurrent micronutrient deficiency is a key advantage. Furthermore, if delivered pre-conception, MMN supplementation potentially targets the intergenerational cycle of undernutrition. Notably, there is evidence of an additional benefit of MMN supplements containing thirteen to fifteen different micronutrients over IFA for birth outcomes^(77,78). Although the WHO does not universally recommend MMN supplementation for pregnant women, new evidence from a robust meta-analysis stands to challenge that recommendation⁽⁷⁸⁾. Fortified products also offer a possible solution to certain micronutrient deficiencies (e.g. folate) among adolescents. However, it is important to exercise caution in fortifying sugar, salt and palm oil, often suitable products for fortification, because they could put adolescents at increased risk of overweight if consumed liberally.

Nutrition-sensitive

Limited knowledge and cultural norms are barriers to reproductive health in Indonesia. Relatedly, delaying age at marriage and first pregnancy may be the most critical nutrition-sensitive intervention, as delaying pregnancy may prevent the intergenerational cycle of undernutrition. Interventions related to reproductive health and/or postponing marriage in Indonesia were not identified and are also difficult to implement in practice, because of engrained cultural norms in Indonesia. But it is plausible that additional exposure to culturally appropriate messages and outreach programmes may help to increase knowledge of reproductive health and contraception use, and once married and pregnant, to optimize the duration of individuals' inter-pregnancy timing, which would reduce the risk of adverse birth outcomes^(79,80).

There is also the potential to improve the coverage of interventions designed to increase school attendance. As demonstrated during the pilot phase in Indonesia, interventions which provide MHM and aim to reduce

school-based bullying may be a relatively low-cost way to promote continued attendance in secondary school among adolescents in Indonesia. However, the impact of MHM on nutrition indicators among adolescents is unclear.

Cash transfer programmes (both conditional and unconditional) and microfinance schemes are implemented widely in LMIC and could be useful for targeting the most vulnerable, low-income adolescents, especially those who may not be easy to reach through more traditional delivery platforms (e.g. schools). Frequent check-ins with adolescents as part of conditional cash transfers or microfinance interventions may be a complementary way to increase access to nutrition services, and several conditional cash transfers have been shown to increase school attendance and retention, and improve nutritional outcomes in Latin America and sub-Saharan Africa^(57,81). However, like all the nutrition-sensitive interventions we have identified, the impact on adolescents' nutrition outcomes is unclear, as prior associations between cash transfers and nutritional outcomes have largely been explored among children⁽⁸²⁾ and some have yielded unintended consequences. For example, the evaluation of Oportunidades in Mexico reported that cash transfers increased overweight risk among the adult women⁽⁸³⁾. Ultimately, cash transfer programmes would need to be tailored to adolescents and the local context in Indonesia.

Conclusions

The lack of coverage of supplement-based interventions (e.g. IFA) and the suboptimal diet suggest that there is considerable potential to improve the nutritional status of Indonesian adolescents. Based on the strength of the evidence and ongoing programmatic work in Indonesia, the following nutrition-specific interventions could be considered as part of a 'minimum package' of interventions: (i) IFA supplements paired with antihelminths delivered at scale; and (ii) diet counselling and nutrition education. To reach both school-going and out-of-school girls and boys, IFA supplements should be delivered via school-based platforms as well as through health centres or community-based networks. Nutrition education should be tailored to the local context/diet and be provided through several mechanisms, including school-based platforms, adolescent youth centres/peer education and technology-based platforms (e.g. social media campaigns). The minimum package of interventions could also include the following nutrition-sensitive interventions: (i) improving access to contraception and to reproductive health services, aimed at delaying first pregnancy and improving knowledge related to reproductive health; and (ii) increasing the coverage of interventions that are designed to increase school attendance, such as MHM. For pregnant and postpartum adolescents, IFA supplements paired with

antihelminths should be provided through regular service delivery and pregnancy weight gain should be monitored.

Importantly, the minimum package of interventions should: reach both school-going and out-of-school adolescents; target both girls and boys, as appropriate; offer adolescent-friendly services for free; and be sustainable. Programmes that are not institutionalized, incorporated into budget lines and/or integrated into other programmes limit the sustainability of implementation at scale and over time⁽⁸⁴⁾. Services should also account for cultural and gender-specific barriers.

Finally, it is critical to invest in efforts to improve data on monitoring and evaluation to strengthen any programmes implemented for adolescents. To improve monitoring and surveillance, it may be possible to incorporate regular collection of anthropometric and Hb measurements into schools in Indonesia. There are few rigorous study designs evaluating adolescent programming and a paucity of data, particularly for programmes that are operating at scale. Having relevant and current data and information on this age group is essential both for tracking progress and stimulating additional investments in Indonesian adolescents in coming decades.

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